6th BACSA INTERNATIONAL CONFERENCE

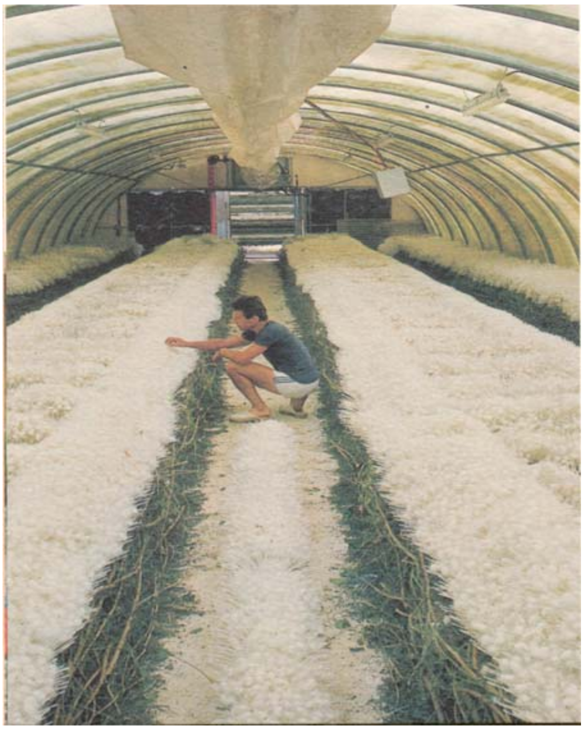
"Building Value Chains in Sericulture"

"BISERICA" 2013

Padua, Italy

April 7th – 12th 2013

P R O C E E D I N G S



of the scientific and technical reports

Black, Caspian Seas and Central Asia Silk Association (BACSA)

Council of Research and Experiments in Agriculture, Apiculture and Sericulture Unit of Bologna, Padua seat, Italy

Padua

2013

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6th BACSA INTERNATIONAL CONFERENCE

"Building Value Chains in Sericulture" ***BISERICA***

Padua, Italy

April 7th – 12th 2013

PROGRAMME

Venue and Dates:
Padua, Italy, San Marco Hotel, April 7th – 12th 2013
7 th April
Arrival of the participants, check in at San Marco Hotel and registration
8th April
8:45 – 9:15 Registration
9:15 – 9:25 Opening by Prof. Dr. P. Tzenov, President of BACSA
9:25 – 9:35 Welcoming speech by Dr. S. Cappellozza, Head of Padua seat of the Honey Bee and Silkworm Unit, (Bologna) Council of Research and Experiments in Agriculture (Rome)
I. Plenary papers session: Chairman Dr. Silvia Cappellozza
9:35 – 9:50 Plenary paper: *"The role of regional cooperation between BACSA member countries in building value chains in sericulture."* by Prof. Dr. P. Tzenov, President of BACSA and Dr. S. Cappellozza, CRAAPI
II. Value Chains in Sericulture Session Chairman Mr. Ueli Ramseier
9:50 – 10:10 *"Building value chains in sericulture – the Swiss experience"* by Mr. U. Ramseier, president of Swiss Silk Vereinigung Schweizer Seidenproduzenten
10:10 – 10:30 *"Role of basic researches in solving topical problems of sericulture and silk processing. Biotechnological aspects"* by Prof. Dr. Shukhrat Madyarov, Institute of Zoology, Uzbek Academy of Sciences
10:30 – 10:50 *"Development of sericulture chain value: from mulberry to designers in Argentina"* by Francisco Pescio et al. – Instituto Nacional de Tecnologia Agropecuaria – FAUBA
10:50 – 11:10 *"Cooperation to increase silk production in Latin America"* by João Berdu Garcia Jr, President of Instituto Vale da Seda and Marcelo Farid Pereira University of Maringa
II. Country reports session: Chairman Dr. Evripidis Kipriotis
11:10 – 3:00 Country reports session 1
11:10 – 11:25 *"Sericulture status, problems, issues and development strategies in Romania"* by Maria Ichim, Institute for Bioengineering,

Biotechnology and Environmental Protection
11:25 – 11:40 Coffee break
11:40 – 11:55 *"Current state in sericulture of Georgia. Problems and strategy of development"* by Magda Bagrationi et al., Agrarian University of Georgia, Scientific Research Institute of Sericulture
11:55 – 12:10 *"Sericulture status, problems, issues and development strategies in Bulgaria"* by Prof. Dr. Panomir Tzenov, Academy of Agricultural Sciences, Sericulture and Agriculture Experiment Station, Vratsa, Bulgaria
12:10 – 12:25 *"Country Report Switzerland 2013"* by Ueli Ramseier, Swiss Silk Vereinigung
Schweizer Seidenproduzenten
12:25 – 12:40 *"State of sericulture, problems, issues and strategy development in Ukraine"* by Nicholas Anatol Drobin, Chairman of the Board of the Corporation "Ukrainian silk"
12:40 – 13:00 *"Sericulture status, problems, issues and development strategies in Greece"* by Dr. Euripidis Kipriotis, National Agricultural Research Foundation (N.AG.RE.F.)
13:00 – 14:00 Lunch
14:00 – 16:00 Country reports session 2
14:00 – 14:15 *"The national strategy for the revival and development of sericulture in Tajikistan"* by Dr. Salimjonov Sanginjon, BACSA National Coordinator in Tajikistan
14:15 – 14:30 *"The sericulture in Turkey"* by Mr. Durmus Yilmaz, Kozabirlik Sericulture Cooperative
14:30 – 14:45 *"Status of sericulture industry, problems, issues and development strategies in the central asian countries: Kazakhstan, Kirghizstan Tajikistan, Turkmenistan and Uzbekistan"* by Prof. Dr. Homid ibn Soky HOMIDY, International Expert & Vicepresident
of BACSA in
region of the Central Asia
14:45 – 15:00 *"State of the art and prospects of development sericulture in Uzbekistan"* by Dr. Shukhrat Madyarov, Institute of Zoology, Uzbek Academy of Sciences and Dr Sh.R. Umarov
15:00 – 15:15 *"New possibilities of sericulture development in Poland"* by Dr. Małgorzata Łochyńska, Institute of Natural Fibres and Medicinal Plants, Poznan, Poland
15:15 – 15:30 *"The present status and future of sericulture industry in Korea"* by Dr. KangSun
Ryu et al., Department of Agricultural Biology,
National Academy of Agricultural Science
15:30 – 15:45 *"New progress in the research on sericulture resource utility"* by prof. Liu Jiping, College of Animal Science, South China Agricultural University, Regional Sericulture Training Centre for the AsiaPacific
15:45 – 16:00 *"National Sericulture Centre (NSC), MINAGRI, RWANDA"* by Pontiano Sebba Nemeyee & Sohn Wookee, NATIONAL SERICULTURE CENTRE (NSC), MINAGRI, RWANDA
Scientific – technical reports session – Oral presentations:

Chairman Prof. Gianluca Tettamanti

SECTION 1. MORICULTURE AND NONMULBERRY FOOD PLANTS FOR SERICIGENOUS INSECTS: SELECTION, PROPAGATION AND CULTIVATION

16:00 – 16:15 *"Screening of mulberry genotypes for alkali tolerance An integrated approach"* by Dr. Sathyanarayana Kutala, Central Silk Board, Ministry of Textiles, and T. Mogili

SECTION 2: SILKWORM GENETICS AND BREEDING

16:15 – 16:30 *"Building value chains in sericulture: the nutritional analysis of Bombyx mori pure strain. Artificial diet as a tool to obtain new silkworm hybrid constitution"* by Dr. Alessio Saviane et al., CRAAPI

16:30 – 16:45 *"Passport data of six Bulgarian strains of silkworm Bombyx mori L. on the base of population genetic parameters"* by Prof.Teodora Staykova et al., Plodviv University

16:45 – 17:00 *"Identification of molecular markers (SSR) associated with thermo tolerance in silkworm Bombyx mori"* by Dr. S.M. Moorthy et al., Central Sericultural Research and Training Institute, Central Silk Board

SECTION 3: SILKWORM EGG PRODUCTION

SECTION 4. SILKWORM REARING AND FEEDING

SECTION 5: SILK REELING AND PROCESSING

17:00 – 17:15 Coffee break

17:15 – 17:30 *"Silk "quality" revealed using Dynamic Mechanical Thermal Analysis (DMTA)"* by Juan GUAN et al., Oxford silk group, Department of Zoology, University of Oxford

SECTION 6: SILKWORM PATHOLOGY

17.30 – 17.45 *"Horizontal transmission of Nosema bombycis infection on rearing parameters of silkworm Bombyx mori L."* by Dr. Bhaskar R.N. et al., UAS, Bangalore

SECTION 7: SILKWORMS AS BIOLOGICAL MODELS

17:45 – 18:00 *"Development of silkworm (Bombyx mori) as a platform for producing biomaterials and growth factors for tissue engineering"* by Dr. J.L. Cenis et al., Instituto Murciano de Investigación y Desarrollo Agrario y Alimentario (IMIDA)

18:00 – 18:15 *"Development of new methods for long term preservation of silkworm bioresources"* by prof. Yutaka Banno et al., Institute of genetic resources, Kyusyu University, Fukuoka

SECTION 8: POSSIBILITIES FOR USING SILKWORM AND MULBERRY FOR NON TEXTILE PURPOSES

18:15 – 18:30 *"The role of science in building value chains for sericulture: the silkworm as food for pet animals"* by Dr. Ludovica Toso, CRAAPI,
Padova

SECTION 9: ECONOMY: DOMESTIC AND INTERNATIONAL MARKETS, PRICES, TRADING, ECONOMIC ANALYSES OF PROJECTS ETC.

18:30 – 18:45 *"Sustainable design in bridalwear sector: proposal for reuse of local silk fabrics in bridalwear"* by prof. Elvan O. Adanır et al., Izmir University Of Economics, Turkey

18:45 – 19:00 *"Life cycle analysis of embodied energy on sericulture in Karnataka India"* by Gunnar Thalwitz et al., Department of Zoology, University of Oxford
19:00 – 19:15 *"Sericultural extension system in China"* by Li Long et al., Chinese Academy of Agricultural Sciences
20:00 Welcoming Dinner
9th April
8:30 – 9 Leaving from the hotel to CRA Honey bee and Silkworm Unit of Bologna, Padua seat
9:30 Arrival at the Institute: visit to the Institute and the Museum of living insects "Esapolis" in two groups
13:00 Lunch at a nearby restaurant
14:30 Presentation of the Institute activities (by Dr. S. Cappellozza)
15:00 presentation byDr. C. Cappelletti: activity if InnovHub – Silk Experimental Station
15:30 Presentation by Dr. E. Moretto: activity of the Museum with regard to different entomological fields
16:00 Presentation by Ms. Roy on ISC and multi – institute wisw collaborative research programmes
16:30 discussion about the possible relationships between ISC and BACSA countries
17:**30** ***Poster session***
18:30 – 19:00 Leaving the MUseum and Institute
20:00 Dinner at the hotel
10th April
7:00 Departure to Como
11:00 For BACSA delegates: visit to Ratti silk industries – Guanzate (Como); For all the other partecipants: visit to the Silk Museum of Como and city centre
13:00 For BACSA delegates: lunch at Ratti; for all the other partecipants: lunch in the city along the lake
14:30 For BACSA delegates: meeting with Ratti's management; for all the other partecipants: visit to the silk weaving factory "Successori Cattaneo" in Albese Concassano (Como)
16:30 For both groups: shopping at the Ratti's factory shop
17:30 Departure to Padua
21:30 Dinner: Italian Pizza **in Monteortone (Padua)**
11th April
9:00 Departure from the Hotel
9:30 Guided visit to the city centre of Padua
12:30 Lunch in the city centre
13:30 Visit to S. Antony Church, S. Justine Church, Prato della Valle and the Ancient Botanical Garden
18:30 Departure to the hotel
20:00 Farewell dinner
12 th April
9:00 – 10:00 Round table discussion: Chairman Prof. Dr. P. Tzenov
10:00 – 10:30 Coffee break.
10:30 – 11:00 BACSA Executive committee meeting

11:00 – 12:00 Conclusion of the conference
12:30 – 13:30 Lunch
14:00 Facultative guided tour to Venice or departure

Opening Speech

By

Prof. Dr. Panomir Tzenov, President, Black, Caspian Seas and Central Asia Silk Association (BACSA)

6th BACSA INTERNATIONAL CONFERENCE

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Ladies and gentlemen, Sericulturists and Distinguished delegates,

It is a privilege and an honor to meet all of you here and I am very pleased to be in the company of fellow sericulturists in this important gathering for the purpose of sharing information and experiences in world sericulture development.

I would also like to express my gratitude to the Council of Research and Experiments in Agriculture, Apiculture and Sericulture Unit of Bologna, Padua seat, Italy and to Dr Silvia Cappellozza personally for their tremendous efforts in organizing the present conference.

You will recall that in the early 1990s, some companies from China and some other East Asian countries damaged the image of silk with the mass production of low quality silk fabrics and wide circulation of the low quality products in the world markets. By the same time the manufacture of super fine synthetic fibers and the improved quality of other natural fibers increased their competitiveness at the market. This "strike" on the World sericultural industries led to a long period of too low silk prices, which reflected in destroy of parts or even whole sericultural value chains in many countries.

The fluctuation of silk price and unstable supply of high quality silk have impacted negatively on silk industry promotion particularly in Europe which led many silk-fabrics and silk garments manufacturing private companies to shift their major products from silk to other synthetic fibers or close.

In the recent years however the raw silk price went up, reaching over US$ 55/kg which gave optimistic expectations for cocoon production revival in many countries whose sericulture activities had been declining dramatically during the previous two decades.

The Black, Caspian Seas and Central Asia Silk Association now associates 17 countries from Europe, Caucasus and Central Asia. In most of them the sericulture has been very negatively affected during the past 20 years, in some countries any detectable sericultural activity has even stopped. Fortunately enough the research potential, even reduced and the germplasm resources have been saved in most of the member countries.

At present the trend for World silk prices increase, the availability of European and national subsidies, long tradition and farmer's experience, the need of European silk industry of raw materials etc. give some new opportunities for the regional sericulture revival.

In this respect the sericulture value chains building is of a crucial importance, as some parts of them have been partly or completely broken in some of the BACSA member states.

Our analyses made manifested that the non working or partly working sericulture value chains parts in most of BACSA countries are the raw materials production, which includes mulberry saplings, silkworm eggs, cocoon production, processing and silk reeling. Therefore the regional coopertaion priorities should be directed mostly in these parts of value chain.

Believing that the work of the present international meeting will be successful and useful for the regional and world sericulture industry development I open the International conference **"Building Value Chains in Sericulture" - "BISERICA" 2013**

Thank you very much for your kind attention!

6th BACSA INTERNATIONAL CONFERENCE

"Building Value Chains in Sericulture"
BISERICA

Padua, Italy

April 7th – 12th 2013

LIST OF PARTICIPANTS

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6th BACSA INTERNATIONAL CONFERENCE

"Building Value Chains in Sericulture" ***BISERICA***

Padua, Italy

April 7th – 12th 2013

AGENDAS FOR THE PANEL DISCUSSIONS

AGENDA

For

the expert panelists' discussions within the 6th BACSA international conference "Building Value Chains in Sericulture" – BISERICA, Padua, Italy, 7th to 12th April 2013.

12 April 2013, Padua, Italy

9:00 – 10:00 **Round table discussions**

Chairperson: Prof. Dr P. Tzenov

Facilitator: Dr S. Cappellozza

Opening: Prof. Dr P. Tzenov

Topics of the discussion:

- Present World raw silk prices, their trend and influence on the sericulture revival and development.
- Problems, issues and development strategies of sericulture to involve the industry in the silk production chain by investing in the agricultural process.
- Problems, issues and development strategies to redistribute the income of the final product at the different steps of the production chain.

- Problems, issues and development strategies of Global silkworm and mulberry germplasm preservation, conservation, utilization and exchange.

- Suggestions for conference decisions, recommendations and follow ups.

AGENDA

For

BACSA Executive committee and member countries participants discussions within the 6th BACSA international conference "Building Value Chains in Sericulture" – BISERICA, Padova, Italy, 7th to 12th April 2013.

12 April 2013, Padova, Italy

10:30 – 11:30 **Round table discussions**

Chairperson: Prof. Dr P. Tzenov

Facilitator: Dr S. Cappellozza

Opening: Prof. Dr P. Tzenov

Topics of the discussion:

- Coordination and cooperation among the different BACSA countries: National or regional sericulture value chains?; Wishes and capabilities; Competition or collaboration? How the regional cooperation may help an integration process?

- The role of the EC in developing sericulture in the EC and neighboring countries: CAP (Common Agricultural Policy) for farmers and Horizon 2020 (Research and Innovation).

- Is the current European economic crisis a challenge to revival sericulture activities?

6th BACSA INTERNATIONAL CONFERENCE

"Building Value Chains in Sericulture"
BISERICA

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April 7th – 12th 2013

PLENARY PAPER

THE ROLE OF REGIONAL COOPERATION BETWEEN BACSA MEMBER COUNTRIES IN BUILDING VALUE CHAINS IN SERICULTURE

By

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1. Introduction.

Until the beginning of 90s of the last century the BACSA region had an annual fresh cocoon production of around 50,000 tons, occupied the third place in the world after China and India and nearly one million farmer's households were engaged with the sericulture. The Central Asian region, including Uzbekistan, Tajikistan, Turkmenistan and Iran still is a big cocoon and silk producer, engaging in this industry more than 450,000 farmer's households, while in Europe and Caucasus the sericulture activities considerably declined. In fact the BACSA member countries have many problems and issues in their sericulture revival and development which could be partly or completely solved by the help of regional cooperation between them. Such problems and issues are the access to the EU funds for research, specializations and training of students and technical personnel, exchange of sericulture germplasm resources and improvement of the mulberry sapling and silkworm egg quality, saving the sericulture germplasm in the BACSA region, increase of silkworm egg production or its revival in some of the member countries, supply of mulberry saplings of high productivity and well adapted to the local conditions varieties and high quality silkworm eggs, solving the problems of cocoon and silk marketing, improvement of the raw silk quality and increase of the share of raw silk export or local processing, small niche textile production of cocoons and silk and silk handcrafts production development. Two associated in BACSA countries - Italy and Switzerland silk industries are demanding high quality silk in addition to a high quantity of silk, but the Chinese market is constantly decreasing its quality, while increasing the prices recently. For this reason, Italian silk industry may re-consider to establish part of cocoon production in Europe and/or Central Asia. The BACSA member states which produce silk carpets such as Iran and Turkey are also comparatively big raw silk importers as the local silk production is not able to satisfy the silk carpet needs of raw material. By the same time presently some of BACSA countries do not have any own silkworm egg production and in some of the Central Asian countries the quality of presently locally produced silkworm eggs does not meet the international standards and their quantity can not satisfy the local needs. Therefore the basic aims of expansion of BACSA inter – regional cooperation are to transmit sericulture germplasms, silkworm eggs, advanced technologies, training, dry cocoons, raw silk and silk allied products.

2. Present situation and possibilities of the regional cooperation between BACSA member countries.

<u>Basic principles of BACSA regional cooperation:</u>

- **BACSA – non profit and non governmental organization, fully independent financially, politically and institutionally from any national governments, international organizations, other NGOs, political parties, private businesses, syndicates and physical persons;**
- **Voluntary work at personal and institutional level for the benefit of regional sericulture revival and development;**
- **Without any commitments with political parties and syndicates;**
- **Leading role of the experts, especially researchers, NGOs and the business - private and state;**
- **Everybody should help to the weakest;**
- **The regional sericulture cooperation participants to have mutual benefit and satisfaction;**
- **Giving priority to the regional sericulture partners and products;**
- **Looking for any possible financing for the regional and national sericulture revival and development;**
- **Permanent monitoring on the EU and national subsidies for sericulture and making efforts in convincing EU and the governments for giving as higher as possible subsidies;**
- **Regional sericulture germplasm preservation, development and utilization;**
- **Priority in restoring the cocoon and raw silk production in the region countries and solving their market problems as the first key steps in sericulture revival;**
- **Priority in improving the "basis" of regional sericulture, such as research, training, technology transfer, supply with mulberry saplings, silkworm eggs and raw materials, such as dry cocoons, raw silk, thrown silk and gray silk fabrics;**
- **Priority in increase of the country's share of final sericulture products export and decrease the share of raw materials export;**
- **Priority in development of small niche textile and silk handcrafts production;**
- **Priority in development of using the sericulture products for non-textile purposes;**
- **Promoting the sericulture as an organic production and the BACSA region silk produced as non polluted and eco friendly;**
- **Promoting the BACSA member countries capacity in expertise, science, sericulture germplasm resources, silkworm egg, silk and silk allied products export;**
- **Creating regional sericulture value chains on the basis of mutual interest.**
- **Associating in BACSA all European and Central Asian countries and also some**

Mediterranean countries having or intending to revive/develop sericultural industries.

The value chain of sericulture includes the following steps:

- science, education and training;
- sericulture germplasm maintenance, development and utilization;
- mulberry saplings production and marketing;
- silkworm eggs production and marketing;
- silkworm rearing, fresh cocoon production and marketing;
- primary cocoon processing and marketing;
- silk reeling, winding, doubling and twisting;
- silk processing to fabrics and garments;
- silk products marketing.

Unfortunately some parts of the sericulture value chain have been partly or completely broken in the BACSA member countries. Presently the situation is as follows:

Country	Parts of the sericulture value chain broken
Albania	science, education and training, sericulture germplasm maintenance, development and utilization, mulberry saplings production, silkworm eggs production, silkworm rearing and cocoon production, primary cocoon processing, silk reeling, winding, doubling and twisting, silk processing to fabrics and garments, silk products marketing
Armenia	sericulture germplasm maintenance, development and utilization, mulberry saplings production, silkworm eggs production, silkworm rearing and cocoon production, primary cocoon processing, silk reeling, winding, doubling and twisting, silk processing to fabrics and garments, silk products marketing
Azerbaijan	silkworm eggs production (partly), silkworm rearing and cocoon production (partly)
Bulgaria	silkworm rearing and cocoon production (partly), primary cocoon processing (partly), silk reeling (partly), silk processing to fabrics and garments, silk products marketing (partly)
Georgia	mulberry saplings production (partly), silkworm eggs production, silkworm rearing and cocoon production, primary cocoon processing, silk reeling, winding, doubling and twisting, silk processing to fabrics and garments, silk products marketing
Germany	education and training, sericulture germplasm maintenance, development and utilization, mulberry saplings production, silkworm eggs production, silkworm rearing and cocoon production, primary cocoon processing, silk reeling
Greece	mulberry saplings production, silkworm eggs production, primary cocoon processing (partly), silk reeling (partly)
Iran	silkworm eggs production (partly)
Italy	mulberry saplings production, silkworm eggs production (partly), silkworm rearing and cocoon production (partly), primary cocoon processing (partly), silk reeling
Kazakhstan	science, education and training, sericulture germplasm maintenance, development and utilization, silkworm eggs production, silkworm rearing and cocoon production (partly), primary cocoon processing, silk reeling, winding, doubling and twisting, silk processing to fabrics and garments, silk products marketing
Poland	sericulture germplasm maintenance, development and utilization, mulberry saplings production, silkworm eggs production, silkworm rearing and cocoon

	production, primary cocoon processing, silk reeling, winding, doubling and twisting, silk processing to fabrics and garments, silk products marketing
Romania	mulberry saplings production, silkworm eggs production, silkworm rearing and cocoon production (partly), primary cocoon processing (partly), silk reeling, silk products marketing (partly)
Switzerland	Science and education, sericulture germplasm maintenance, development and utilization, mulberry saplings production, silkworm eggs production, silkworm rearing and cocoon production, primary cocoon processing, silk reeling
Tajikistan	silkworm eggs production (partly), silk processing to fabrics and garments (partly), silk products marketing (partly)
Turkey	silk reeling (partly)
Ukraine	silkworm rearing and cocoon production, primary cocoon processing, silk reeling, winding, doubling and twisting, silk processing to fabrics and garments, silk products marketing
Uzbekistan	silkworm eggs production (partly), silk processing to fabrics and garments (partly), silk products marketing (partly)

It is evident that in the most region countries the broken sericulture value chain parts do not coincide with the broken parts in the others, so it might be possible some of the problematic parts of the value chain in one country to be "repaired" by the help of other countries where the same part of the value chain is well working.
We believe that the regional cooperation between the BACSA member countries development is an important tool to "repair" some broken parts of the sericulture value chains. This cooperation will facilitate creation of regional value chains with participation of two or more countries as well.

2.1. Cooperation in the science and technology transfer, education and training.
So far the regional scientific cooperation is restricted to only bilateral projects for mainly exchange of mulberry varieties and silkworm breeds. The several joint project proposals, submitted to the EU programmes unfortunately have not been approved for financing. The exchange of students and specialists for training even already exists is still too weak. The cooperation in the science and technology transfer, education and training may develop in the following directions:
- bilateral research projects: they may be financed by the each participating country's government as the existing practice through grant competitions, announced periodically by the Ministries of education and sciences.
- bi and/or multilateral projects, financed by the EU: the initiative should be taken by the scientists/experts from BACSA countries which are EU members through forming consortiums and attracting as co – participants also researchers and experts from the non – EU BACSA countries.
- specializations and training of students and technical personnel in leading research centers and commercial companies, financed by EU/national programmes.

2.2. Mulberry saplings production and supply.
Of course the best way would be each country to self-supply with mulberry saplings, but it is not always possible. In fact almost all BACSA member countries have some own mulberry genetic resources available. However in some countries the mulberry genebank collections are bigger and they also have more productive and adaptable varieties. The richest mulberry genetic resources are in Azerbaijan (about 290 accessions), Uzbekistan (~220), Bulgaria (~150), Italy (~120), Ukraine (~110) and Georgia (~90). In some region countries however the mulberry sapling production costs are too high, in some countries there are no human capacity and facilities for sapling production, so they are forced to import saplings. It's'recommendable to

import mulberry saplings preferably from some neighboring countries because the varieties are well adapted to the similar climatic conditions and the transportation may be cheaper and easier. Mulberry sapling import from China or other far East countries is not recommended because of the following two main reasons:

- the mulberry varieties have been developed at much different climate, thus they hardly adapt to the BACSA countries conditions, especially to the too cold winter;
- the saplings are usually delivered by ship cargo for lower costs and because of the too high distance most of them are harmed during the transportation.
- we risk to import pest insects or diseases which are not typical of our countries.

Some BACSA member countries like Greece and Turkey had a bitter experience in importing mulberry saplings from China. In fact a big portion of the saplings dead during the ship transportation and a part of them dead later on because of their too low frost tolerance. Therefore the mulberry sapling import is too riskily and before importing huge quantities it's good to test for several years the foreign varieties performance under the local climatic, soil and agrotechnical conditions.

2.3. Silkworm egg production and supply.

Ideally it is the best if each country is able to satisfy by itself the silkworm egg needs. Unfortunately presently it is not possible in most of BACSA member sates. Silkworm genetic resources are not available in Albania, Armenia, Germany, Kazakhstan, Kyrgyzstan, Poland and Switzerland. The silkworm genetic resources available are comparatively small in Tajikistan, Turkey and Greece. The richest silkworm germplasms are maintained in Bulgaria (265 strains), Italy (~200), Uzbekistan (~180), Ukraine (~115), Azerbaijan (~90), Romania (~ 50) and Georgia (~50). Recently in some member countries like Ukraine, Georgia, Greece and Romania due to the bad managerial and financial status of maintaining institutions and lack of governmental support the silkworm germplasm resources are under a risk of destroy and lose. In this respect now the problem of silkworm germplasm preservation in the BACSA region is of a crucial importance. One of the solutions is the most valuable germplasms from countries where it is damaged of lose to be transported to other region countries for maintenance and preservation.

The quality of regional silkworm germplasm was evident from the results, obtained by the BACSA regional project "Comparative studies of silkworm hybrids performance for sericultural enterprise development in Black, Caspian seas and Central Asia region", implemented in 2006 and 2007 and partly supported by the FAO. From the testing as a general conclusion appeared that the silkworm hybrids, produced in BACSA member countries (Azerbaijan, Bulgaria, Italy, Turkey, Romania, Ukraine and Uzbekistan) had comparatively high hatchability, pupation rate, cocoon weight, shell weight and fresh cocoon yield by one box of silkworm eggs, but compared with the Japanese and Korean hybrids the local hybrids manifested lower cocoon shell ratio and raw silk percentage. Based on this conclusion it was recommended to the BACSA member countries research institutions to direct their efforts towards improvement the silk productivity of the hybrids, by the same time preserving their comparatively high survivability and cocoon yield. As results recently in Bulgaria, Romania, Uzbekistan and Azerbaijan several new silkworm hybrids, manifesting silk productivity, comparable with those of the Japanese hybrids were created. The project revealed also that the Chinese hybrid Bai Yun x Qin Feng tested performed worse compared with the local hybrids. Therefore presently definitely the best silkworm hybrids, produced in the BACSA region countries perform at the level of the best world standards.

The availability of silkworm genetic resources however is not enough to produce commercial eggs for the market. For an economically viable egg production also the availability of good pure lines as parents of the F_1 hybrids, qualified personnel, suitable facilities and costs of production, allowing to suggest reasonable prices are necessary. So due to those different reasons not all of BACSA member states are capable to produce their own silkworm eggs now. In the present time the only one commercial silkworm egg producers in Europe and Caucasus are Bulgaria, Turkey and Azerbaijan, while Italy has a very low silkworm egg production (around 250 boxes per

year). The rest countries like Albania, Armenia, Georgia, Germany, Greece, Switzerland, Poland, Romania and Ukraine if they are in need of commercial silkworm eggs they should import them. Unfortunately countries like Georgia, Romania and Ukraine who still have had commercial silkworm egg production several years ago now are not able to produce. In Central Asia, in Tajikistan, Turkmenistan and Uzbekistan the local silkworm egg production provides only about 55-70 % of the demand, and the remaining eggs are imported from China. The egg production situation is especially critical in Tajikistan where the import share is more than 70 %. The bad quality of silkworm eggs imported often causes considerable loses of cocoon crop. For example in 2011 in Tajikistan, the yield of fresh cocoons decreased to 10.3 kg/box only, due mainly to the bad silkworm eggs imported from China quality. According to some Greek farmers when they used to rear silkworm eggs, imported from China the fresh cocoon yield was as low as about 5 – 8 kg/box. On the other hand now Iran is able to satisfy the country's silkworm egg demand, but there are some problems with the silkworm egg quality in terms of diseases and stress tolerance.
Therefore it might be recommended to those who import silkworm eggs to increase the share of eggs, imported from BACSA member states. The silkworm egg import price of the Chinese eggs in Tajikistan, Turkmenistan and Uzbekistan is about 8 - 9 US$/box. At the same price even a bit lower price silkworm eggs may be imported also from Bulgaria for example. If the silkworm egg market is safe the egg production might be revived in some countries like Ukraine, Romania, Georgia and much increased in Azerbaijan and Bulgaria. If realized, this will increase the cocoon production in those countries and also would contribute to the general sericulture revival. For example the total silkworm egg import from China in Central Asian countries in 2012 was about 450000 boxes. If those eggs are produced in the BACSA member states, having this potential, around 200 tons of seed cocoons will be produced annually for the purpose and the total gross income would be about over 3.5 million US$.
Therefore one of the main roles of BACSA is to facilitate the silkworm egg trade among the region countries.
There is also an other option for the regional cooperation which may lead to silkworm egg quality and quantity improvement: this is the P_3, P_2 and P_1 silkworm egg categories to be produced in one country, but the F_1 eggs production to be in other country. In this scheme even also countries having good pure lines and qualified personnel, but too high labor and other costs may be involved. The upper categories of silkworm eggs are produced in not big volume, but the egg price is much higher than the F_1 eggs. Even though the P_1 egg price is higher than the F_1, the P_1 egg costs if they are imported will be much lower compared with the costs to maintain local facilities and personnel for the same purpose, but with doubtful egg quality produced.
Other option is a joint silkworm egg production between two neighboring countries where the different parts of egg production process are shared between the two countries according to their the best capabilities.

2.4. Dry cocoon marketing.

As in some of the BACSA member states the fresh and dry cocoons marketing is a real problem which limits the amount of production even stops any silkworm rearing, the regional cooperation in the dry cocoon and raw silk marketing is also very important. Presently there are no any or not in commercial operation silk reeling facilities in Albania, Armenia, Georgia, Germany, Greece, Italy, Kazakhstan, Poland, Romania and Ukraine. That means those countries either should send their cocoons to some other country for reeling or to process the cocoons without any reeling or to export dry cocoons. In some region countries like Turkey, Greece, Uzbekistan and Tajikistan even they have reeling facilities due to different reasons sometimes the dry cocoon export appeared to be more profitable than raw silk export. An option of the regional cooperation is the cocoons, produced in one country to be reeled in some neighboring country and the raw silk produced to be returned back. In the BACSA region presently it seems that only Iran and Azerbaijan import some dry cocoons, but at comparatively low prices like 7-9 US$/kg. Therefore the dry cocoon trade between the BACSA region countries is not very promising.

2.5. Raw silk marketing.

Presently the raw silk producers in the region are the following:
In Europe and Caucasus: Azerbaijan, Bulgaria and Turkey;
In Central Asia: Iran, Tajikistan, Turkmenistan and Uzbekistan.
The raw silk exporters from the region now are Tajikistan, Turkmenistan and Uzbekistan.
The raw silk importers from the BACSA member countries are Iran, Italy, Switzerland, Turkey, Greece, Romania and Bulgaria. Iran and Turkey use the raw silk mostly for silk carpets manufacture, thus the raw silk quality is not of so big importance.
As it was already mentioned the Italian and Swiss silk industries are demanding comparatively high quality and quantity of silk, and the Chinese market is constantly decreasing its quality, but increasing the prices. For this reason, Italian industry is re-considering to establish part of cocoon production in Europe and/or Central Asia. In our opinion the region countries which have good potential to be created as new high quality raw silk sources are Bulgaria, Romania, Ukraine, Georgia and Azerbaijan. By the same time the state policies in the Central Asian countries like Tajikistan, Turkmenistan and Uzbekistan should be directed in increase the share of raw silk export or local processing on the account of decrease of dry cocoon export. On the other hand in some countries, having well developed silk industry, but too high labor and other costs like Greece, Italy and Switzerland efforts may be made for some small niche textile production of cocoons and silk as a kind of internal cooperation between the different parts of sericulture value chain. An other option for most of the BACSA member countries would be the silk handcrafts production and their selling both at the local market and export to some of the region and other countries. By this way the problem for local market of fresh cocoons and subsequent raw silk produced could be solved partly or this manufacture may be supplied with raw silk from some other region country as the already existing practice.

2.6. Thrown silk and gray silk fabrics marketing.

The present exporters from BACSA member states are Italy, Tajikistan, Turkmenistan, Uzbekistan, Bulgaria, Switzerland and Romania. Some of them however buy the raw silk from China and after further processing re-export it. The main importer is Italy. The region countries which have good potential to be created as new high quality twisted silk and gray silk fabrics sources are Bulgaria, Romania, Ukraine, Georgia and Azerbaijan.

2.7. Silk fabrics and garment production and marketing.

The main producers in the BACSA region countries are Italy, Germany, Switzerland and Uzbekistan, but Iran and Turkey are big silk carpet producers. The biggest market of silk fabrics and garment is in the western European countries like Germany, Switzerland and Italy. It is however expected that in the Eastern Europe EU member states, Russia, Ukraine and Turkey the silk products demand will increase in the future. A medium-term target may be increase of silk fabrics and garment production in Eastern Europe and Central Asia mostly for export to EU and Russia.

3. The role of BACSA in the regional cooperation.

In order to see the BACSA role in the regional sericulture development it is necessary to compare the situation before 2005 when the association was established and in the present time:

Item	Situation in 2005	Present situation
Contacts between the key specialists and institutions,	Very few, well developed	Good contacts between all BACSA member countries key sericulture

engaged in the sericultural industries	between some of the Ex-Soviet union and Eastern Europe countries only	specialists and most of the institutions
Regional sericulture database	Not available	Available, uploaded on the BACSA web site and regularly updated
Number of countries, associated in BACSA	only 8 Eastern Europe, Caucasus and Central Asia countries	17 countries from Europe, Caucasus and Central Asia, out of them 6 EU member states, which gives possibilities to apply for projects financing from the EU funds.
Enquiry system for sericultural products marketing	Not available	Available: enquiry to BACSA → distribution the enquiry to the national coordinators → distribution the enquiry to the possible interested people/entities in each member country for direct contacts; uploading the sell/buy enquiries on the BACSA web site.
Exchange of sericulture germplasm resources between the BACSA member countries	Very few, well developed between some of the Ex-Soviet union and Eastern Europe countries only	At a much bigger scale, based on bilateral scientific projects
Export of mulberry saplings and silkworm eggs	Very few, between some of the Ex-Soviet union states only	There is, but still in a too small scale.
Regional conferences and meetings	Very few, well developed between some of the Ex-Soviet union and Eastern Europe countries only	Regular BACSA international conferences, one per each 2 years, already 6 conferences organized
Specializations and training of students and technical personnel in leading research centers and commercial companies in BACSA member countries	No	There is, but still in a too small scale.
Sensitizing the national governments about the regional BACSA executive meetings results, decisions and follow ups	No	Yes, by the BACSA national coordinators
Responding to different enquiries, concerning the sericultural industries in the region	No	Yes, by BACSA president and national coordinators
Supporting the sericultural institutions and specialists in the	No	Yes, by BACSA president and selected experts

BACSA member countries by providing when necessary letters of support, personal recommendations, reviews of scientific monographs and doctoral dissertations etc.		
Popularization of Europe and Central Asia sericultural industries in the world through participation at international conferences and meetings	Scarce	Yes
Development of regional sericulture projects and looking for donors	No	Yes
Promoting making bilateral and multilateral agreements for cooperation between the BACSA member states	No	Yes

4. Building regional value chains in sericulture.

The main parts of the possible regional value chains could be:

- Regional integrated research, training and germplasm preservation;
- Regional supply with mulberry saplings and silkworm eggs;
- Regional supply with dry cocoons, raw silk, thrown silk and gray silk fabrics.

5. Conclusions.

We expect the following medium/long term outputs from the regional cooperation between BACSA member countries development:

- Bilateral research projects, financed by the each participating country’s government;
- Bi and/or multilateral research/technical projects, financed by the EU;
- Specializations and training of students and technical personnel in leading research centers and commercial companies in other region countries;
- Exchange of sericulture germplasm resources between the BACSA member countries and improvement the mulberry sapling and silkworm egg quality;
- Saving the sericulture germplasm in the BACSA region;
- Supply of mulberry saplings of highly productive varieties in the countries having needs;
- Increase of silkworm egg production in Azerbaijan and Bulgaria and revival of silkworm egg production in Italy, Ukraine, Romania and Georgia for meeting the local demands and export to some BACSA region countries;
- Where necessary and possible the cocoons, produced in one country reeled in some other BACSA region country and the raw silk produced returned back.
- Creation of some of Eastern European countries as new high quality raw silk, twisted silk and gray silk fabrics sources for the Western European silk industries by attracting investors.
- Improvement the raw silk quality and increase the share of raw silk export or local processing on the account of decrease of dry cocoon export in Tajikistan, Turkmenistan, Uzbekistan, Greece, Turkey etc.;
- Small niche textile production of cocoons and silk and silk handcrafts production development in some of the region countries;
- Increase of silk fabrics production in Eastern Europe and Central Asia mostly for export.
- Creation of regional sericulture value chains with participation of two or more countries.

VALUE CHAINS IN SERICULTURE SESSION

Building value chains in sericulture – the Swiss experience

By

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(ORAL PRESENTATION)

ROLE OF BASIC RESEARCHES IN SOLVING TOPICAL PROBLEMS OF SERICULTURE AND SILK PROCESSING. BIOTECHNOLOGICAL ASPECTS

By

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(ORAL PRESENTATION)

ABSTRACT: Uzbekistan is a long-standing and significant world producer of cocoons, raw-silk, silk products and goods. More than 60% of production of sericulture and its processing in former USSR produced in Uzbekistan. Mulberry tree *Morus alba* L. and mulberry silkworm *Bombyx mori* L. are an industrial base of sericulture which came to us from ancient time. As a result of human activity they are changed very much in comparison with wild varieties. In this connection the sericulture could be referred to biotechnological manufacture along with crop growing, livestock farming, bread baking, cheese- and vine making and other similar ancient productions.

In spite of achievements of scientists in creation of new high-productive mulberry tree varieties and mulberry silkworm breeds as well as in mechanization of mulberry silkworm rearing this branch still remains seasonal manufacture depending on weather conditions, pests and diseases. It is based on cottage work in silkworm rearing which still is far from industrial methods of manufacturing. In this work presented some of application of biotechnological approaches in solution of topical problems in traditional sericulture and silk technology.

Such studies were primary performed at the Uzbek Research Institute of Sericulture (URIS) and further at the Institute of Physiology and Biophysics as well as the Institute of Zoology of Academy of Sciences of Uzbekistan. Some parts of the studies was performed by international contracts in tropical Malaysia, South Korea and also in frames of Uzbek-

American international projects. At present the biotechnological approaches are continued to be developed at URIS.

Results of such application of biotechnological approaches will lead to significant progress both in traditional sericulture and in mass rearing of silkworm with use of developed artificial diets, in environmentally safe protection of mulberry trees from pests and also in rational utilization of raw material, by-products and wastes of sericulture and cocoons processing in present day bio- and nanotechnological directions of new consumer goods manufacturing.

Main summary of application of biotechnological approaches and methods in field of sericulture and silk technology is presented here as the following:

1. Physico-chemical and biochemical methods of components selection for mulberry silkworm artificial diets from local raw material, methods of its preparation, storage, feeding technology, adaptation and selection criterions of mulberry silkworm breeds to it and its fields of practical application have been developed.

2. Biochemical, biophysical and biotechnological aspects of food digestion-absorbtion processes was studied and modeled. Asporogenic yeasts which hydrolyse cellulose to glucose were found out in intestinal contents of mulberry silkworm. The synergetic effects of interaction of water-soluble and membrane-bound proteolytic enzymes giving reasons for effective application of industrial and immobilized enzyme preparations in feeding were found out. This principle was probed and used in designed bioreactor “Artificial intestine” working in conditions of digestion-absorption simulating functions of high-efficient digestive system of mulberry silkworm.

3. For the first time cluster-forming and vector mechanism of activation, functioning and membrane regulation of one of lipolytic enzymes – phospholipase D was investigated. This practically expended range of mulberry silkworm development stimulators.

4. The conception of efficient increasing of mulberry silkworm productivity by stimulation of larvae development in junior instars when expenses for stimulation are minimal but the effect in end production is remarkable was developed.

5. For the first time the space experiment was performed with mulberry silkworm using artificial diet. The experiment confirmed hypothesis about possibility of silkworm breeding in any geographic region of the Earth and at any season of year. Mulberry silkworm as transgenic animal could be an efficient on-board test-organism and producer of bio-active substances.

6. The possibility of use of wild and recombinant baculoviruses in early control of dangerous mulberry plantings pest – mulberry pyralid, a new host of alfa-alfa looper *Autographa californica* virus was developed. At the same time these bioinsecticides don’t affect silkworm larvae. Due to identity of endogenic virus of mulberry pyralid and densovirus of mulberry silkworm risk of infection of mulberry silkworm by it increases.

7. Drying of artificial diet, mulberry silkworm larvae, pupae, alive cocoons and other bio-objects with preservation of native composition of biologically active substances in dried products with use of IR- irradiation on base of functional ceramics was developed. Mulberry silkworm larvae and pupae dried by this bio-protective method are a new resource of biologically active substances for medicine, food industry, fodder production and cocoons have advanced technological properties. Cuticle of larvae and pupae, pupae themselves and moths after egg laying are an additional source of chitin.

8. Hydrolisates of fibroin, sericin and other unusable proteins by improved chemical method up to any planned depth of hydrolysis were obtained. Properties of the final product do not require its additional purification, output of this product significantly exceeds output in traditional analogue. Improvement of the product quality was achieved at hydrolysis of protein substrates by soluble and immobilized proteases on carbon-mineral sorbents or on fibroin biosorbents. In this processes it is succeed to avoid inhibition of enzyme by reaction product in specially designed bioreactor “Artificial intestine”.

9. Silk biopolymers being biocompatible and biodegradable proteins have found more valuable application in the native form. Fibroin composites and biosorbents are irreplaceable material for design of biosensors, means of drug delivery, modeling of high-efficient enzyme systems similar to insects peritrophic membrane or animal intestinal mucosa, for creation analogues of transport vesicle and other parts of alive cells. Stabilized enzymes stereospecific functioning in waterless organic media are developed on the base of fibroin and could be used for bioseparation in pharmaceutical industry.

10. Nanoglobular structure of silk biosorbents and composites from regenerated fibroin is determined by electronic microscopy. Observed dense-crowded nanoparticles probably represent nanocrystals grown from spontaneously formed crystallization centers in concentrated fibroin solutions in conditions of fast dehydratation at thread formation during process of cocoons waving from silkworm silk gland secrets and at sublimation of regenerated silk composites.

The developed biotechnological methods and approaches in traditional sericulture and silk technology will be an important landmark in present day developments not only in this branch.

Key words: Mulberry, silkworm, biochemical composition, feeding, physiology, biochemistry, bioregulators, artificial diet, space experiments, silk, wastes, resources saving, mulberry pyralid, biocontrol, biotechnology, nanotechnology.

Uzbekistan is a long-standing and significant world producer of cocoons, raw-silk, silk products and goods. More than 60% of production of sericulture and its processing in former USSR was produced in Uzbekistan. Mulberry tree *Morus alba* L. and mulberry silkworm *Bombyx mori* L. are an industrial basis of sericulture which came to us from ancient time. As a result of human activity they have been changing very much in comparison with wild varieties. In this connection the sericulture could be referred to, like a biotechnological manufacture along with crop growing, livestock farming, bread baking, cheese- and wine making and other similar ancient productions.

In spite of scientific achievements in creation of new high-productive mulberry tree varieties and mulberry silkworm breeds as well as in mechanization of mulberry silkworm rearing, this branch still remains seasonal manufacture depending on weather conditions, pests and diseases. It is based on cottage work in silkworm rearing which still is far from industrial methods of manufacturing. In this work some applications of biotechnological approaches are presented as a solution of topical problems in traditional sericulture and silk technology.

Such studies were primarily performed at the Uzbek Research Institute of Sericulture (URIS) and further at the Institute of Physiology and Biophysics as well as the Institute of Zoology of Academy of Sciences of Uzbekistan. Some parts of the studies were performed through international contracts in tropical Malaysia, South Korea and also in the frameworks of Uzbek-American international projects. At present the biotechnological approaches have been developing at URIS.

Results of such applications will lead to significant advances both in traditional sericulture and in mass rearing of silkworm with use of developed artificial diets, in environmentally safe protection of mulberry trees from pests and also in rational utilization of raw material, by-products and wastes of sericulture and cocoons processing in up-to-date bio- and nanotechnological directions to create new goods appreciated by consumers.

A summary of the main applications of biotechnological approaches and methods in the field of sericulture and silk technology is presented here as follows:

1. Physico-chemical and biochemical methods of component selection for mulberry silkworm artificial diets from local raw material, methods of its preparation, storage, feeding technology, adaptation and selection criterions of mulberry silkworm breeds to it and its fields of practical application have been developed.

2. Biochemical, biophysical and biotechnological aspects of food digestion-absorption processes were studied and modelled. Asporogenic yeasts, which hydrolyse cellulose to glucose were found out in intestinal contents of mulberry silkworm. The synergetic effects of interactions of water-soluble and membrane-bound proteolytic enzymes giving reasons for effective application of industrial and immobilized enzyme preparations in feeding were found out. This principle was probed and used in designed bioreactor "Artificial intestine" working in conditions of digestion-absorption simulating functions of high-efficient digestive system of mulberry silkworm.

3. For the first time cluster-forming and vector mechanism of activation, functioning and membrane regulation of one of lipolytic enzymes – phospholipase D was investigated. This practically expanded the range of mulberry silkworm development stimulators.

4. The conception of efficient increasing of mulberry silkworm productivity by stimulation of larvae development in juvenile instars when expenses for stimulation are minimal but the effect in end production is remarkable was developed.

5. For the first time the space experiment (?)was performed with mulberry silkworm using artificial diet. The experiment confirmed hypothesis about possibility of silkworm breeding in any geographic region of the Earth and at any season of the year. Mulberry silkworm as transgenic animal could be an efficient on-board test-organism and producer of bio-active substances.

6. The possibility of use of wild and recombinant baculoviruses in early control of dangerous mulberry plantings pest – mulberry pyralid, a new host of alfa-alfa looper *Autographa californica* virus was developed. At the same time these bioinsecticides do not affect silkworm larvae. Due to identity of endogenic virus of mulberry pyralid and densovirus of mulberry silkworm risks of infection of mulberry silkworm by it increases, when mulberry plants are attacked

7. Drying of artificial diet, mulberry silkworm larvae, pupae, alive cocoons and other bio-materials with preservation of native composition of biologically active substances in dried products with use of IR-irradiation by using functional ceramics was developed. Mulberry silkworm larvae and pupae dried by this bio-protective method are a new resource of biologically active substances for medicine, food industry, fodder production and cocoons have advanced technological properties. Cuticle of larvae and pupae, pupae themselves and moths after egg laying are an additional source of chitin.

8. Hydrolizates of fibroin, sericin and other proteins by improved chemical method up to any planned depth of hydrolysis were obtained. Properties of the final product do not require its additional purification, output of this product significantly exceeds output in traditional analogues. Improvement of the product quality was achieved through hydrolysis of protein substrates by soluble and immobilized proteases on carbon-mineral sorbents or on fibroin bio-sorbents. In this processes enzyme inhibition is succesfully avoided by using reaction products in a specially designed bioreactor called "Artificial intestine".

9. Silk biopolymers being biocompatible and biodegradable proteins have found more valuable application in the native form. Fibroin composites and biosorbents are irreplaceable material for design of biosensors, means of drug delivery, modeling of high-efficient enzyme systems similar to insects peritrophic membrane or animal intestinal mucosa, for creation analogues of transport vesicle and other parts of alive cells. Stabilized enzymes stereospecific functioning in waterless organic media are developed on the base of fibroin and could be used for stereospecific bioseparation in pharmaceutical industry.

10. Nanoglobular structure of silk biosorbents and composites from regenerated fibroin is determined by electronic microscopy. Observed dense-crowded nanoparticles probably represent nanocrystals grown from spontaneously formed crystallization centers in concentrated fibroin solutions under the conditions of fast dehydration occurring during thread formation from silkworm silk gland secrets or during sublimation of regenerated silk composites in the process of cocoons weaving.

The developed biotechnological methods and approaches in traditional sericulture and silk technology will be an important landmark in present day developments not only in this branch.

Key words: Mulberry, silkworm, biochemical composition, feeding, physiology, biochemistry, bioregulators, artificial diet, space experiments, silk, wastes, resources saving, mulberry pyralid, biocontrol, biotechnology, nanotechnology.

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APPENDIX

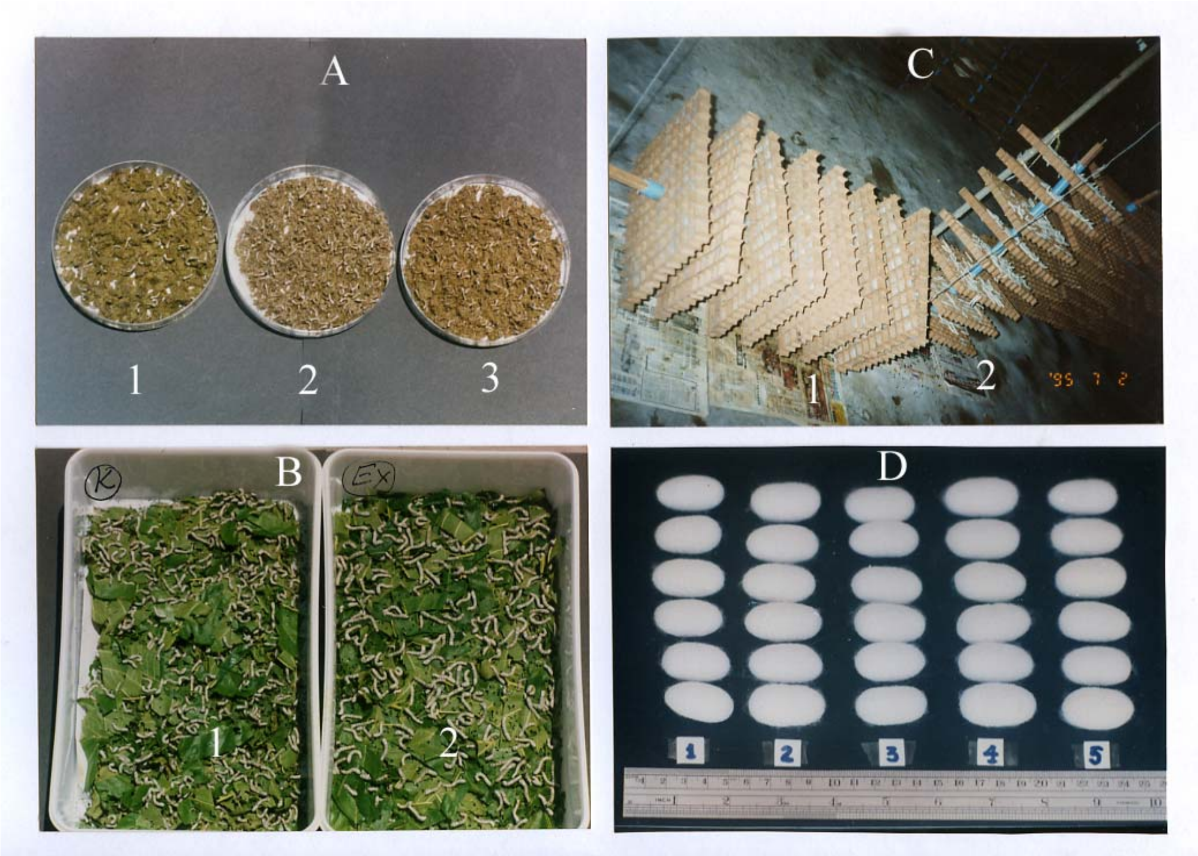


Fig. 1. Effect of EVA bio-additive on development and cocoon production of mulberry silkworm (Qiufeng x Baiyue, China) on artificial diet (AD) and on mulberry leaves (ML) in conditions of tropical sericulture of Malaysia: **A:** 1- I-st instar silkworms on AD of Japan; 2- AD of Malaysia + EVA; 3 - AD of Malaysia**.** **B**: 1 – II-nd instar silkworm larvae (ML); 2 – ML+ EVA; **C**: 1 - waved cocoons of ML+ EVA experiment; 2 – larvae in control (ML); **D:** Obtained cocoons; 1 – ML; 2 – ML+ EVA; 3 –AD of Japan; 4 – AD of Malaysia + EVA; 5 – AD of Malaysia.

Table 1. Effect of EVA preparation on average weight of cocoons, cocoon's shells and shell / cocoon ratio (MARDI, Terengganu, Malaysia, 1995)

N	*Variants,* methods of rearing	Average cocoon weight (a), g	Average cocoon shell wt.(b), g	Ratio (c) = b/a x 100%
1.	Control (ML)	1.492	0.290	19.4
2.	ML + EVA treatment	1.845	0.305	19.8
3.*	AD of Japan	1.692	0.342	20.2
4.*	AD of Malaysia + EVA	2.013	0.396	20.0
5.*	AD of Malaysia	1.653	0.340	20.6

* - Feeding by AD only during I-III instars, IV-V instars, mulberry leaves feeding.

Fig. 2 a. An effective parasite of mulberry pyralide *Glyphodes piloalis* Wlk. – *Bracon hebetor* Say. Attack of larva, paralyzation and eggs laying.

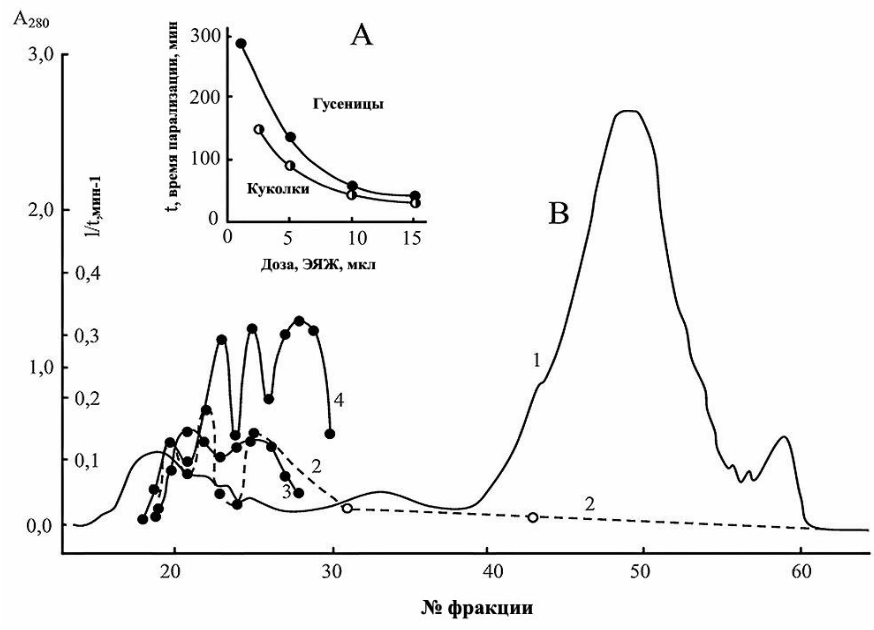


Fig. 2 b. Paralyzing effect of venom gland extract of *Bracon hebetor Say* (A) and its fractions (B) obtained by gel-filtration (G-100, 1) on larvae (2), pupae (3) and on imago (4) of mulberry silkworm.

Fig. 3. New parasite of mulberry pyralid from *Elasмidae* family.

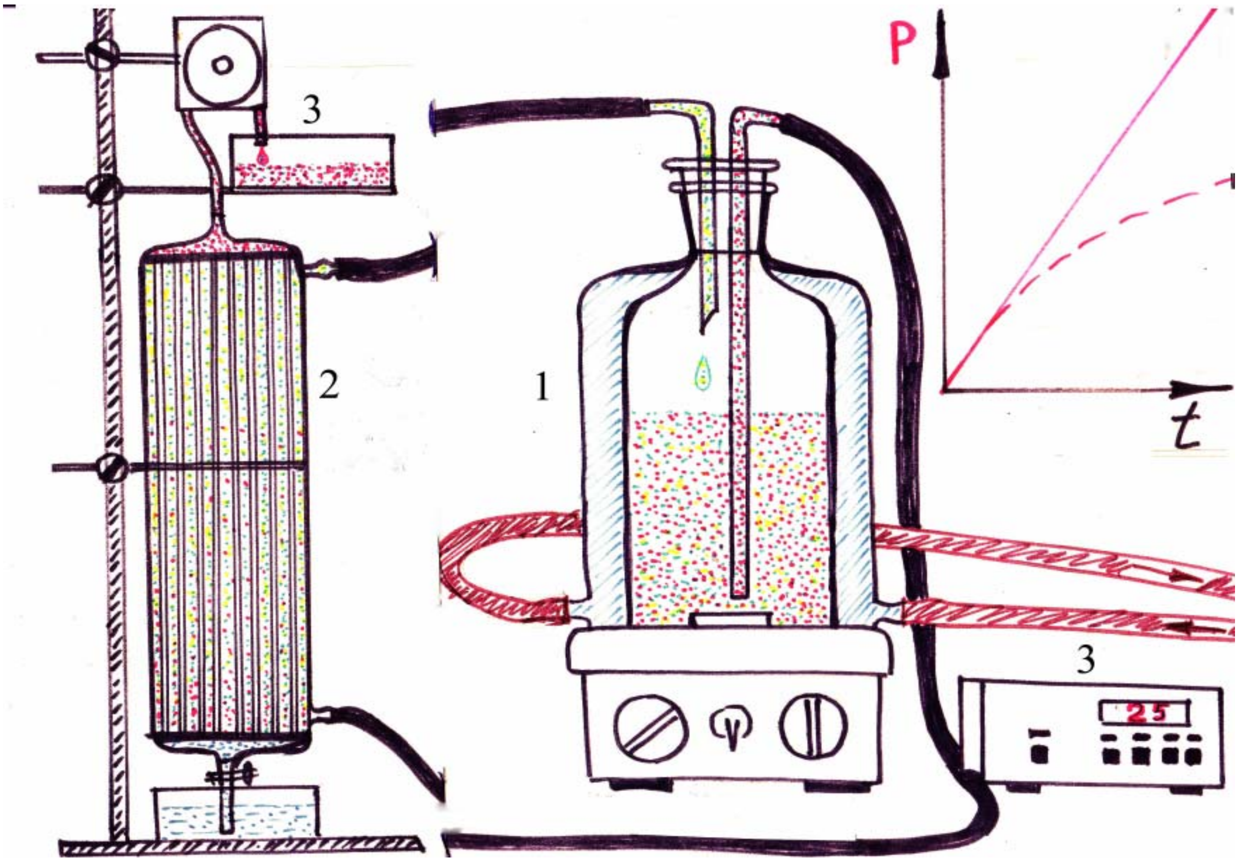


Fig. 4. Schematic representation of working installation “Artificial intestine” modeling substrate hydrolysis and reaction product absorption. 1 - thermostatable reactor with reaction system and magnetic stirrer; 2 - ultrafiltration saparator with hollow fibers; 3- peristaltic pump.

A **B**

C **D**

Fig.5. Some characteristics of different fibroin hydrolysates: **A** – acidic hydrolysates obtained by traditional methods (upper line) and by improved method (lower line); **B** – fall-out of tyrosine residue from gel-chromatographic fractions of acidic hydrolysate; **C** – effect of UV irradiation on creams containing acidic and enzyme hydrolysates; **D** – stability of hydrolysates to infection by room microorganisms.

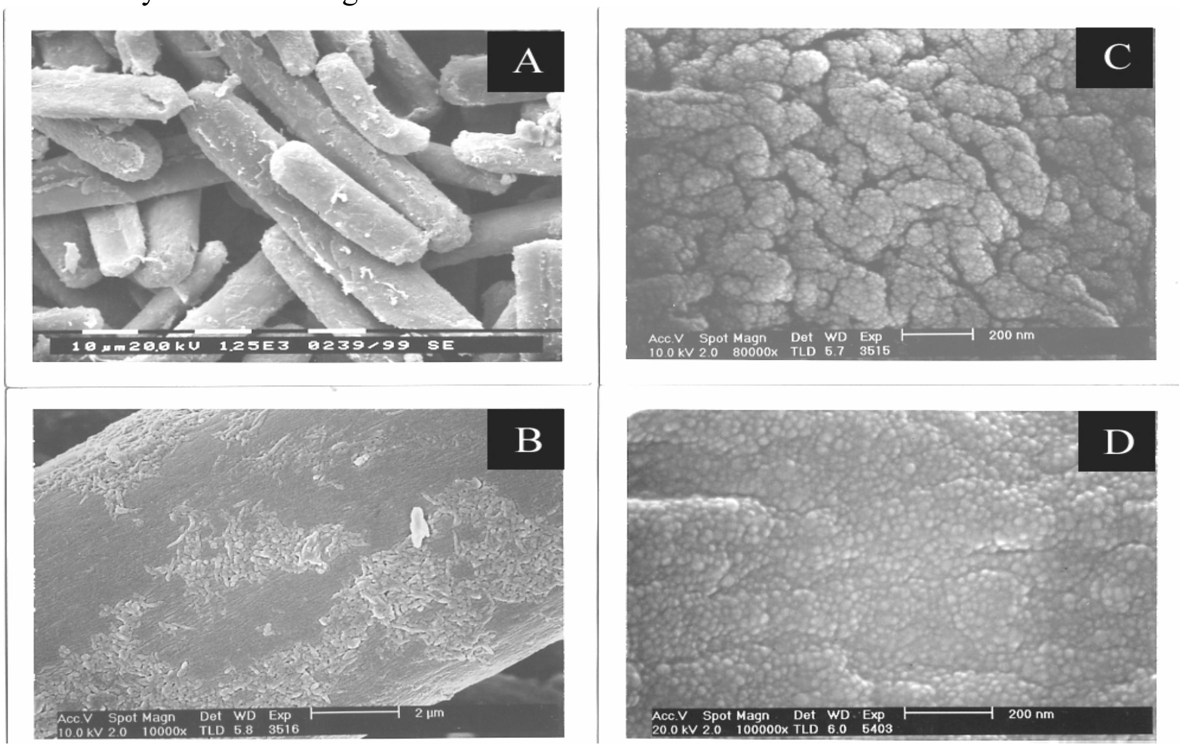
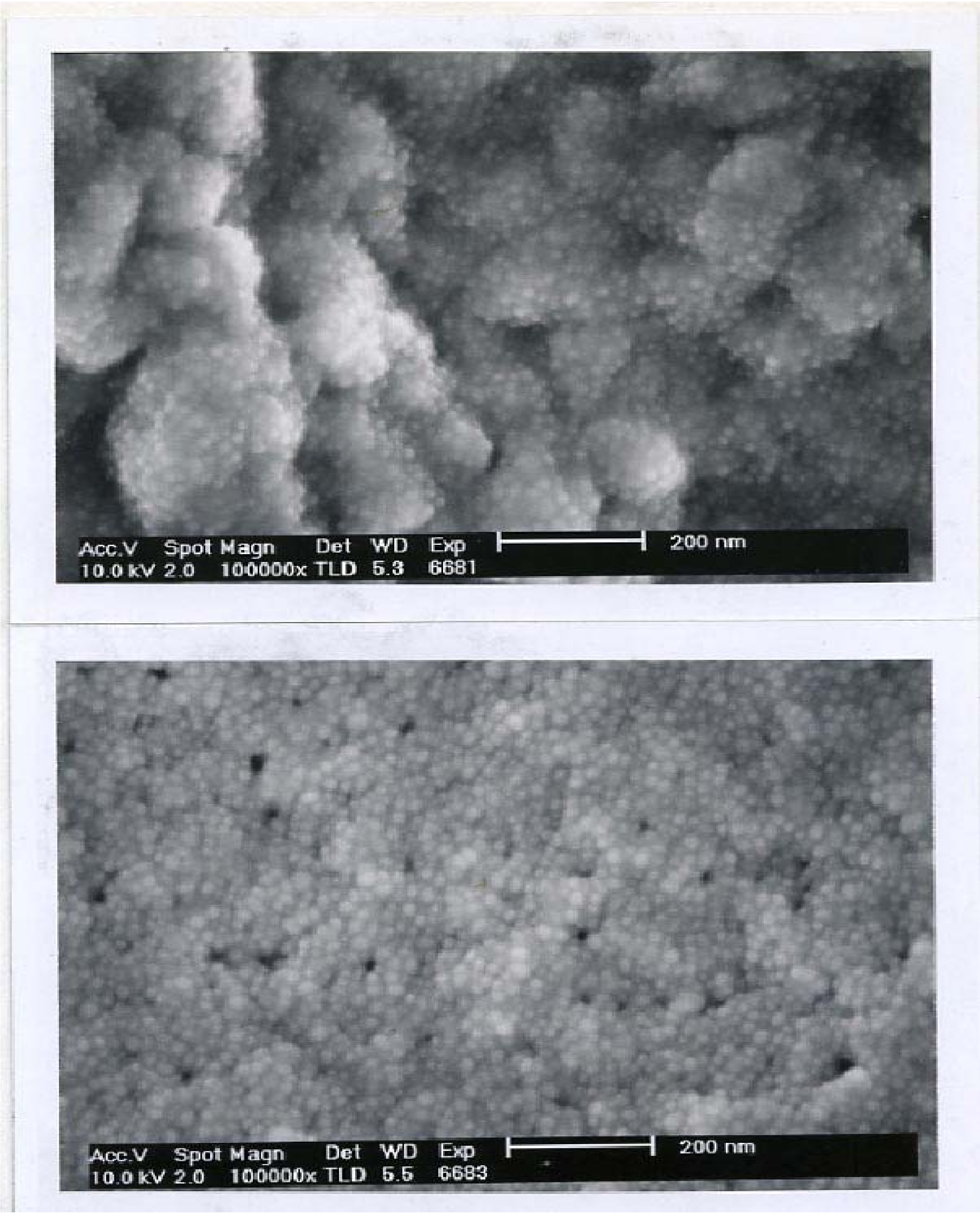


Fig. 6. Scanning electron microscopy (SEM) pictures of sorbents samples from natural silk thread: A – scale is 10 μm; B – 2 μm; C – 200 nm and from regenerated fibroin; D – 200 nm.

A



B

Fig. 7. SEM of fibroin- hemoglobin composite (A) and after three-stage water extraction (B).

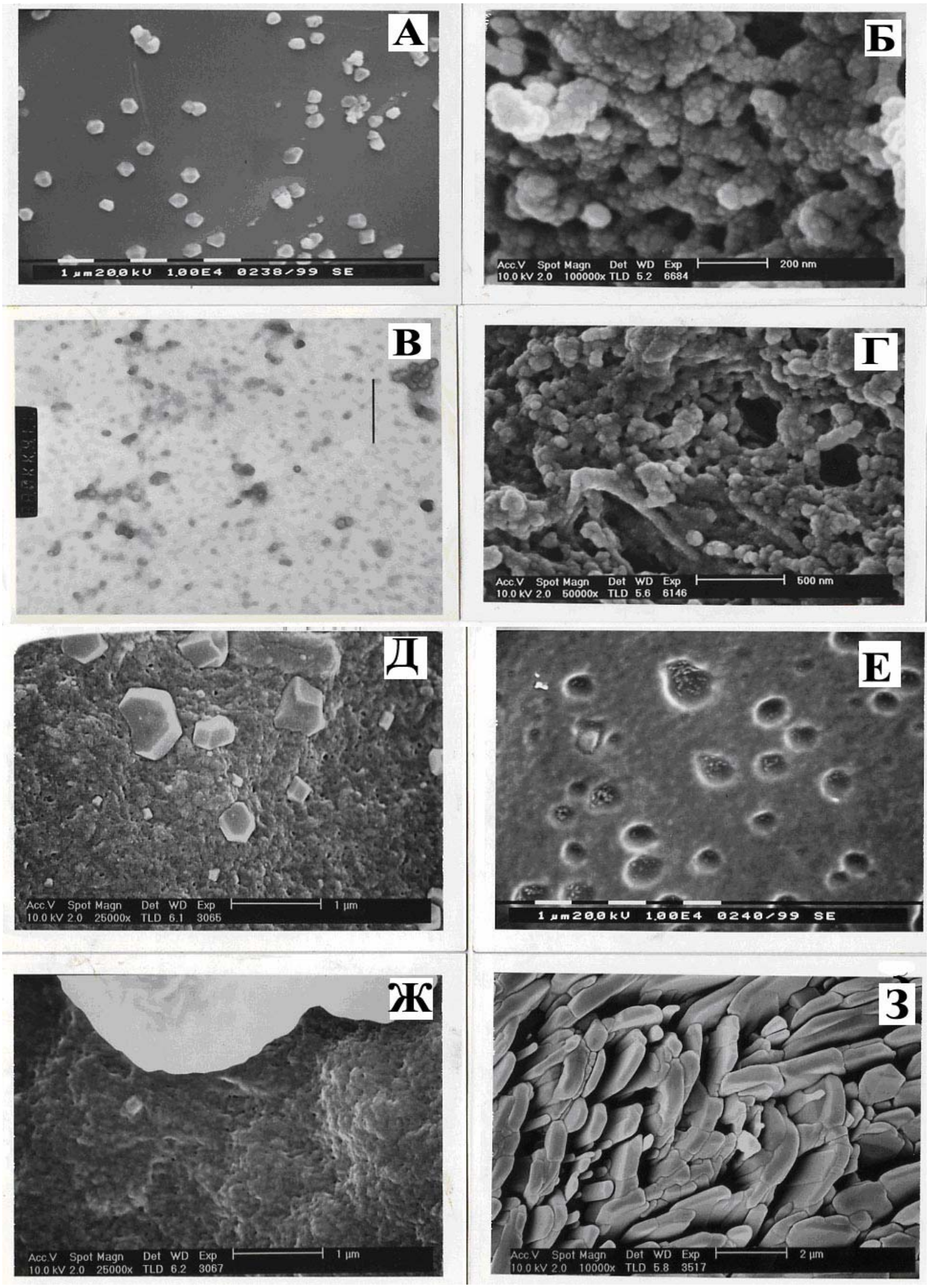


Fig. 8. EM pictures of nanoparticles fibroin-PAA-lipase (F-PAA-CRL, A) and F- Dextran blue (Б), F - PLD (В), F- lysozyme (Г), F- *E.coli* cells (Д)*,* F-vitamin B_{12} (Е); F- *Saccharomyces cerevisiae* cells (Ж) and F- cytochrome c (З) composites.

Development of sericulture chain value: from mulberry to designers in Argentina

By

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(ORAL PRESENTATION)

ABSTRACT: Sericulture in Argentina had strong development until the 1940s but later retracted by the appearance of synthetic fibers. As a result of the deep economic crisis, sericulture production began again, performing in 2002 the 1st National Sericulture Conference. The argentine sericulture value chain is focused on the production and processing of silk on a small scale. Cocoon production is performed by about 300 small farmers spread over much of the country. Mulberry plantations are mainly under tree cutting system. The cocoons are transformed by local artisans and design entrepreneurs , but quality and sale prices vary widely. The *Red Latinoamericana de la Seda* supported the creation of three sericulture demonstration centers, strengthened Argentina's production of silkworm eggs and leaned specialized training for farmers and professionals of various state agencies and universities. Among the results was the increase in the number of producers and volume of cocoons, the quality of the final products and the development of appropriate technologies for silk processing. A novel proposal was the implementation of sericulture in educative centers. For this purpose, several pedagogical methodologies were developed with corresponding support materials. Today, more than a hundred urban and rural schools use and promote sericulture activity in their community. Among institutional goals emphasize the integration of Argentina at Red Latinoamericana de la Seda, the enactment of a specifically national law and continuity in the conduct of the National Sericulture Conference. Sericulture in Argentina has an incipient development, but presents a promising future as a tool for local development.
Keywords: sericulture - value chain – Red Latinoamericana de la Seda – education

Introduction.

Sericulture is a traditional activity in Argentina and has been culturally rooted for more than 300 years. There is documented production in Argentina, always in the economic domestic sphere, since the seventeenth century (Corcuera, 2006). This activity has always been linked to production of domestic order; however, the fate of its main product, the cocoon was changing over time. Until the nineteenth century, it was used exclusively for regional handicrafts. With the later european immigration, strengthened its spread and increase the volume of cocoons produced. Thus, by the early twentieth century there was already a processing industry. The largest production came in mid-1940s, where the production of fresh cocoons reached the 70,000 kg (División de Sericicultura, 1948), which were processed industrially by four reeling factories, which had a annual processing capacity of over 400,000 kg of raw silk.

In the early 1950s the silk industry was in crisis by the appearance of synthetic fibers and finally disappears. This resulted in a significant decrease in the number of silkworm rearers, remaining only those limited to very small scale, often oriented to non productive purposes.

In 1993, in the deep argentinian economic crisis, a group of researchers from the National University of Tucumán began again to encourage activity. As a result of this extension work, new producers and technical agencies incorporated sericulture in their development strategies. In 2002, performed the 1st National Conference on Sericulture in order to coordinate efforts and organize the sector. Among the main weaknesses identified were highlighted the difficulties in obtaining accurate technical information, access to critical quality inputs (especially selected silkworm eggs and mulberry) and lack of market channels, among other problems. Ten years after those workshops, and an increase in silk production, is then important the characterization of the argentinean sericulture chain value, in order to identify project constraints.

Methods and Materials.

The methodological strategy used was based on methodological triangulation (Valles 2007) using quantitative and qualitative methods. Primary sources were based on in-depth interviews with qualified informants, following the methodology proposed by Ander-Egg (2003) and the query to the database of the National Register of Sericulture (MAGyP, 2012). As secondary sources were used bibliographic fonts. The methodological approach to analyze the value chain was proposed by Kaplinsky and Morris (2000) and Ceverio *et al* (2010). The sericulture phases were grouped in accordance to the productive stages proposed by Soria *et al.* (2001): moriculture, silkworm and processing stage. At each stage, was presented a brief technology characterization, and in cases where possible, we analyzed the different stakeholders involved. Furthermore, we analyzed chain related activities, such as the non-mulberry silkworms rearing, educational sericulture and institutional and legal framework.

Results.

Moriculture Stage.

The most frequent specie in Argentina is *Morus alba L.* The total area planted with mulberry is not properly dimensioned for two major reasons: its behavior as endemic species and its widespread use in urban forest. The species *m alba*. with its varieties quickly adapted to local environmental conditions, being one of the major woody weeds for a large part of Argentina (Ghersa, 2002). Due to cross pollination, a lot of spontaneous hybrids were generated, which can be a reservoir of genes of interest in the long term. A peculiarity of Argentina is that mulberry was widely used in multipurpose systems, as urban forest, shelterbelts and silkworm feeding. For these reasons, planted mulberry trees come from old European varieties

The principal uses of mulberry are production of fruit jellies and liqueurs, livestock feeding and rearing of silkworms. The use of the fruit is widespread, being a traditional raw material for making jellies. In the case of livestock feed, is intended especially for small farm animals (otter, poultry, rabbits), goat and sheep.

The production of mulberry for silkworm rearing is mainly based on the use of old high stem trees and wild mulberry trees (Grekov D. *et al*, 2005; Lim, 1990) .The strategy consisted in harvesting branches of large size trees located near the rearing house. Although no food shortage problems were detected, the harvest is complex and risks of pesticide contamination have been high (Pescio, 2010a). According to estimations, were necessary about 30 adult specimens of mulberry to supply 10 grams of silkworm egg (Pescio, 2005). Silkworm feeding from wild mulberry is usually problematic and generated mediocre results. However, it has allowed to identify plants with characteristics of interest for mulberry breeding programs.

In most experienced rearers was observed a gradual implementation of mulberry plantations from hardwood cuttings. Each farm has a range of 0.5 to 3 ha implanted with mulberry, depending on the planned level of cocoon production. In the subtropical regions (near

Brazil), bush type plants were predominant; with a planting density of 10,000 plants / ha, and a low stem pruning system (Grekov *et al*, Op. Cit. ; Lim; Op. Cit). In temperate and semi-arid areas, the density was about 3,000 plants / ha, with medium and high stem pruning system; in order to generate larger sized plants. In several cases, planting schemes included intercropping techniques like horticultural crops (lettuce, pumpkin) or green manures (as *vicia sp*, *medicago sativa*, etc.) (Pescio 2010a). With regard to management problems, not been reported important situations with pests or diseases of importance.

The cuttings were selected from local specimens, mostly derived from old introduced european varieties. Research institutes have isolated about 8 potential varieties, although these have not been completely characterized yet. Several farmers and researchers said they had introduced cultivars of *Morus alba* and *M. indica L* , but discontinued its use by low adaptation to local conditions.

Silkworm rearing stage.

Rearing is performed from the South of the Province of Buenos Aires to the north of the country. At higher latitudes, the combination of low temperatures and rainfalls cause a very short rearing season (Figure Nº 1).

Since there is no statistical data of national sericulture (the national registry is voluntary), the number of silkworm rearing units as the number of equivalent egg boxes (10 gr/box) was estimated from field work. It was observed that silkworm rearing was strongly spread in small units, with a diffuse distribution covering Central and Northern areas of the country (Table Nº1). Currently some farmers groups are emerging, with a coordinated production and a shared strategy, such a production cluster; but this situation is still minority.

For statistical purposes, National Register of Sericulture (MAGyP, 2012) considered as *silkworm rearing unit* as those with can raise more than 10 grams of silkworm egg per year. In fact, there were records of those farms using eggs provided by multiplication centers (MAGyP, Op. Cit).

Table Nº 1. Number of silkworm rearing units and equivalent egg boxes per Region. Argentina

Region	Nº Rearing Units	Nº egg boxes
Northwest	50	25
Northeast	130	50
Central	40	17
Total	20	85

Autor elaboration based on MAGyP (2012) and interviews.

The most representative silkworm rearers were who used sericulture as diversification activity. Most production units were located in small towns or suburban areas of cities. A significant percentage of rearers were women, using sericulture as a direct source of cash income. In several cases, sericulture was used to create sociabilization spaces, since the groups of women who reared larvae used group meetings as encounter moment. This had great appreciation during interviews

The quantities reared annually by each farmer ranged from 1 to 10 boxes of 10 g/seed, and was defined according the disponibility of labor, since in most cases was provided by family members. Almost all farmers were rearing a complete cycle, from 1^{st} up to 5^{th} instar. Only those units near Demonstratives Centers made cooperative rearing of young silkworms.

The predominant form of egg supply was the combination of self-production and the purchase of hybrids on the market. While yields and uniformity of larvae obtained by self production are irregular and poor quality, this egg supply strategy has allowed those isolated units could sustain its production over time, even with restrictions on obtaining quality eggs from providers . The most experienced producers mainly used hybrid eggs produced experimentally in our country or from different international centers of multiplication.

Average yields were 25 kg of fresh cocoons / box, which is below the international average (Cifuentes and Sohn 1998). In analyzing the qualities of cocoons, there was a significant variation according to farmer studied. Those who had more experience, achieved rates of up to 70% of first class-cocoons. This coincided with progressive additions of hybrid materials.

The most common technique used for young larvae was shelf rearing. For late-age silkworms, shoot rearing or shelf rearing were used, depending on the size of the rearing house.

There were diverse approaches to mounting methods. Initially, the farmers allowed the larvae build cocoons over branches, like paddy straw batch method (Grekov *et al*, Op. Cit). However, this method was abandoned for being very disadvantageous, producing lot of defective cocoons. Later, was replaced with frames made with recycled poultry egg containers, like a a rotary mountage frame. Actually, with the support of RELASEDA, from INTI began to produce plastic mounting systems, which were quickly adopted by farmers. Today, plastic mounting frames coexist with the poultry-egg mounting frames.

Regarding sanitary problems, in subtropical areas *Nomurea rileyi* and *Beauveria bassiana* outbreaks were detected, especially during the rainy season. In agricultural regions have been identified numerous cases of poisoning by agrochemicals, especially in those units that mulberry leaves were harvested outside the limits of their farm.

Silk Production Stage.

The trade is mainly as raw silk or other silk intermediates. The commercialization of fresh cocoons is very small. Among the principal causes highlights the low volumes produced by each farmer and the lack of collection agents, the great distances between producers and buyers and lack of knowledge of processing technologies by potential buyers (artisans, designers, companies, etc).

The 2^{nd} class cocoons, discard cocoons, and even a proportion of 1st class cocoons were converted into spun silk yarn and non-yarn products (e.g. silk hankies). These products are traded very easily because both manual hand-spinning wool as its subsequent products are traditional crafts from Argentina, and have high consumer demand. In fact, we detected a significant number of products made in combination with silk and cotton, wool, llama and vicuña fibers, among others.

There were three major strategies of productive organization in the processing stage: the first, vertical integration, linking stages of breeding, spinning, weaving and, in some cases, the making of clothes. Another strategy included coordination with actors performing silk yarn or products, and then a common commercialization. The last option was to purchase cocoons and yarns by traditional artisans or design entrepreneurs, so that then they would generate different products and making the sale to the final consumer. There were some trials of textile SMEs (Small and Medium Enterprises) to buy national raw silk or cocoon, but was very difficult to achieve the required volumes.

Both farmers and the different actors who processed silk offered a range of products with varying degrees of processing: dried cocoons, skeins of raw silk, silk yarn dyed with natural dyes, silk noil yarn, silk hankies, silk paper, etc. . According to some studies, as Acerbi et al.(2005) and Pescio (2005) this behavior is completely rational, because in this way can capture a larger share of the final value of the products (Watanabe and Yamaoka, 1998) and diversify income with products that have different Capital turnover rates (Pescio, 2010 Op. Cit.).

The units surveyed who purchased cocoons or silk by-products required low volumes (about equivalent to 10 kg raw silk / purchaser / year). It is mainly traditional textile artisans and entrepreneurs. While there are clusters scattered throughout the country, most are in the large cities: Buenos Aires, Rosario and Cordoba. The figure of design entrepreneurs has great importance for Argentina textile value chain, as these SMEs are usually created by textile _, fashion and industrial designers, which generate high added value products, whether clothes, furniture and decorative accessories. In this situation, silk was used as raw material of differentiation. This allowed to obtain significant price differentials as well that the terms of trade were relatively equitable.

There are not serious studies of silk consumption in Argentina. There is official information about imports of dry cocoons and raw silk, but the volume is quite small. An important source of silk products were finished garments and clothes, but is not declared but its An important part of this consumption is represented by local buyers of artisan and design entrepreneurs products. These last made export of their products. There are also companies that import massively different silk goods, as finished garments and clothes, although its composition is not detailed. Other consumers were the subjects described in the processing stage, besides the people who make and buy crafts, tourists, etc.

Prices fixation Mechanism.

A major point of controversy was the establishment of mechanisms for determining quality and price of silk. Until 2010 was used information from international markets. During the annual meetings of the National Conference were held formal and informal meetings between the actors in the sector. At these meetings, prices and costs were shared which served as a common reference. So, for the 1º and 2º class cocoons of 1º and 2º were used the table of values proposed by RELASEDA, according to its classification system. For raw silk and yarn were used prices reported from neighboring countries and Europe.

Unlike other countries with sericulture tradition and strong industries, silk products in Argentina have not presented a classical behavior of commodities, with quality systems adjusted and institutionalized commercialization channels. His behavior as a product is comparable to that of non-traditional agricultural (Ceverio et al. Op. Cit.) Thus, each farmer had to create their own channel to meet demand, and given the lack of raw material replacement, there was a relative independence of the international prices. This meant that the need to create and use new commercialization channels, or vice versa, the absence of established channels involved a process of business development for producers. This apparent lack of market information was a barrier to entry for new farmers activity (Carlton 2005).

However, it was observed that there were peculiarities that distorted international prices taken as reference, which led to a reformulation of the strategy for pricing reference. Generally, transactions of the various products (cocoons, yarn and crafts) were fixed to local scale (town or region). Furthermore, in the production areas was not feasible the supply of imported silk. In this way, an important part of farmers expressed the cocoons prices did not cover their production costs (this is partly due to inefficient production). All this was manifested in "*the difficulty in acquiring cocoons*" as an expression of the imbalance of demand over supply. However, local situation s was not reflected in the price adjustment. From that moment, we decided to use international prices for general reference, but where the final fixation would arise from free interaction of supply and domestic demand. Thus, the prices grow up quickly, so the price of raw silk skeins craft to March 2012 was about USD 150/Kg; while fresh cocoons were, in some cases, around 30 USD/Kg.

Support Institutions.

In analyzing the structure of value chain of sericulture, several authors emphasize the importance of institutions that could organize and promote the activity. In the case of Argentina, it was a country without an established chain (Grekov *et al*, Op. Cit.), which, despite its productive potential, was essential to have public support and international cooperation (ISC & ISA, 2001) to consolidate the sector.

Among the major achievements can be highlighted the enactment of a national law to support Sericulture, which included various benefits and financial support to production. From this law began the regulatory process of different protocols for production and regulation of activity. Although the Ministry of Agriculture, Livestock and Fisheries of the Nation (MAGyP) established a special sericulture development area, this did not have enough budget to establish general development plans.

Within support public agencies, highlighting the actions that were carried out by the TEXTILES center, belonging to INTI (National Institute for Industrial Technology), who contributed to the generation and validation of technologies for silk processing, from development specified machinery to support the management of design, craft training, cooperative techniques, among others. This group also made a strong work to articulate actions of various private and public stakeholders of argentinean sericulture, with the aim of a common development.

Other public institutions involved have been INTA (National Institute of Agricultural Technology), who through their Family Agriculture Programs, such as the ProHuerta Program or its EEA AMBA (Experimental Station of Area Metropolitana de Buenos Aires), has supported the expansion and strengthening of silkworms rearing through equipment financing and agricultural extension. In the case of National Universities, these have specialized in breeding and production of silkworm eggs.

However, except in the case of INTI, there are even specific areas in sericulture, rather the activity is based on the work of existing territory technicians, who added, voluntarily, sericulture in their development programs.

An important element was the inclusion in 2006 of Argentina to the Project *Red Latinoamericana de la Seda (RELASEDA)* - Silk Latinamerican Network-, funded by the Istituto Italo Latino Americano (IILA) and with the support of SocioLario (Italy). With the technical and financial support were trained in Good Agriculture Practices in sericulture both farmers, craftsmen and professional personal. Trainings were also conducted using natural dyes, silkworm breeding and eggs production, biomedical applications, among others areas. In total, we were able to train more than 15 farmers and professionals in more than 25 training and scholarships in the major production and research centers of Latin American and Europe. Selected silk handycrafts also participated in Fiera Milano 2009.

With funding from the RELASEDA, built three Demonstration Centers, located in the Central Region, the city of Realicó (La Pampa), in collaboration with the Housewives' League; in the Nothwesth Region, in El Galpón in the province of Salta, in collaboration with INTA; and in the Northeast Región, in the Technology Park in Posadas, Misiones province. This last one was constituted as the Entomology Research Center, where it is conducted breeding and multiplication of silkworm eggs and mulberry.

Finally, it is noteworthy that the National Conference on Sericulture had been performed continuously, with an annual regularity. They have had a double purpose. On one hand, a mechanism of presentation of productive experiences and technical advances, and on the other, as an instance of generating discussion and agreements between the various stakeholders involved. An important milestone was the realization in 2009 of the Latin American Silk Meeting, meeting attended by the leading specialists in the region.

Development and adaptation of appropriate technology for sericulture.

One of the problems identified during the 1st National Conference was the technological gap for different stages of sericulture. The diagnosis showed it was really difficult to establish spinning mills to export raw silk in large volumes, since the global market is fully mature (Ceverio et al., Op. Cit.).

Therefore, under the technological framework proposed by Enciso and Pescio (2012), the technologies to develop or validate should meet the following criteria: be adoptable by small farmers or SMEs, close economic circuits locally, be low cost of acquisition and input use, flexibility in terms of volume and quality of raw material (cocoons), generate demand for labor and ultimately achieve results in products that allow greater incorporation of added value and differentiation.

In mulberry production and silkworm rearing stages, were validated international knowledge and systematized national experiences; generating training courses for farmers and technical personal, reference materials and technical support to farmers in Good Agricultural Practices, adapted to the specific conditions of each region (Pescio *et al*., 2008). With the support of RELASEDA, we obtained a plastic injection matrix for making plastic mounting frames, which were distributed free to farmers. In addition, there was support to build cocoon steam stifling, as proposed by Martos Tupes (2009).

For raw silk reeling, was developed in 2003 a prototype semi-automatic reeling machine (Marino *et al*., 2007), which received successive improvements up to a fully functional in 2009. The machine has two ends reeling, with an approximate working capacity of 100 g / h (50 den). This machine is aimed to raw silk reeling with industrial quality using a low cost technology, which is an improvement over manual reeling systems.

For re-reeling and finishing stage, we developed a four-position assembled single yarns machine and a two-position drum twister for ply yarns, each machine with speed adjustable by each position (Enciso and Pescio, 2012). These three machines can use domiciliary voltage, have high performance and security systems, and are affordable for small producer groups. The product obtained was twisted continuous filament cones, suitable for use by handicrafts or small industries.

For the case of cocoons unsuitable for reeling, the development approach was to expand the scope of available techniques. In the case of spun and silk floss, courses and workshops were delivered, especially to improve manual spinning techniques. Also were investigated other processing techniques. So, we worked with silk hankies, silk paper, felt and products on whole cocoon. These techniques were incorporated with relative ease.

Among wet processes, were generated protocols for degumming and dyeing (Martinez and Pescio, 2004; Martínez, 2010). These methods were easy to perform and fit to be done by small production units. For the specific case of natural dyes, it was possible to achieve a series of recommendations on the use of natural and eco friendly dyes, presenting a significant color palette, including fluorescent colors.

As for design management, tutoring activities were conducted to artisans and designers in order to improve product quality and marketing. In addition, a technical group worked in various seminars oriented to industrial designers, textile and clothing, in order that they experiment with silk, so that they can subsequently be incorporated as raw material in the generation of new products, and thus facilitate linking farmers with design entrepreneurs.

Educational approach of sericulture.

One key element of sericulture Argentina is his strong cultural component. That is, it was observed that those making strategy sericulture exceeds many times profit oriented logic. Since there is a great European tradition of immigration, there are countless people who silkworm rearing for family tradition, even without aiming a commercial interest. Although volumes reared by these subjects are minimal, makes the activity is not odd to people.

This tradition allowed a great diffusion of sericulture for educational purposes. These educational institutions of different levels (kindergarten, primary, secondary, agro-technical, technological) have progressively incorporated silkworm rearing and silk handicrafts in their curricular activities. For the most part these are schools with people in situations of vulnerability, many of them located in rural areas. Until 2012 were detected around 200 institutions that had incorporated sericulture in their educational strategy.

From the experience of many teachers and researchers, was conducted during 2009 a series of participatory meetings that were crystallized in several educational materials used as methodological guidelines for other schools, as Pescio (2010b).

Non mulberry silkworm experiencies.

There are in Argentina several native species of Lepidoptera belonging to Rothschildia genre (*R. schreiretiana., R. jacobaceae*, *R. maurus,* among others).

Indigenous-peasant communities of northern region of the country developed techniques for collecting and processing these lepidopterous cocoons for hundreds of years. However, this knowledge was gradually disappearing. Actually, there are some research institutes, as the University of Cordoba (Beccacece Hernán M 2011; Zapata 2005) making efforts to systematize these techniques, studying their biological cycles, feeding and reproductive habits. The main goal is to establish a system that can increase and maintain its sustainability. While this is an incipient study, its correct use will allow vast marginal rural areas could improve their economic situation, generating enhancement of resources that has the forest.

Conclusions

Sericulture has given a new impetus in Argentina, although the results are still limited. While it has a historical tradition, its development in the last fifty years was minimal. From the deep economic crisis that occurred in the 90s, new producers began to emerge, but in a disorganized way. From technological supporting institutions began to be developed and extension development strategy, so that could sericulture mainly generates income for farm families, but also fulfills other social and productive functions. However, the learning process took several years.

The current objective is not to position Argentina as a country provider of fresh cocoons or silk yarn, especially regarding to high volumes. This development differs from previous historical experiences, where the industry had a strong presence. The orientation is predominantly small scale; strengthen products that have high added value, with short channels of commercialization and distribution as fairly as possible between each link in the chain. This calls for coordination and consensus among stakeholders. An important point is the price fixation mechanism used up today. These prices, notoriously different to international markets, surely act as an incentive to production, expecting an increase in production volumes. While the production volume increase due to the incentive of good prices, will be able to satisfy the demand. This will undoubtedly lead to a gradual decline in the price.

There is a sort of productive autonomy in several producers, which appear and disappear from the market, according to prices, interest, etc.. This autonomy is given as they make their self-production of low-quality eggs, produce their own yarns and commercializes in the region. This can be a strength, since they operate without external or state intervention; but it is a problem too, because they can not improve quality, it is impossible to generate volumes that allow the development of other marketing channels and is always the risk of diseases.

In analyzing the issues raised in 2002, we see that a significant portion of it was resolved, leaving even some initial problems unresolved, as domestic production of hybrid eggs and good mulberry cuttings supply.

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Cooperation to increase silk production in Latin America

By

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(ORAL PRESENTATION)

ABSTRACT: Brazil is the second world's largest exporter of raw silk and Brazilian sericulture generates one direct job for each hectare planted with mulberry trees. In 2011 sericulture was responsible for maintaining approximately 10.000 jobs among small farmers in Brazil. In Latin America, several government initiatives aimed at the production of silk cocoons, as an economic alternative for small farms, have not achieved the expected results. Among reasons for this scenario there are the high asset specificity of silk production chain and the existence of different barriers to entry for new participants. Further to current and forecasted silk production in Brazil, this paper describes recent silk producing initiatives in Argentina, Bolivia, Chile, Colombia, Ecuador, Mexico, Paraguay, Peru and Venezuela, proposing a cooperation network based on existing silk industry in Brazil to face these obstacles. This network aims to provide coordination and guidance to produce and trade high quality cocoons, contributing to overcome difficulties that so far have prevented sericulture growth in Latin America.
Keywords: cooperation network; sericulture; Latin America

INTRODUCTION

Brazil occupies a prominent position in the international silk market due to the quality of raw silk produced (Thomas, 2009). Besides Brazil, several Latin American countries have sought the development of sericulture as an alternative to economic exploitation to be developed on small farms. Each one of Latin American countries which invested in sericulture has a considerable number of farmers who could benefit from economic exploitation of sericulture, which is known to be labor intensive.

However, none of these several government actions to support private initiatives of silk cocoons production as an economic alternative for small farms, has achieved expected results. Among many reasons for this scenario, it can be mentioned the high asset specificity presented by silk production chain and existence of different barriers to entry for newcomers. This paper presents a proposal for a cooperative network based on existing silk industry in Brazil to overcome these obstacles. Such cooperation network will have governance based on institutional trust that allows coordination of efforts that may lead to an increase of cocoon production in different countries of Latin America.

To achieve this goal this paper is divided into two sections, besides this introduction and the conclusion. First section presents a theoretical framework on the institutional aspects that may have influenced the projects conducted in Latin America in recent decades. Second section is a brief history and current situation of sericulture in some Latin American countries.

1 - Institutional Aspects

1.1 - Industry and competitiveness

In the implementation of a new industry defined by Porter (1986) as a group of companies manufacturing similar products, it is remarkable the effects of aspects such as competitiveness, existence of specific assets and barriers to entry for newcomers. The settlement of cooperation networks in many cases is the answer given by companies to these difficulties. Confidence is a key factor in the formation of cooperation networks and proper governance determines its consolidation and growth.

According to Porter (1986), competitive industries are those whose companies have the capacity to improve and innovate to maintain a competitive advantage. The author identifies as one of the key elements of competitive advantage the existence of suppliers, distributors and competitive customers, stressing the fact that a vertical relationships of dependency have great influence on the performance of companies. Also according to Porter, in a systemic environment competitiveness isn't related only with individual capabilities, but also with the perception of interdependence and interrelatedness among the actors in the chain of activities.

1.2 - Asset Specificity

Williamson (1996) says that interaction between different actors in a chain of activities is strongly impacted by the specificity of assets involved in the transactions. The asset specificity refers to the ability to use assets for other purposes without reducing its value. Thus, the higher is the specificity, the lower is asset's value to other uses and therefore the greater the risk involved in a transaction. For Williamson the specificity happens in six distinct types: a) locational, involving the distances between companies, transportation and storage costs; b) physical, concerning the use of the asset; c) human, related to training of manpower; d) brand specificity; e) dedicated assets, where existing assets do not have alternative uses; f) temporal specificity, which refers to the period in which the transaction occurs.

If the level of asset's specificity in the production of an item is low, transactions between agents can occur via market, governed by relative prices. As the level of specificity increases, costs are added to the renegotiation process, resulting inefficient the use of market governance (Williamson, 1996). The increase in asset's specificity favors the emergence of cooperation networks, which are forms of relationship based on lasting and intensive cooperation between companies, different than anonymous market relations, without reaching the level of formalized hierarchical relationships. For Williamson (1996), intermediate forms of governance allow the reduction of transaction costs without losing the dynamism and flexibility through market relations.

1.3 - Cooperation Networks

Among different forms of organizational flexibility described by Castells (1999) there is the model of multidirectional cooperation networks, implemented between small, medium and even large companies. According to the author, small and medium enterprises often take the initiative of establishing relationships in networks with several companies of different sizes, finding market niches and cooperative ventures.

The settlement of a cooperation network implies the need for coordination. For Williamson (1996) coordination is not an intrinsic characteristic of supply chains, but the result of economic agents' actions. In order to reduce transaction costs, agents make use of appropriate mechanisms to regulate a particular transaction, establishing a governance structure. Governance, according to Williamson (1996) is the driving structure aimed at achieving reliable and efficient contracts in a continuous process by which it is possible to accommodate conflicting interests in order to overcome difficulties presented by the market.

1.4 - Barriers to Entry

Porter (1986) points out that among difficulties faced in market there are barriers to entry for newcomers in a particular industry. Based on the analysis of the determinants of their existence and their magnitude, the barriers to entry can be classified into five basic types: a) product differentiation b) access to distribution channels, c) training of qualified human resources; d) economies of scale and e) high initial investment.

1.5 - Reliability

Trust plays a key role on overcoming the barriers to entry and difficulties related to assets' specificity. As well as on the accommodation of conflicting interests between companies within a cooperation network. Coleman (1990) says that social actors are completely motivated by self-interest and argues that decision to trust or not is constructed by a rational calculation. In making this calculation, social actors determine the gain and potential loss arising from the act of trust and the probability that gain outweighs loss makes it possible to assume the risk to invest in trust. The risk of trust is related to the return obtained by the actor who trusts. If this perspective does not leave a clear return for these players, they will not invest in trust (Coleman, 1990).

For Zucker (1986), trust can be divided into three types: a) process based: arises when the relationships are shown stable over time, b) based on characteristics: it assumes that shared characteristics such as family ties, religion or ethnicity may be good reasons to trust c) institution-based trust: comes into operation when trust is tied to the existence of formal structures in society, regardless of momentary preferences and actions of individuals. The existence of institutions and agents in a local production system with strong credibility among companies contributes to the development of this type of trust.

2 – Silk cocoon production in Latin America

According to the International Sericultural Commission (ISC 2012) in 2010 world production of cocoon was 789.313.200 kg. Of this total China, India, Thailand and Brazil accounted for 99.95% of production. The world's largest producer China was responsible for 82.2% of production and India answered for 16.6% of world cocoon production. Thailand with production of 4.655.000 kg and Brazil, with production of 4.439.000 kg respectively accounted for 0.59% and 0.56% of world production.

The sericulture has great potential to generate jobs and income among small farmers. In Latin America, in February 2001, has been created a network called Red Andina de la Seda, now called Red Latinoamericana de la Seda, aiming to promote local and regional synergies, enabling cooperation among Latin American countries in order to promote concrete actions towards the sustainable development of sericulture (RAS, 2001).

As shown in **Table 1**, in countries belonging to the Red Latinoamericana de la Seda, in 2010 there were 306 silkworm rearing farmers, with a production of 6.528 kg of cocoon. Colombia accounted for 79% of this production.

Table 1
Silkworm rearing farmers, craftsmen and production of silkworm cocoons in countries of Red Latinoamericana de la Seda - Year 2010

Country	Number of craftsmen	Number of silkworm rearing farmers	TOTAL	Cocoon production (kg)	%
ARGENTINA	15	30	45		
BOLIVIA	12	3	15	42	1%
COLOMBIA	155	180	335	5.175	79%
EQUADOR	25	10	35	517	8%
PERU	49	78	127	794	12%
CUBA		2	2		
GUATEMALA	10	3	13		
TOTAL	**266**	**306**	**572**	**6.528**	**100%**

Source: Red Latinoamericana de la Seda (Cifuentes, 2012)

2.1 - Sericulture in Argentina

In 2004 Argentine National Congress enacted Law No. 25,747, regulated by Decree 526 in 2007, as a way to promote a significant increase in the activities of sericulture. The decree establishes the creation of tax incentives to encourage industrial scale of cocoon production in the country. Among provinces that joined the terms of Law No. 25,747 there are Salta, Catamarca, La Pampa and Misiones. However, the combination of actions from state institutions and companies did not impact significantly sector's development (Vieites et al. 2010).

Also according Vieites et al. (2010) the lack of coordination and common goals, originating from ignorance or indifference to the potential of sericulture and the existence of individual interests that overcomes collective interest has prevented cooperation, keeping each sector isolated from others and disrupting sericulture development. The authors emphasize that under any circumstances, there will always be people or companies that achieve success, finding the path to the expense of their own initiatives. However, aiming the development of a sector, continuous efforts must be made to ensure the integration of the chains, assuring a fair price for each activity.

2.2 - Sericulture in Bolivia

Bolivia had their projects funded by Propise - Pilot Proyeto Serícola del Centro de Investigación Tropical Agriculture (CIAT), through funding sources of the Bolivian government, resources of United States Agency for International Development (USAID PL480) and World Bank resources. From 1990 to 1997 there were two companies of Korean origin operating in Bolivia in the production of silk cocoons. In 1997, after great difficulties, both companies were closed (Cifuentes, 1997).

After the frustration of projects developed with Korean companies due to the 1998 crisis, in 2000 with the goal of finding new markets for sericulture, it has been built a silkworm cocoon drying unit in the town of La Guardia through a cooperation project between the city government and silk rearing farmers. Also in 2000 the city of Santa Cruz, through the Provincial Resolution No 532/2000 created a three-year plan (2000-2003) for development of the Project Technology Transfer Sericulture - PROTTESE. The objective of this project was to develop and transfer technology to farmers through specialized technical assistance for the implementation of mulberry cultivation and silkworm breeding as alternative for sustainable income generation for household farmers. In 2004, production was halted and cocoon farmers were awaiting the establishment of a revolving fund, financed by IILA - Istituto Italo-Latino Americano, dedicated to finance the purchase and production of cocoons (Vieites et al., 2010).

2.3 - Sericulture in Colombia

In the 80s two Korean companies have established themselves in the cities of Pereira (Cokosilk SA) and Popayan (Cosedas). These investments were motivated by the high prices of raw silk in the international market. In 1992, the price of silk in the international market suffered a dramatic decline, leading to immediate closure of the company Cosedas, and a complete change in the original design of the company Cokosilk in the city of Pereira (Cifuentes & Sohn, 1998).

In 1993 a bilateral agreement was signed between Colombia and the European Union (Project ALA 91/31), aiming to cultivate around 1,500 hectares of mulberry trees that would support the production of cocoons to be reeled on a reeling unit to be installed in the municipality of Santander Quilichao. In 1994, the Centro de Desarrollo Tecnologico de Sericulture - CDTS was created with the objective to develop a technology to promote sericulture through determination and development of silkworm hybrids adapted to Colombia. Silkworm eggs produced by CDTS have already been exported to Bolivia, Ecuador, Venezuela and the Canary Islands (Cifuentes & Sohn, 1998).

In 1998, the EU decided to interrupt the support to sericulture department of Cauca, since the project has not developed as planned, causing demotivation among silkworm rearing farmers. But one group remained motivated and in 2000 founded the Corporation for the Development of Cauca Sericulture - Corseda, which integrates silk producers and artisans of the region, as well as ten local organizations. Corseda aims at self-sustainability to cope any crisis that may come in the future. Aiming to reduce conflicts of interest between silkworm rearing farmers and artisans in search of a continuous integration process, Corseda created a standard for cocoon's quality and size, and also a minimum selling prices index for fabrics in order to prevent unfair competition between organizations and between artisans in each one of their groups (Vieites et al., 2010).

Also according to Vieites et al. (2010), Corseda silkworm rearing gathers 170 farmers and 120 artisans in the municipalities of El Tambo, Timbío, Popayan, Piendamó, Morales, Caldono, Santander and Quilichao Caloto. They are grouped into five associations of silkworm rearing farmers and five associations of artisans and farmers. Among the associates the illiteracy levels are around 65% and the percentage of families with incomes below the poverty line reaches 75%. The articulation process of Corseda altered substantially the relationship between producers and artisans. It makes them realize the exiting interdependence between them and the necessity of an organization that would act to resolve conflicts and provide services that improve sericulture in Cauca. The involvement of affiliates with the Corporation increases transparency in the management and for its members Corseda is also a place to meet friends, further to provide cocoon producers a guaranteed market for their products and a safe and close source of raw material to artisans.

2.4 - Sericulture in Cuba

Considering sericulture as an alternative to agricultural diversification within a sustainable regional development policy, Cuban government created in 2004 at the Experimental Station of Pastures and Forages "Indio Hatuey" a Programme for Sericulture Research, Innovation and Production, whose main objective is to introduce and promote sustainable development thru production and trade of silk items. Results got since 2006 at Indio Hatuey SCFE show that on small scale, high quality cocoons can be produced in Cuba. Sericulture fits in agricultural diversification policy that seeks alternatives to sugar cane production. The growth of tourism is an attractive market for handmade silk products that may be produced in the country (Vieites et al., 2010).

2.5 - Sericulture in Ecuador

According to Cifuentes (2012) the production of silkworm cocoon in Ecuador in 2010 was 517 kg, and the country had ten silk rearing farmers and 25 artisans. Current figures indicate a considerable reduction in the number of silkworm rearing farmers since 2004. Data from Red Latinoamericana de la Seda report that in 2004 there were 500 farmers trained and more than 110 hectares of mulberry trees planted in 11 different provinces. There were a hatchery for silkworm eggs and an acquisition cocoon unit at Penipe. At distribution center there were about 990 kg of first grade dry cocoon, 82 kg of second quality dry cocoon (produced in the years 2001, 2002 and 2003), along with a stock of yarn processed and finished piece goods. Center also has a space for training in handicraft production, where about 95 craftsmen were trained in the process of reeling, dyeing and weaving (Vieites et al., 2010).

2.6 - Sericulture in Mexico

In order to support sericulture among more vulnerable rural communities, the Ministry of Agriculture and Rural Development (SAGAR), developed since 1991, the National Sericulture Project. Since 2009, the Mexican Government, through the State System of Family Development (DIF), the Ministry of Rural Development (SEDER), and Ministry of Agriculture Livestock, Rural Development, Fisheries and Food (SAGARPA) support sericulture, delivering the silkworms to silkworm rearing farmers and artisans of the regions of Sierra Norte Valle Central Mixteca y (Vieites et al., 2010).

From 1995 to 2012 have been delivered about 15 million heads of silkworms for the sector which now has 100 ha planted in different parts of the state of Oaxaca, where there is a project to settlement of a silkworm production centers in order to extend their service to small farmers in the region (AMIA, 2012).

2.7 - Sericulture in Paraguay

Also in Paraguay federal government shows interest in sericulture. In 2003 the Ministry of Agriculture and Livestock (MAG) presented the National Sericulture Plan as a line to the diversification of family farming, with the following goals: to strengthen sericulture as a cost effective alternative for small farmers to diversify, optimize the use of resources available and involve the public and private sectors to improve the living standards of rural households involved (Vieites et al., 2010).

A private company has been settled by Italian investors in 1988 aiming cocoon production and silk reeling. The company Seda y Fibras Srl started its activities with the goal of developing a long-term technology transfer, encouraging the development of sericulture in the region and also to produce thrown silk. The supply of raw material is being done mostly from abroad. Silkworm cocoons and raw silk came mostly from Brazil and Turkey, since the capacity of raw silk production reaches only 6% of what is produced of thrown silk by Seda y Fibras (Vieites et al., 2010).

In 2011, Seda y Fibras signed a cooperation agreement with a Brazilian university located in the State of Paraná, the State University of Maringá – UEM. The agreement’s objective is the maintenance of University’s silkworm germplasm bank and also the development of a breeding program to improve silkworm hybrids races belonging to University. The research project also aims the development of stronger and more productive hybrids (Woehl, 2011).

2.8 - Sericulture Peru

Having decided to promote sericulture development as an alternative to diversify small farmer’s production, on May 5, 2005 Peruvian government has promulgated the Law on the Promotion and Production of Sericulture and Mulberry Cultivation. This law considers sericulture as an important economic activity in Peru, considering it a priority among programs to create alternative to cultivation of coca. In 2007, the Regional Government of Cusco and Peru held a workshop on sericulture, aiming to sensitizing official authorities, heads of public institutions, regional and local members of private sector to support this initiative.

In 2008, the governments of Peru and China have established a Memorandum of Understanding establishing guidelines for cooperation which includes the implementation of a pilot project with the cultivation of two hectares of mulberry in the National Agrarian University of La Selva in Huanuco (Amazonia). The project aims at the future sultivation of 14.000 ha of mulberry to produce silk to Asian market, while promoting joint research and exchange of information which are relevant to implementation and development of projects in areas of extreme poverty (Vieites et al., 2010).

In 2006 there were several projects of different sizes in Peru, and in the central jungle area had a total area of 10 hectares of mulberry, 50 silk rearing farmers and ten artisans. On farms, usually small in size - from 500 m2 to two hectares - there are up to four creations per year. The handmade product made with crochet or loom is sold in local fairs (Vieites et al., 2010).

Sericulture in Venezuela

Sericulture in Venezuela began in the mid-nineteenth century in Merida, Venezuelan Andes. In 1983 was founded the Veneseda also in Mérida, a company dedicated to the study and dissemination of processes and techniques of sericulture and silk weaving. Veneseda maintains close contact with cultural and educational institutions in the country to disseminate sericulture and silk weaving. It has signed cooperation agreements with the Ministry of Agriculture and organizations devoted to regional development and cooperation agreements with foreign companies in the sector (RAS, 2012).

In the early 90s, as an alternative to development of different parts of the country, a project was designed based on the export of cocoon that once reaching industrial scale would be processed in the country. This initiative has suffered a sharp downturn after the sharp decline in the price of raw silk in the international market, making cocoon production not competitive against other farming alternatives (Vieites et al., 2010).

Even in the 90s, the company resumed its initial orientation, promoting activity and making the entire production process to obtain handmade pieces sold on the domestic market in Venezuela. The search for international cooperation agreements has continued and in 2012 with the support of IILA - Istituto Italo-Latino Americano, Veneseda received a donation of machine for silk yarn twisting from a Italian company named Torcitura di Domaso (RAS, 2012th).

2.10 - Sericulture in Brazil

According to the International Sericultural Commission (ISC 2012), Brazil is the second largest exporter of raw silk. China is by far the first. The State of Paraná accounts for 91.95% of the Brazilian silk cocoon production and about 88% of the Brazilian production of silk yarn is exported as raw silk or thrown silk. Facing a world market unfavorable to export of raw silk, there was a disincentive to rural areas, especially among producers who work under a partnership system, causing a decline in the number of Paraná silkworm rearing farmers, which went from 7.914 in 1998 to 3.947 in 2010 (SEAB-PR, 2010). Table 2 shows the performance of cocoon production in Brazil between 1991 and 2012.

Due to the reduction of silk cocoon production, Brazilian silk reeling industry works with idle capacity while demand for silk in the international market for Brazilian silk seems remains stable. The fluctuation in raw silk price in the international market has a direct influence on prices paid to Brazilian cocoon. In 1989, with the international market heated, the average price paid to the producer in Brazil was US$3.51/kg of fresh cocoon. Decline in the price of silk yarn in the international market in early 90s has kept the price paid to fresh cocoon from 1991 to 2000 in the range of US$ 2.19/kg of fresh cocoon. From January 2001 to May 2010 the average price paid was US$ 2.51/kg of fresh cocoon (SEABR-PR, 2010a).

In the season 2011/2012, under a bullish raw silk international market the average price of R$10,89/kg to first quality fresh cocoon was paid to Brazilian producers. In the season 2012/2013, which started in September/2012 the price settled to a first quality 15% silk content cocoon was R$10,00/kg (US$4.90/kg) and estimated average price to be paid in the 2012/2013 crop is R$11,90/kg of first quality fresh cocoon (US$ 5.83/kg), according to BRATAC (2012).

The prospects for the exports of Brazilian raw silk in the international market are optimistic and it requires the development of close partnerships with all segments of producers and their organizations as well as agencies of municipal, state and federal government. In this sense, IAPAR, EMATER and Federal and State Universities of Paraná promoted throughout 2009/2010 crop several courses, research projects for the modernization of silkworm rearing sector in Paraná (PR-SEAB, 2010).

Also according to SEAB-PR (2010) among these projects it can be highlighted actions to enhance Brazilian silk production chain aiming the local production of silk items in order to reduce the percentage of raw silk exported. In this sense, the Project Vale da Seda, proposed by Technology Incubator of Maringa, emphasizes sustainable regional development and enabled the creation of a Cooperative of Silk Handicraft Producers - Artisans Brazil. This cooperative, formed by 40 women living in rural area of Nova Esperança city, exports scarves and other handmade silk items to fair trade network called Artisans Du Monde, in France.

Table 2
Brazilian production of silkworm cocoon by companies from 1991 to 2012
(Tons)

Year / Company	Bratac	Kanebo/ Fujimura	Cocamar	Kobes	Shoei	Cooperseda	TOTAL
1991 / 92	7.865	3.603	2.663	1.460	1.514	481	17.586
1992 / 93	8.784	3.909	2.777	1.464	1.779	421	19.134
1993 / 94	9.048	3.716	2.299	1.200	1.719	278	18.260
1994 / 95	8.477	3.454	1.727	1.075	1.527	CD	16.260
1995 / 96	9.046	3.185	1.293	1.111	733		15.368
1996 / 97	8.999	3.332	1.376	1.104	CD		14.811
1997 / 98	9.175	3.792	1.627	CD			14.594
1998 / 99	6.603	2.669	1.033				10.305
1999 / 00	5.495	2.343	635				8.473
2000 / 01	6.290	2.900	726				9.916
2001 / 02	6.897	2.381	960				10.238
2002 / 03	6.871	2.204	891				9.966
2003 / 04	5.504	1.853	648				8.005
2004 / 05	4.833	1.767	546				7.146
2005 / 06	5.609	1.877	565				8.051
2006 / 07	6.516	2.101	CD				8.617
2007 / 08	4.709	1.557					6.266
2008 / 09	3.610	1.225					4.835
2009 / 10	3.368	1.071					4.439
2010 / 11	3.037	CD					3.037
2011 / 12	2.601						2.601

CD = Closed Down
Source: BRATAC, 2012

CONCLUSION

Despite efforts made by federal governments in various countries in Latin America, yet it was not possible to guarantee the development or maintenance of initiatives that were designed to produce silkworm cocoon by small-scale producers. In Brazil, silk ensures the generation of on job in rural areas for each hectare planted mulberry (ABRASSEDA, 2002), supported by a reeling industry very well positioned in the international raw silk market and that is working with idle capacity due to the reduction of silkworm cocoon production.

Sericulture equipments are exclusive, having no value if intended for other activities. Asset specificity of silk production chain is also observed on manpower training and qualification. The necessary training of human resources, including farmers, is also a barrier to entry for new participants in the silk chain of production, which added to the barriers on access to clients and necessity economy of scale to reach economic viability of the whole chain, can be pointed out as aspects that influenced significantly on the failure of several initiatives to encourage sericulture in Latin America in recent decades: the lack of qualified producers on the cocoon production prevented the operation of silk cocoon reeling units and weaving on an industrial scale. On the other hand, the lack of stable demand for cocoon production at prices and quality previously fixed prevented the training of producers to expand production.

Under such considerations, it could be said that based on current international raw silk market conditions and institutional environment in several Latin American countries, recent investments in sericulture may have a different result than investments made in the 90s, if a cooperation network based on institutional trust governance could be settled. This network would coordinate efforts towards to increase production in different countries, if the cocoon production is intended to meet the demand of Brazilian silk reeling industry, which has already achieved scale of production and has consolidated distribution channels. This new proposed structure of cooperation would enable the development of the whole silk chain in the region, mostly among family farmers.

As suggestion of future research there is a study on the technical and economic feasibility of deploying a cooperation network between a silk reeling industry in Brazil and entrepreneurs in Argentina, Bolivia, Chile, Cuba, Colombia, Ecuador, Mexico, Paraguay, Peru and Venezuela, seeking the production of silk cocoons on a industrial scale. It is worth noting that Vale da Seda project, developed at Technological Incubator of Maringá, points out that large scale cocoon production provides a favorable environment for development and support of silk handcraft production, which could gradually increase on the consumption of the silk cocoon stably produced in the region.

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SERICULTURE STATUS, PROBLEMS, ISSUES AND DEVELOPMENT STRATEGIES IN AZERBAIJAN

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ABSTRACT: The sericulture in Azerbaijan has an ancient 1500 years history and famous traditions. According to historical sources, azerbaijanians have started to be engaged with sericulture still in V th century A.D. In 15th – 17th centuries the Azerbaijan silk was very popular in the markets of Italy, France, Russia, Turkey, Iran and other countries of Europe and Asia. However the most powerful and stably sericulture development in Azerbaijan has been achieved during the Soviet authority. In 1925 in the city of Gandja, a Republican Sericulture Experimental Station was established and further was transformed into Azerbaijan Sericulture Research Institute (ASERI) in 1958. The volume of fresh cocoons production in republic started to increase in the line of ascent, reaching 3113 tons in 1960, 3664 tons in 1970, 4981 tons in 1980 and at last in 1989-the highest level of volume of cocoon production for all history of sericulture in Azerbaijan - 5924 tons has been produced. During this period in republic 3.6-4.3 tons (288000-344000 boxes) various categories of silkworm eggs were produced in total annually by operated two P_3-P_1 stations and 7 hybrid egg production factories. With the silkworm rearing/cocoon production were engaged more than 150 000 country families (families of collective farmers and state-farm workers). Sericulture development and increase in production of cocoons in republic stimulated also development of the silk industry. In republic have been created 3 large silk processing enterprises: Sheki silk reeling and textile factory, Ordubadskaja and Hankedinskaja silk reeling factories. In these enterprises it was annually made 250-350 tons of raw silk, more than 30 million sq. meters of a ready fabric and various final products. 10-15 % of the production made were consumed inside our republic, and 85-90 % were sent in other republics of the former USSR. At that time only in Sheki silk reeling and textile factory worked more than 7 thousand person. The government of republic planned to reach a volume of cocoon production by the year 2000 with 10 thousand tons. The respective increase in manufacture of raw silk was planned also. However, these plans could not come true. In 1991 Azerbaijan, the first among all union republics, has officially declared secession of Soviet Union and then manufacture of cocoons and raw silk in Azerbaijan began to be reduced annually. After 1996 cocoon and raw silk production in the in republic has practically been nearly stopped. The reason of such decline of sericulture and the silk industry were set of factors, basic of which, in our opinion, the following:
1) After disintegration of Soviet Union, all economic relations well organized up to that time between former union republics have broken.

2) Occupation of 20 % of territory of Azerbaijan by Armenia, since 1988. In an occupied zone have remained some large sericultural areas, which in total annually made more than 1000 tons of cocoons annually.

3) The deep economic crisis during 1990-1995 and unprecedented rates of inflation in the republic, reached some hundreds, and sometimes and up to thousand percent. The sericulture farmers handed over made by them fresh cocoons to the procuring organizations in June, and money for the fresh cocoons received in 5-6 months, at the end of the year. For this time, as a result of strong inflation, purchasing capacity of money was considerably reduced. It was reduced very much with interest of farmers to rearing of silkworms.

4) Strong easing of the forage reserve of sericulture in the republic. The crisis phenomena occurring in the beginning of 90th years have affected also system of power supply in the republic. Sharply there was no electric energy, natural gas and coal. The population during this period has cut down a significant part of mulberry plantations.

It is necessary to note, that despite of all dramatic character of position, in Azerbaijan still there are big potential opportunities and all necessary preconditions for revival and development of sericulture and the silk industry. In the country there are very favorable climatic conditions for cultivation of the mulberry and silkworm, as well as though also out-of-date, but still suitable to use of the facilities and equipment two P_3-P_1 egg production stations and 7 hybrid egg production factories, 80 centers for cocoon drying and storage, located in 30 areas of the republic, indefatigable interest of farmers to sericulture in which their fathers, grandfathers and great-grandfathers were engaged, presence of rich genetic resources of the silkworm and mulberry. And at last, the most important precondition for revival of sericulture appears to be the transformation of Sheki silk reeling and textile factory in a joint-stock company "Sheki Ipek". The government has allocated to this joint-stock company of 2 million US$ for carrying out of improving actions of manufacture. Now potential annual capacity of joint-stock company "Sheki Ipek", under condition of the organization of two-shift work, makes 150-200 tons of raw silk for what as raw material it is required more than thousand tons of fresh cocoons.

On the basis of the analysis carried out we count, that for sericulture revival in Azerbaijan it is necessary to realize the following suggestions in the near future:

1) to organize silkworm breeding system in the form of scientific-breeding association with inclusion here one P_3-P_1 egg production station, two hybrid egg production factories and Azerbaijan Sericulture Research Institute (ASERI) as governing and coordinating agency. Association in the first 4-5 years it should be financed by the state, and then gradually to pass to self-financing;

2) to organize open joint-stock company on primary cocoon processing, with transfer to it all the property (equipment, drying machines, buildings etc.) of the former regional sericultural centers, which will play a role of the intermediary between the silkworm egg producers, sericultural farmers and silk reelers. In the first 4-5 years a control share holding of the joint-stock company should be at the government on behalf of the Ministry of Agriculture or the Ministry of economic development of republic, and then it is gradually possible to carry out full privatization of joint-stock company;

3) to allow to accept to foreign investors individual share in creation and activity joint-stock company on preparation and a preprocessing of cocoons.

We, agree also with such opinion, that for more successful solving of all problems and the reasons preventing sericulture revival in all countries of the region, it is necessary to undertake joint efforts. For this purpose, national coordinators of the BACSA should joint efforts to make various international projects on sericulture and to achieve their financing from the various international organizations, in particular at EU, ISK and FAO.

1. INTRODUCTION

The sericulture in Azerbaijan has an ancient 1500 years history and famous traditions. According to historical sources, Azerbaijanians have started to be engaged with sericulture still in V th century A.D.[1] Glorified all over the world, due to high quality, the Azerbaijan silk since XII century, began to export on the Great Silk Road to the countries of Asia and Europe [2]. In 15th – 17th centuries the Azerbaijan silk was very popular in the markets of Italy, France, Russia, Turkey, Iran and other countries of Europe and Asia [3]. It led to formation not only trading, but also cultural and political connections of Azerbaijan with other countries of the world.

The most powerful and stably sericulture development in Azerbaijan has been achieved during the Soviet authority, due to putting the industry on a wide scientific basis. In the first years of the Soviet authority have been organized silkworm egg production stations in Zakatala, Sheki, Goekchay and Kjurdamir areas. Due to activity of these silkworm egg production stations, since 1929 delivery of silkworm eggs from abroad has been stopped, also the republic began to satisfy the needs of silkworm eggs by own manufacture. In 1925 in the city of Gandja, a Republican Sericulture Experimental Station was established and further was transformed into Azerbaijan Sericulture Research Institute (ASERI) in 1958. This scientific institute has played a significant role in development of sericulture in Azerbaijan. Here have been created set of highly productive mulberry varieties, white-cocoon silkworm breeds and hybrids, possessing high efficiency and the best technological parameters of cocoons, have been developed a number of effective technologies on silkworm rearing, on cultivation and harvesting of mulberry, on primary processing of cocoons. As a result of wide introduction of all these scientific achievements in the practice, the volume of fresh cocoons production in republic started to increase in the line of ascent, reaching 3113 tons in 1960, 3664 tons in 1970, 4981 tons in 1980 and at last in 1989-the highest level of volume of cocoon production for all history of sericulture in Azerbaijan - 5924 tons has been produced. During this period in republic 3.6-4.3 tons (288000-344000 boxes) various category of silkworm eggs were produced in total annually by operated two P_3-P_1 stations and 7 hybrid egg production factories. With the silkworm rearing/cocoon production were engaged more than 150 000 country families (families of collective farmers and state-farm workers).

Sericulture development and increase in production of cocoons in republic stimulated also development of the silk industry. In republic have been created 3 large silk processing enterprises: Sheki silk reeling and textile factory, Ordubadskaja and Hankedinskaja silk reeling factories. In these enterprises it was annually made 250-350 tons of raw silk, more than 30 million sq. meters of a ready fabric and various final products. 10-15 % of the production made were consumed inside our republic, and 85-90 % were sent in other republics of the former USSR. At that time only in Sheki silk reeling and textile factory worked more than 7 thousand person. The government of republic planned to reach a volume of cocoon production by the year 2000 with 10 thousand tons. The respective increase in manufacture of raw silk was planned also.

However, these plans could not come true. In 1991 Azerbaijan, the first among all union republics, has officially declared secession of Soviet Union. After it and other union republics have started to leave structure of the USSR. In 1992 the Soviet Union disintegrated. From now on manufacture of cocoons and raw silk in Azerbaijan began to be reduced annually. After 1996 cocoon and raw silk production in the in republic has practically been nearly stopped.

The reason of such decline of sericulture and the silk industry were set of factors, basic of which, in our opinion, the following:

1) After disintegration of Soviet Union, all economic relations well organized up to that time between former union republics have broken. In consequence of it, the products of Sheki silk reeling and textile factory (raw silk and other products), 85-90 % of which during Soviet time were sent for realization in other union republics, began to collect in warehouses of the factory. The incompetence of the heads of factory at that time and absence of a control over the

governmental organizations for search of foreign markets on realization of the saved up goods, has resulted the Sheki silk reeling and textile factory in insolvency. The factory could not pay off with regional offices on cocoon purchasing, drying and storage for purchased at them dry cocoons. In turn the regional offices on cocoon purchasing, drying and storage could not pay off with sericulture farmers for purchased at them fresh cocoons and with the silkworm egg production factories for the industrial (hybrid) eggs. The hybrid silkworm egg factories could not pay off with P_3-P_1 egg production stations for the P_1 silkworm eggs. As a result all the above-stated parts of sericultural system of the republic have stopped their activities;

2) Occupation of 20 % of territory of Azerbaijan by the Armenian aggressors, since 1988. In an occupied zone have remained such large sericultural areas as Zangilinskii, Gubadlinskii, Djabrailskii, Fizulinskii and Agdamsky, which in total annually made more than 1000 tons of cocoons. In an occupied zone has remained and Hankedinskaja silk reeling factory.

3) The deep economic crisis during 1990-1995 and unprecedented rates of inflation in the republic, reached some hundreds, and sometimes and up to thousand percent. The sericulture farmers handed over made by them fresh cocoons to the procuring organizations in June, and money for the fresh cocoons received in 5-6 months, at the end of the year. For this time, as a result of strong inflation, purchasing capacity of money was considerably reduced. It was reduced very much with interest of farmers to rearing of silkworms.

4) Strong easing of the forage reserve of sericulture in the republic. The crisis phenomena occurring in the beginning of 90th years have affected also system of power supply in the republic. Sharply there was no electric energy, natural gas and coal. The population during this period has cut down a significant part of mulberry plantations.

It is necessary to note, that despite of all dramatic character of position, in Azerbaijan still there are big potential opportunities and all necessary preconditions for revival and development of sericulture and the silk industry. In the country there are very favorable climatic conditions for cultivation of the mulberry and silkworm, as well as though also out-of-date, but still suitable to use of the facilities and equipment two P_3-P_1 egg production stations and 7 hybrid egg production factories, 80 centers for cocoon drying and storage, located in 30 areas of the republic, indefatigable interest of farmers to sericulture in which their fathers, grandfathers and great-grandfathers were engaged, presence of rich genetic resources of the silkworm and mulberry. And at last, the most important precondition for revival of sericulture appears to be the transformation of Sheki silk reeling and textile factory in a joint-stock company "Sheki Ipek". The government has allocated to this joint-stock company of 2 million US$ for carrying out of improving actions of manufacture. Now potential annual capacity of joint-stock company "Sheki Ipek", under condition of the organization of two-shift work, makes 150-200 tons of raw silk for what as raw material it is required more than thousand tons of fresh cocoons.

Despite of the set forth above potential opportunities, the sericulture revival in republic it is braked by the following principal causes:

- absence of local production of parental and hybrid silkworm eggs, basically due to the lack of financial support of the government;
- absence of a good links between the silkworm egg producers, cocoon producers (farmers) and raw silk producers;
- absence of a price policy in the field of sericulture and effective economic mechanisms of payments between the silkworm egg producers, cocoons and raw silk producers.

On the basis of the analysis carried out we count, that for sericulture revival in Azerbaijan it is necessary to realize the following suggestions in the near future:

1) to organize silkworm breeding system in the form of scientific-breeding association with inclusion here one P_3-P_1 egg production station, two hybrid egg production factories and Azerbaijan Sericulture Research Institute (ASERI) as governing and coordinating agency. Association in the first 4-5 years it should be financed by the state, and then gradually to pass to self-financing;

2) to organize open joint-stock company on primary cocoon processing, with transfer to it all the property (equipment, drying machines, buildings etc.) of the former regional sericultural centers, which will play a role of the intermediary between the silkworm egg producers, sericultural farmers and silk reelers. In the first 4-5 years a control share holding of the joint-stock company should be at the government on behalf of the Ministry of Agriculture or the Ministry of economic development of republic, and then it is gradually possible to carry out full privatization of joint-stock company;

3) to allow to accept to foreign investors individual share in creation and activity joint-stock company on preparation and a preprocessing of cocoons.

We, agree also with such opinion, that for more successful solving of all problems and the reasons preventing sericulture revival in all countries of the region, it is necessary to undertake joint efforts. For this purpose, national coordinators of the BACSA should joint efforts to make various international projects on sericulture and to achieve their financing from the various international organisations, in particular at EU, ISK and FAO.

2.Summary Review of Sericultural Statistics 2008 ~ 2012

And now, I would like to analyze a condition sericulture and the silk industry of republic for last 5 years (2008-2012). As I have already mentioned, in 1991 Azerbaijan left structure of the USSR. In 1992 Soviet Union has completely collapsed. Degradation processes in sericulture and the silk industry from now on have begun, and after 1996 there was their full decline which remains and nowadays. The areas of mulberry plantations in republic since 2002 began to decrease catastrophically. The matter is that local authorities began to distribute mulberry plantations to local population, in particular young family for construction of apartment houses and subsidiary economic constructions.. In 2008 of the area of mulberry trees have made only 236 hectares, i.e. In comparison with 1992 have decreased in 85 times. Proceeding from it, experts of JSC Sheki-Ipak and ASERI all forces have directed on planting of linear plantings along roads, irrigation canals and on personal plots of the farmers who are engaged sericulture (table 1). In 2008, the country produced 17.9 kg and 70.8 kg of elite hybrid silkworm eggs (table 2), which in comparison to 1992, respectively, 9.5 and 61.3 times less Production of live cocoons of 2008 decreased by more than 79 times, and the number of sericultural households 177 times (table 3). Raw silk production (tale. 4) was reduced in 4.3 times. By 2012 all aforementioned indicators have worsened even more (table 1-4).

Thus, by the early 21st century there was a complete decline of sericulture and silk industry in Azerbaijan. We shall consider the most significant and essential reasons caused this decline. In 1991 in republic there was a change of political and economic system. From global practice of mankind it is well-known, that similar revolutionary changes do not occur without serious consequences and without heavy economic consequences. The socialist economy in republic has been destroyed, and the market economy for the present was not generated. During this period in republic reigned economic chaos and there were deep crisis processes. Rates of inflation reached several hundreds, and sometimes and up to thousand percent. According to an existing rule of selling-buying between the manufacturer and the supplier (buyer), accepted since times of the Soviet authority, sericulture farmers handed over made by them fresh cocoons to the purchasing organizations approximately in June, and money for production (fresh cocoons) received at the best in 5-6 months, at the end of a year, and sometimes and in the beginning of the next year. During Soviet time there weren't any problems, as the rate of the Soviet ruble(currency) remained stable. However, during the post-Soviet time, the similar delay of payment for 5-6 months, as a result of strong inflation, led to significant reduction in purchasing capacity of

Table 1

Data about the mulberry trees, mulberry leaf yield and mulberry sapling production in Azerbaijan

Year	Number of mulberry trees, thousands numbers	Average mulberry leaf yield per 1 tree, kg	Production of mulberry saplings, thousands numbers
2008	3474.8	2.0	722.9
2009	4197.7	2.0	722.7
2010	4920.4	2.2	-
2011	4920.4	2.4	490.0
2012	4969.4	2.5	50.0

The note: In 2012 monitoring has been carried out and found out that for the various reasons 2127608 trees were lost

Table 2

Annual production of P_3-P_1 and F_1 silkworm eggs and their selling prices in Azerbaijan

Year	Annual silkworm egg production, kg/boxes		Selling price of 1 kg/1box silkworm eggs in US$	
	P_1	F_1	P_1	F_1
2008	17.920 / 618	70.810 / 2442	11205 / 324.9	6130 / 177.8
2009	6.612 / 228	36.880 / 1272	11391 / 330.3	6211 / 180.1
2010	5.104 / 176	38.454 / 1326	11529 / 334.3	6324 /183.4
2011	4.060 / 140	13.340 / 460	11618 / 336.9	6385 / 185.2
2012	3.745 / 129	14.930 / 515	11923 / 345.8	6555 / 190.1

Table 3

Information about the fresh cocoon production, yield by 1 box of silkworm eggs, cocoon price and the number of sericultural households in Azerbaijan

Year	Fresh cocoon production, ton	Fresh cocoon yield by 1 box of eggs, kg	Purchasing/selling price of 1 kg cocoons in US$		Number of sericultural households
			fresh	dried	
2008	65.865	21.5	3.82	17.74	872
2009	27.307	18.2	3.82	19.58	457
2010	13.576	17.4	3.82	15.25	338
2011	11.173	18.6	3.82	17.55	265
2012	7.490	15.3	3.82	16.52	234

Table 4

Information about the production activity of “Sheki Ipek” J.S.C. during 2008-2012

Items	Volume of production				
	2008	2009	2010	2011	2012
1. raw silk, ton	43.1	24.7	52.9	8.5	2.1
2. twisted silk, ton	14.2	18.4	25.4	20.3	18.7
3. pure silk fabrics, thousands m^2	496.7	543.6	735.8	674.4	660.7
4. silk carpets, m^2	138.4	123.3	126.5	137.6	101.6
5. national style lady’s head cloth “kalagai”, thousands m^2	191.7	219.8	222.3	252.8	25.5
6. costs of 1 kg dried cocoons, $	17.74	19.58	15.25	17.55	16.52
7. costs of 1 kg raw silk, $	78.34	64.58	72.00	79.27	87.13
8. renditta*	3.51	3.19	3.76	4.50	4.04
9. value of the total production, thousands $	5964.3	4724.8	7443.3	5853.5	7547.8
10. value of the production sold, thousands $	2392.4	3374.9	4174.5	5006.4	2760.5

* Amount of dried cocoons, necessary to produce 1 kg raw silk

money received by the farmer which did not correspond to the spent work on manufacture of fresh cocoons. It was reduced very much with interest of farmers to silkworm rearing.

The crisis processes occurring in republic, have affected also system of power supply of the country. There was a sharp shortage of electric energy, natural gas, coal and other heating means. During this period, a significant part of the mulberry plantations of republic have been cut down for heating inhabited and industrial rooms during winter time. It, has led to strong easing of sericulture forage reserve and has negatively affected the fresh cocoon production.

Occupation of 20 % of territory of Azerbaijan by the Armenian separatists also has negatively affected the fresh cocoon production. In an occupied zone have remained such large sericultural areas as Zangilan, Djabrail, Agdam, Gubadli and areas Fizuli which annually made in total more than one thousand tons of fresh cocoons. In an occupied zone has remained also Hankedinskaja silk reeling factory.

After disintegration of Soviet Union, economic relations existing up to that time between all former union republics have broken. As a result of it, the produced by Sheki silk reeling and textile company raw silk/silk allied products, 85-90 % of which during Soviet time were sent for realization in other union republics, began to collect in warehouses of the company. The low competence of company's heads at that time and absence of the help on search of foreign markets for realization of the saved up goods, has resulted the company in insolvency. The company could not pay off with regional sericulture offices (cocoon drying centers) for purchased at them dry cocoons. In turn regional offices on sericulture could not pay off with sericulture farmers for purchased from them fresh cocoons and with egg production factories for hybrid (industrial) eggs. The egg production factories also could not pay off with P_3-P_1 egg production stations for the P_1 eggs. Finally, all above-stated parts of sericultural chain of republic have gone bankrupt and stopped their activity.

During this period, any subsequent years, and all of Azerbaijan Research Institute of Sericulture was the only institution of sericulture, which did not stop their activities. True, this was a great merit of the government of an independent republic, which despite the acute shortage of financial and economic resources, even in the most difficult times for the country did not stop funding of research institutions, including the Azerbaijan Institute of Sericulture. Proceeding from this, last 10-15 years the Azerbaijan Sericulture Research Institute worked on prospect, i.e. researches were carried out in those directions which results to the greatest degree can promote sericulture revival in the country. From number of more important results it is possible to name the following: 1) It is developed scientific-methodical bases and principles of a new direction in selection of the silkworm of adaptive selection which purpose is evolving highly productive breeds, steadier to adverse conditions of environment. Thus it is meant stability not only stability of viability of silkworms, but also stability of such important characters as the single fresh cocoon and shell weight, filament length and thickness, etc. There are already first practical results of adaptive selection. Created several new highly resistant silkworm breeds, 4 environmentally sustainable hybrid (Mayak-2 x Mayak-3, Mayak-1 x Chinar and the opposite cross) approved for zoning, 4 new highly stable hybrid transferred to the State Commission of Testing and Protection of New Varieties of Plants; 2) Are created a number of highly productive, ecologically stable varieties of the mulberry, possessing very high nutritional value of leaves. Part from them are handed to the State Commission on test and protection of selection achievements; 3) together with the Institute of Agro mechanization it is developed and tested light-type silkworm rearing house of a modular type, equipped by 3-floor trays, the heating-cooling, humidifying and ventilating device. Each module is designed on rearing of about 1 box of eggs (12.5 g).

The biggest merit of collective of the ASERI consists that despite of many difficulties of the organizational-technical order, they have managed to save and keep up to now the rich genetic resources of mulberry and silkworm, which are one of the important preconditions for sericulture revival in the country. Now in 3 collection plantations of ASERI, 311 varieties and forms of mulberry (Appendix 1) are collected. From them 203 varieties and forms are production of the Azerbaijan selectors. Other varieties and forms were introduced from various foreign countries, including from Uzbekistan-29, from Japan-40, from Bulgaria-11, from Vietnam-7, from Ukraine-7, from Italy-3, from India-3, from Georgia-2, from China-3, from Russia-2 and from France-1. Below, we present to introduce a data sheet yields the most promising varieties of mulberry Azerbaijan (Appendix 2).Such rich germplasm of mulberry considerably facilitates the work of mulberry breeders and raises efficiency of selection at evolving new varieties. In selection of the mulberry, methods of inter-species and intra-species hybridization, polyploidy and stage-by-stage selection of the most allocating forms and elite plants are used.

The genetic bank of the silkworm collected in collection fund of ASERI now will consist of 100 breeds (Appendix 3) from which 58 breeds are production of the Azerbaijan breeders. The others 42 breeds were introduced from various foreign countries, including Uzbekistan, Bulgaria, Georgia,Ukraine, Japan, India and China. The breeds available in collection fund of ASERI, considerably differ from each other as on voltinism, to morphological characters of the larvae and cocoons, and to many economic-valuable biological and technological traits. It substantially facilitates the task of breeders at a choice of desirable parental breeds and obtaining synthetic selection materials with a required complex of economic-valuable traits for evolving new breeds. By the Azerbaijan breeders at evolving new breeds of the silkworm basically are used synthetic selection (inter-breed hybridization) and a little bit less often analytical selection, with the subsequent selection and selection of the most valuable families and individuals. Thus, for the purpose of increase of productivity and efficiency of selection, methods of the genetiko-mathematical analysis, genetic parametres and methods of adaptive selection are widely used.

Once again it is necessary to emphasize, that presence in the country of such rich genetic resources of the silkworm and mulberry represent itself one of potential opportunities and preconditions for sericulture revival. However, in the country there are also other potential opportunities and preconditions for sericulture revival. It is possible to attribute presence to their number in Azerbaijan 9 of 11 climatic types existing on globe, rich thousand-year experience of agricultural population on cultivation of the silkworm, presence of starting material base, pure line egg production stations, hybrid egg production factories and regional cocoon drying centers. The process of re-establishing the Great silk road in the territory of Azerbaijan as a modern highway which will pass through many countries of Europe, too will play a positive role in sericulture revival. And at last, the most important precondition for revival of sericulture in republic is the transformation of Sheki silk reeling and textile factory to a joint-stock company "Sheki Ipek". The government has allocated to this joint-stock company of 2 million US$ for carrying out of improving actions and adjustments of manufacture. Due to this, joint-stock company "Sheki Ipek" since 2002 has started to operate and in each next year increased volume of production. The volume of raw silk production, twisted silks (silk yarn), fabrics from natural silk , began to produce also national lady's head cloths "kelagai" and to master manufacture of carpets from natural silk. "Sheki-Ipak" JSC has got some new machine tools, including 2 lines for spinning cotton and and 4-row automatic reeling machine tool manufacture of China. However, production increase lasted not long. For last five years sharp decrease in production of raw silk (tab. 4) because of absence of enough of dry cocoons is observed. Potential annual capacity of joint-stock company "Sheki Ipek", now, under condition of the organization of two-shift work, makes 150-200 tons of raw silk for what as raw material it is required more than one thousand tons of fresh cocoons.

3. Major Problems and Issues, and Recommendations

Thus, the analytical review of the present state of sericulture and silk industry shows the presence of big potential opportunities and necessary preconditions for revival of these branches in Azerbaijan. However the sericulture revival in republic is braked by the following principal causes:

- absence of local production of parental and hybrid silkworm eggs at the stations and factories, basically for the lack of financial support of the government;

- absence of a link (organization), the intermediary playing a role between the silkworm egg producers, sericulture farmers and silk reelers;
- full absence of a price policy in the field of sericulture and effective economic mechanisms of regulation the payments between producers of silkworm eggs, fresh cocoons and raw silk;
- weakening of the forage reserve (mulberry plantations) in republic.

On the basis of the carried out analysis we count, that for revival of sericulture in Azerbaijan it was necessary to realize the following suggestions in the near future:

1) to restore silkworm breeding system in the form of a scientific-breeding association with inclusion here at the beginning one P_3-P_1 egg production station, two hybrid egg production factories and the Azerbaijan Sericulture Research Institute as head establishment. Association in the first 4-5 years it should be financed by the state, and then gradually to pass to self-financing;

2) to organize an open joint-stock company on preparation and primary processing of cocoons, with transfer to it all the property (stocks, the equipment, simplex and other cocoon drying machines, industrial premises, incubatory chambers, etc.) of the former regional sericulture offices which would carry out functions of the organizer industrial silkworm rearings and intermediary mission between silkworm egg producers, fresh cocoon producers (farmers) and raw silk producers. In the first 4-5 years control of the share holding of the joint-stock company should be at the government on behalf of the Ministry of Agriculture and (or) the Ministries of economic development of republic, and then it is gradually possible to carry out full privatization of joint-stock company;

3) to restore old or to organize 2-3 new state nurseries for mulberry sapling production;

4) to develop and establish the scientifically-grounded prices for the mulberry seeds, seedlings and saplings, P_1 and F_1 silkworm eggs, seed and industrial fresh cocoons;

5) to ask the government of the country to establish concessionary terms for the manufacturers of mulberry saplings, silkworm eggs, cocoons and raw silk, namely to exempt them from payment of all kinds of taxes within 10 years from the moment of the beginning of activity of the manufacturer, to give to them electric energy, natural gas, combustible and fuel materials under the reduced tariffs, to exempt from the customs the imported of foreign countries materials, equipment and techniques for sericulture and silk processing industries, to open short-term and intermediate term demand lines of credit for sericulture farmers.

4. The national program of sericulture development in Azerbaijan

4.1. Strategy of the program.

Strategy of the program is conceived as a component of strategy of the economic policy, spent by the state in the country. It is known, that the state policy spent now for the further strengthening of the national economy is directed on acceleration of development of the branches which are not concerning to oil sector, on the basis of rational use of the big economic successes achieved in oil sector of the country. In view of it, the sericulture development can play the important role in development of two important branches of the country not concerning to oil sector - light industry and the agriculture. At the same time, as a result of sericulture development, the raw silk obtained from processing of strategically important raw material - cocoons of the silkworm, can be realized in the world markets due to what inflow of a foreign currency to the national economy will amplify.

4.2. The purpose and problems(tasks) of the program.

The basic purpose of the program consists, by the interconnected development of all sericulture parts - a forage reserve (mulberry plantations), a breeding affair (silkworm egg manufacture), cultivation, preparation and primary processing of fresh cocoons, manufacture of raw silk from dry cocoons - in achievement below-mentioned:

- ✓ Increase in the export potential of the country by manufacture and deliveries to the world markets of competitive raw silk;
- ✓ Strengthening of inflow of a foreign currency in the national economy;
- ✓ Creation of the new processing enterprises in agrarian sector and the industry;
- ✓ Promotion to acceleration of social and economic development in sericultural regions;
- ✓ Maintenance of the population of the country with new workplaces (including 25-50 thousand seasonal and up to thousand constant workplaces);
- ✓ Maintenance of effective industrial activity of Sheki Ipak J.S.C. on the basis of production of enough cocoon raw material in the republic.

For achievement of the above-stated purposes it is necessary to solve below-mentioned problems:

- ➢ To strengthen the forage reserve of sericulture by improvement existing and planting of new mulberry trees on the basis of agrotechnical actions;
- ➢ To organize breeding works on manufacture high-quality P_2, P_1 and F_1 (hybrid) silkworm eggs on a scientific basis;
- ➢ To increase volume of production of qualitative industrial cocoons on the basis of progressive improvement of the silkworm rearing technology;
- ➢ To organize preparation and qualitative primary processing of fresh cocoons at a high level;
- ➢ To complete silk reeling manufacture by the modern process equipment;
- ➢ To increase volume of manufacture and export of competitive raw silk on the basis of modern technologies.

4.3. Creation of regulatory-legal base of branch.

For correct and objective (on the lawful bases) settlements of carried out industrial - technological processes, labor and relations of production in all directions of sericulture, and also for a correct estimation of quality made products (for example: silkworm eggs, fresh cocoons, dry cocoons, etc.), presence of regulatory-legal base is required. This base will consist of various instructions, norms and specifications of the charge of materials and time for carried out works in various directions of sericulture, and most important of state standards on cocoons of the silkworm - fresh, air - dried and waste cocoons. These standards in sericulture of the republics are available. However, all of them are accepted during the Soviet authority, have become outdated and today do not correspond to requirements of free market economy. And new national standards in republic till now are not developed. Despite of it, there is a simple decision of this question. In 2004, Interstate council of the CIS countries on standardization, metrology and certifications has accepted at the session interstate standards on cocoons of the silkworm fresh, air - dried and waste (the report № 25 from May, 25, 2004). For acceptance of these standards have voted 6 countries engaged in the sericulture, including Azerbaijan. For coming into force of these interstate standards in our republic, only corresponding order of the head of republican State Kommittee on standardization metrology and patents is required.
Besides the Ministries of economic development and agriculture should present in the government the offer on preparation of the project and acceptance of a "Law about sericulture".

4.4. A choice of the most suitable areas for accommodation and developments of sericulture.

Definition of the most suitable areas of republic for sericulture accommodation and the further development is carried out on the basis of the following criteria: presence in area of a forage reserve (mulberry plantations) and their volume, a degree of technical suitability of regional base on primary processing fresh cocoons and the process equipment available in it, presence in the area suitable personal and farms for silkworm rearing and people showing interest to these.

On the basis of the analysis of the information on the above-stated criteria of the areas extracted by experts of Sheki Ipak J.S.C., for sericulture accommodation and developments at the given stage are chosen 14 below-mentioned areas of republic:

1. Agdash	8. Kakh
2. Agdjabedi	9. Qabala
3. Oguz	10. Sheki
4. Balakan	11. Udjar
5. Barda	12.Yevlakh
6. Gokchay	13. Zakatala
7. Kurdamir	14.Zardab

Mulberry plantations existing now in republic in volume of 2342 hectares are concentrated on territory of the chosen areas. The technical condition of bases of primary processing of cocoons and process equipments in the chosen areas also are more satisfactory, than in other areas. Besides in the chosen areas the quantity of suitable for silkworm rearing personal and farms and people, wishing to be engaged in this business are relative higher, than in other areas.
From available in the chosen areas 14 bases of primary processing of cocoons 9 are privatized, the others 5 are at a stage of privatization.
Manufacture of P_2 and P_1 silkworm eggs is solved to organize on Kakh parental egg station, manufacture hybrid (industrial) eggs – on Sheki, Zaqatala and Balakan egg production factories. All of them are on balance and submission of the Ministry of Agriculture.
The management of Sheki Ipak J.S.C., for realization of the program of sericulture development, plans to organize work of all above-stated industrial structures on a contractual basis.

4.5. The basic directions and actions in sericulture development.

The sericulture as a branch of national economy, has complex structure and it is actually divided on two large sub-branches - the silk industry and silkworm rearing and cocoon production. In turn, everyone sub-branch will consist of the several industrial structures distinguished from each other by industrial - technological and organizational features. Experts name these structures the basic directions of sericulture. These industrial structures (the basic directions) of sericulture are the following:
In silkworm rearing and cocoon production:
- A forage reserve (manufacture of forage for the silkworms);
- Breeding business of the silkworm (manufacture of silkworm eggs of various category);
- Silkworm rearing and manufacture of fresh cocoons;
- Preparation and primary processing of fresh cocoons (manufacture of dry cocoons).

In the silk industry:
- Processing dry cocoons (unwinding of cocoons and manufacture of raw silk);
- Processing waste products of silk reeling;
- Silk twisting;
- Silk weaving;
- Silk dyeing/printing etc.

It is necessary to note, that production obtained (mulberry leaves, silkworm eggs, fresh cocoons, dry cocoons etc.), in each of the above-stated industrial structures (directions), is used in the subsequent structure as raw material for obtaining of other production. Therefore, wrong planning of volume of manufacture or infringement of normal industrial activity for any reason in what or from these structures negatively influences industrial activity of the subsequent structures, and finally leads to reduction in volume and quality of made raw silk and silk allied products.

For realization of the program of development actions on the basic sericulture directions, which are developed on the basis of the executed calculations have relationships with each other on all agrotechnical, zootechnical, to technological and industrial parameters. At performance of calculations a number of specifications and instructions on the basic sericulture directions (on moriculture, silkworm egg production, silkworm rearing, primary processing fresh and processing of dry cocoons), and also existing scientific recommendations and literary data are used.

Below, in corresponding sequence, it is stated actions of development on the basic directions of sericulture.

4.5.1. Strengthening the forage reserve.

For forage reserve strengthening of sericulture in republic increase of productivity of sheet existing and a bookmark of new mulberry trees is necessary.

Increase of productivity of mulberry leaf of existing mulberry trees. - Now in republic are available 2155 thousand pieces of mulberry trees. Their placing and quantity on republic areas is given in table 5. The greatest quantity of trees (in thousand pieces) are concentrated in Sheki (442.5), Udzhar (288.7), Zakatala (280.1), Barda (260.8), Zardab (237.0), Belokan (142.2) and Kjurdamir (112.1) areas which in total make 81,8 % of mulberry trees available in republic.. It is necessary to note, that as a result of the insufficient agrotechnical care in the last 10-15 years, leaf productivity of mulberry trees available in republic has considerably decreased. So, in opinion of experts, in 2013 expected average productivity of leaves from 1 tree will make 2.5 kg and the total yield of sheet - 5387 tonnes (table 6). At the same time, on the basis of corresponding agrotechnical actions, the crop of sheet from each tree can be increased in 2-3 times. Therefore, since 2013, will be spent a number of agrotechnical actions with available mulberry trees. First of all, operation of a rejuvenation of the grown old trees will be spent. First of all, operation of pruning the old mulberry trees will be carried out. For this purpose each old tree it will be cut at the basis of a crone. Subsequently, the new shoots will be transformed into one-year branches, which will be formed as fist form. On younger trees operation of “thinning” will be carried out. For this purpose, on each young tree it will be cut off 30-50 % of available branches, and the dried up and underdeveloped branches first of all will be cut off.. Each tree it will be cleared from young growths, appeared near the stem.Will be held 6-8 times the watering of trees for the entire growing season. Plowing inter-rows in plantations and irrigation them for 6-8 times for all vegetative period will be carried out. Along with these activities, to meet the needs of mulberry trees in fertilizer each year will be included ammonium nitrate, superphosphate and potassium chloride in the right amount. As a result of these measures, it is expected a gradual increase in yield with each leaf of the tree is operated up to 6 kg (table 6).

The bookmark of new mulberry trees - According to the prepared program, on republic is planned to finish annual volume of manufacture of live cocoons to 1000 tons (table 9). For this purpose, (table 8) is required to bring up not less than 24245 boxes eggs (one box =29 g) and to spend about 25 thousand tons of leaves of a mulberry for what it is necessary to have 4156 thousand maintained mulberry trees.

For finishing of a forage reserve of republic to the demanded volume, taking into account existing trees, it is necessary to pawn (4156-2155) =2001 thousand new mulberry trees. Thus, a bookmark of 2001 thousand new trees it will be finished in 2016 as new trees are placed in operation for 3rd year

Table 5 The forecast about distribution and increase in plantings of a mulberry tree in areas of Azerbaijan (2013-2017)

Areas	Quantity of mulberry trees, thousand pieces									
	2013		2014		2015		2016		2017	
	At the beginning of the year	Newly plantings	At the beginning of the year	Newly plantings	At the beginning of the year	Newly plantings	At the beginning of the year	Newly plantings	At the beginning of the year	Newly plantings
Agdash	94.5	29.0	123.5	22.8	146.3	18.1	164.4	23.1	187.5	22.0
Agjabedi	21.6	8.3	29.9	6.5	36.4	5.2	41.6	6.6	48.2	6.3
Oguz	11.0	4.0	15.0	2.6	17.6	2.1	19.7	2.6	22.3	2.5
Balakan	142.2	54.6	196.8	43.0	239.8	34.2	274.0	43.5	317.5	41.5
Barda	260.8	100.2	361.0	79.0	440.0	62.6	502.6	79.7	582.3	76.2
Goychay	64.6	24.8	89.4	19.6	105.0	15.5	120.5	19.7	140.2	18.5
Kurdemir	112.1	43.0	155.1	34.0	189.1	26.9	216.0	34.2	250.2	32.7
Qakh	96.9	37.3	134.2	29.5	163.7	23.3	187.0	29.6	216.6	28.3
Qabala	86.2	33.1	119.3	26.2	145.5	20.7	166.2	26.4	192.6	25.2
Sheki	442.5	178.4	620.9	142.4	763.3	112.1	875.4	142.7	1018.1	138.6
Udjar	288.7	110.0	398.7	87.1	485.8	68.9	554.7	87.6	642.3	83.7
Yevlakh	17.2	6.6	23.8	5.2	29.0	4.1	33.1	5/3	38.4	5.0
Zakatala	280.1	107.6	387.7	85.1	472.8	67.3	540.1	85.6	625.7	81.5
Zardab	237.0	91.1	328.1	72.0	400.1	57.0	457.1	72.4	529.5	69.0
Total:	2155.0	828.0	2983.4	655.0	3634.4	518.0	4152.4	659.0	4811.4	630.0

Table 6. Prognosis about mulberry leaf yield in Azerbaijan

Years	**Quantity of maintained trees, thousand pieces**	**Leaf yield**	
		from 1 tree, kg	total, ton
2013	2154.8	2.5	5387
2014	2982.8	3.5	10440
2015	3638.4	4.5	16373
2016	4156.3	6.0	24938
2017	4815.0	6.0	28890

from a bookmark. Last two years (2016-2017) will be put in pawn 1289 thousand more new trees.
For finishing of a forage reserve of republic to the demanded volume, taking into account existing trees, it is necessary to pawn (4156-2155) =2001 thousand new mulberry trees. Thus, a bookmark of 2001 thousand new trees it will be finished in 2016 as new trees are placed in operation for 3rd year from a bookmark. Last two years (2016-2017) will be put in pawn 1289 thousand more new trees.
Thus, in 2017 the amount of forage in the country will reach 5441 thousand trees, which is 2.5 times more than in the current volume. The total amount pledged again mulberry trees distributed among regions (table 1), taking into account the dynamics of the production of live cocoons in these areas (table 9).

In the future productivity of leaves of planting mulberry trees, the important role will play the quality of planting material. As a planting material, as a rule, are used seedlings and saplings of mulberry. For high quality maintenance of both kinds of planting material, they should be prepared from highly productive mulberry varieties and meet the technical requirements of state standard.

Demanded quantity of a landing material on years for a bookmark of new mulberry trees in the planned volume, are presented in table 7. Apparently from data of this table, for a bookmark of new trees annually it is required 518-828 thousand saplings. Manufacture of a landing material is planned to be organised on Fakhrali base on moriculture which is in submission ASERI. This base has 80 hectares of the ground area from which 39 hectares are under mulberry plantations. In these plantations about 300 mulberry varieties and forms created worldwide, including in Azerbaijan are collected. Besides here there is seed mother plantation on 3 hectares.

4.5.2. The organization of silkworm egg production.

In sericulture, for obtaining of high crops of cocoons, the important role is played with the correct organization of breeding works on manufacture of silkworm eggs. As a rule, in sericulture are made eggs in 3 various categories – P_2, P_1 and F_1 (hybrid). These eggs differ to destination. The P_2 and P_1 eggs are prepared from pure breeds and serve for duplication of these breeds on stages of breeding work. Hybrid egg it turns out from hybridization of two pure breeds (female moths of one breed are crossed to male moths of other breed) and intend for manufacture of fresh industrial cocoons. The P_2 and P_1 eggs are produced at the parental egg stations, and the hybrid eggs - on hybrid egg production factories.

Volume of manufacture P_2, P_1 and F_1 (hybrid) eggs, required for realization of the program of sericulture development on years(table 8) it is designed in view of existing fodder resources and dynamics of their development, i.e. the forecast of mulberry leaf yield. (table 6).

Manufacture P_2 and P_1 eggs is solved to organize on Kakh parental egg station, and hybrid eggs – on Sheki, Zakatala and Balakan hybrid silkworm egg factories..

All complex it is industrial - technological actions and the operations which are carried out for manufacture P_2 and P_1 eggs and are in details stated in the "Basic methodical positions of breeding work with the silkworm ", and for manufacture hybrid eggs - in the instruction " Key rules of preparation industrial silkworm eggs on egg production factories ". For maintenance of manufacture qualitative eggs of all categories, experts of a sericulture department at Sheki Ipak J.S.C. will be carried out the strict control over performance of requirements of the specified instructions by workers Kakh parental egg station, and also Sheki, Zaqatala and Balakan hybrid egg production factories up to the mark. Alongside with it, in the specified enterprises will be carried out a number organizational - economic actions.

With the purpose of a choice of elite facilities for parental egg station and breeding facilities for hybrid egg factories, are examined the work force available and the farms located in a zone of their activity and are determined most suitable of them for carrying out elite and breeding silkworm rearings. In the chosen elite and breeding facilities it will not be allowed to conduct silkworm rearing of industrial purpose. Delivery the brought up on elite and breeding facilities of fresh cocoons in places of accep-tance them at the parental egg station and hybrid egg factories only in the morning (till 10^{00} A.M.)

Table 7 Prognosis about mulberry saplings production in Azerbaijan

Years	Mulberry saplings, thousand pieces.	Costs of saplings (1 piece 0.20 manat or 0.25 $)	
		In manat	in US$
2013	828,0	165600	207200
2014	655,0	131000	163750
2015	518,0	103600	129500
2016	659,0	131800	164750

2017	631,0	126200	157750
Total	3291,0	658200	822750

Table 8. Prognosis about the dynamics of P_2, P_1 and F_1 silkworm egg production development in Azerbaijan

years	P_2		P_1		**F_1 hybrid**	
	boxes	kg	boxes	kg	**boxes**	**kg**
2013	37	1,073	528	15,3	8511	246,8
2014	45	1,305	726	21,0	13138	381,0
2015	51	1,479	895	26,0	18384	533,1
2016	55	1,595	1034	30,0	23156	671,5
2017	59	1,711	1168	33,9	27802	806,2

and only in firm container (baskets, wooden or plywood boxes with lateral apertures for aeration, etc.), that will allow to prevent deterioration of fresh cocoons.
For carrying out mother moth examination for pebrine are purchased 30 phase- contrast microscopes of foreign mark which are distributed between the parental egg station and three hybrid egg factories. Use of these microscopes at the factory and state microanalysis will allow to determine more precisely infected with illnesses egg batches, in due time to reject them and to exempt sold eggs from diseases.

4.5.3. Silkworm rearing and fresh cocoon production.

One of the primary goals of the program of sericulture development is the increase of fresh cocoon production. A number of other tasks of the program, namely strengthening and expansion of the forage reserve, and also silkworm eggs of various categories production, are directed on the successful solving of this primary goal.
According to plans of the program, in republic (table 6) is planned to reach manufacture of fresh cocoons from 242 tons in 2013 with 1009 tons in 2016. Distribution of total amount of cocoons made in republic on years and areas (table 9), are designed in view of corresponding conditions (the current condition and the subsequent development of the forage reserve, amount of facilities, suitable for carrying out silkworm rearing, etc.) in each area.
For increase in manufacture of fresh cocoons in republic, actions both extensive, and intensive type will be carried out. For extensive development of manufacture of fresh cocoons, the increase in silkworm rearing volumes, organized on republic is planned, according to rates of development of the forage reserve. So, in view of an existing condition of the forage reserve in 2013 the volume of industrial silkworm rearings will make 8511 boxes, breeding rearings - 565 boxes. These volumes will be gradually increased on years and in 2017 the volume of industrial rearings will reach 27802 boxes, and breeding rearings - 1227 boxes (table 8).

For increase in manufacture of cocoons actions of intensive development will be carried out also. For realization of intensive action - correct silkworm rearing techniques will be transmitted by experts and regional representatives of the sericulture department of Sheki Ipak, prior to the beginning and in the course of rearing, explanatory conversations with agricultural population on places, the organization of seminars for farmers - sericulturists, the publication in local regional newspapers of articles about rules of silkworm rearing is planned.
Taking into account a considerable role of the correct silkworm incubation in obtaining of high crops of cocoons, it is planned to organize in 2006 from above 30 incubatory chambers. With this purpose, in cocoon producing areas will be found and suitable premises in which incubatory chambers will be organized, rented and provided with all necessary materials and stock (thermometers, humidity-meters, 2 - 3 floor rearing shelves, technical balance, covering paper, fuel, etc.) for correct carrying out of silkworm egg incubation.
As a result of carrying out of planned actions, the increase in average productivity of cocoons from 1 box of eggs (29 g) on industrial rearings from the planned 51 kg in 2013 up to 53 kg in 2017, on breeding rearings - accordingly from 56 kg up to 58 kg (table 10) is expected. Alongside with it, improvement of quality (high-quality structure) made fresh cocoons is expected also. So, if in 2013 in total amount of a crop of the fresh cocoons accepted to primary processing, high-quality cocoons will make 87 %, and the spoilage/unreelable cocoons - 13 %, in 2017 these parameters will make accordingly 89 % and 11 % (table 11). Thus, the amount of high-quality cocoons in the general crop of fresh cocoons will be raised for 2 absolute percent that is high enough result.

4.5.4. The organization of preparation and primary processing of fresh cocoons.

Quality of cocoons intended for production of raw silk, substantially depends on the correct organization of preparation and primary processing of fresh cocoons.

Table 9. Distribution and dynamics of fresh cocoon production in Azerbaijan (2013-2017), in ton

Regions	2013	2014	2015	2016	2017
Agdash	5,8	11,0	21,5	31,2	48,0
Agjabedi	1,6	3,7	5,6	9,0	16,5
Oguz	-	0,5	1,0	4,0	8,5
Balakan	19,6	36,0	49,2	70,5	87,0
Barda	37,5	74,0	95,0	128,5	143,0
Goychay	4,0	8,0	15,8	25,0	40,0
Kurdemir	12,1	25,0	37,5	53,0	72,5
Qakh	6,6	12,0	28,7	41,2	64,5
Qabala	4,5	9,5	24,8	36,0	60,0
Sheki	46,0	85,0	159,0	214,0	280,0
Udjar	42,5	83,0	105,2	139,0	150,0
Yevlakh	-	1,0	3,0	8,0	15,5
Zakatala	30,0	56,0	94,7	131,5	173,0
Zardab	32,0	61,0	86,1	119,0	132,0

Total:	242,2	465,7	727,1	1009,9	1290,5

Table 10. Prognosis about the number of silkworm egg boxes reared, fresh cocoon yield by one box of eggs and total cocoon production in Azerbaijan

Years	Number of silkworm egg boxes reared		Fresh cocoon yield by one box of eggs, kg		Total cocoon production, t		
	hybrid	pure line	hybrid	pure line	hybrid	pure line	total
2013	4327	383	51	56	220,7	21,5	242,2
2014	8511	565	51	56	434,1	31,6	465,7
2015	13138	771	52	57	683,2	43,9	727,1
2016	18384	946	52	57	956,0	53,9	1009,9
2017	23156	1089	53	58	1227,3	63,2	1290,5

Preparation of cocoons is meant as purchase of fresh cocoons from the farmers - business executives, quantitative and quality standard of parties of cocoons (definition of percent and physical weight of high-quality and low-grade cocoons in parties), registration of the documentation on payment of the accepted parties of cocoons, time storage of the accepted fresh cocoons before primary processing.

Primary processing of cocoons mean their stifling and the subsequent drying. For cocoon stifling and drying exist set of ways. However, among them, the most suitable for practical use is the fresh cocoon stifling by hot air and their subsequent shadow drying. At such primary processing, natural and technological properties of cocoons are kept better. Now many regional bases are equipped with simplex devices and shadow dryers which allow to carry out primary processing of fresh cocoons by the mentioned above way.

Considering above-stated, is solved to organize preparation and primary processing of the fresh cocoons made in chosen areas, on bases of the same areas. For carrying out of preparation and primary processing of cocoons it is up to the mark planned a number of actions.

For successful carrying out of preparation of fresh cocoons, in territory of base the procuring item consisting from waiting - room, balance, storehouses for high-quality and defective cocoons, laboratories will be organized. The waiting - room intends for preparation of parties of cocoons for delivery to the inspector. Balance, the area of 20-30 m^2 intends for definition of weight of an accepted party of cocoons, conformity of cocoons in a party to requirements of state standard and sampling for the laboratory analysis. The storehouse of fresh cocoons will serve for time storage of them within 1-2 days before primary processing. For protection of stored fresh cocoons against a wind, a rain and solar beams, the canopy here will be established. Taking into account absence in republic of national state standard on fresh cocoons of the silkworm, the estimation of accepted parties of cocoons will be carried out on the basis of specifications on the interstate standard (31257-2004).

For a correct and objective estimation of parties of cocoons, they will be accepted only in the afternoon. Parties of cocoons, they are sometimes artificially humidified and containing unripe cocoons, therefore such a parties will be accepted only after enough drying in a shadow and maturing of cocoons. Generally speaking, unripe cocoons are one of principal causes of

deterioration of cocoons at primary processing. Therefore, for elimination of this lack and prevention of cocoon batches deterioration, experts of Sheki Ipak J.S.C. during the period of cocoon spinning/mounting will visit the sericulture farmers to determine the degree of maturity of cocoons and day of their harvesting from the mountages.
Other principal cause, worsening quality of cocoons is delivery of fresh cocoons to places of acceptance in soft container (in bags, etc.). Therefore, corresponding measures for delivery of fresh cocoons to places of acceptance only in firm container (in baskets, wooden, plywood or cardboard boxes/cages with lateral apertures for aeration, etc.) will be adopted.
For qualitative primary processing of fresh cocoons corresponding measures also will be accepted.
On each base, prior to the beginning of silkworm rearing season, simplex devices and shadow dryers will be checked up, in required cases are repaired and resulted in a condition the worker of readiness. For maintenance of trouble-free work of simplex devices during primary processing of cocoons, the bases will be supplied with all necessary materials and fuel. At primary processing of cocoons correct observance of a mode of stifling and duly performance of all required technological operations, for qualitative drying of cocoons will be provided during 1.5-2.0 months.
The complex of planned actions will give a number of positive results. For example, improvement, to be exact reduction such important economically parameter, as factor of an output of dry cocoons from fresh is expected. This parameter making 2.68 in 2013, will be gradually reduced on years and in 2017, 2.58 (table 11) will be achieved. And it means, that the cost price of dry cocoons will considerably decrease. Alongside with it, improvement of quality (high-quality structure) dry cocoons is expected also. So if in 2013 high-quality cocoons will make 87 % of total amount of dry cocoons gradually improving on years, will reach 89 % in 2017. It in turn, will create good preconditions for manufacture of qualitative raw silk.

4.5.5. Processing dry cocoons and manufacture of raw silk

One of the basic purposes of sericulture development in republic is the production of enough local cocoons for maintenance of trouble-free work of the silk reeling manufactures of Sheki Ipak J.S.C. with

Table 11. Basic quantitative and qualitative parameters of fresh and dry cocoon production in Azerbaijan (2013-2017)

		years				
		2013	2014	2015	2016	2017
Fresh cocoon production, t		242,2	465,7	727,1	1009,9	1290,5
Out of them used in the silkworm egg production, t		5,8	8,7	12,1	14,9	17,5
Cocoons for primary processing, t		236,4	457,0	715,0	995,0	1273,0
Out of them:	good quality, t	205,7	402,2	629,2	885,6	1133,0
	rejected and waste, t	30,7	54,8	85,8	109,4	140,0
Dry cocoon obtained from fresh cocoon coefficient		2,68	2,65	2,63	2,60	2,58
Production of dry cocoons, t		88,2	172,4	271,9	382,7	493,4
Out of them:	good quality, t	76,8	151,8	239,2	340,6	439,1
	Rejected and waste, t	11,4	20,6	32,7	42,1	54,3

full capacity. At the same time, for trouble-free work of this enterprise with full capacity, alongside with enough cocoons, it is required also the corresponding technical and technological conditions providing economically effective manufacture. Therefore, the management of Sheki Ipak J.S.C., with the purpose of creation of required conditions, has carried out a number of actions.

Industrial premises of silk reeling units, units on processing waste products and boiler-house are completely repaired. In the units are carried out repair – adjustment works of all technical constructions and the process equipment, including multiends silk reeling machines, the ventilating system is established. The factory is provided by natural gas. Alongside with it, for improvement of working conditions of workers, are built a number of household objects (a dining room, a locker room, a bath, a toilet, etc.), adequate to modern sanitary-and-hygienic norms.

Along with the spent actions, a joint-stock company management, for increase in capacity of the enterprise, has bought two foreign automatic reeling lines.

Thus, taking into account the acquisition of two foreign auto reeling lines, annual output of raw silk in the enterprise will be 216.9 tons. Required by year volume cocoon raw material for a specified number of raw silk, is presented in table 12. The data in this table, in 2017, can provide need reeling production by 68% due to local production of raw cocoons. To cover the whole production of raw materials, will have an annual import (if possible) dry cocoons in the amount specified in table 12.

It should be noted that implementation of all activities of the program of development of sericulture in the country, along with the increase in production of live and dry cocoons will also improve a number of quality indicators, including silk shell percentage and the raw silk percentage. Because of this, the flow of dry cocoons to produce 1 kg of raw silk per year will decline (table 12). This will lead to an annual reduction of dry cocoons spent on getting 216.9 tons of raw silk. For example, in 2013, to produce 216.9 tons of raw silk will be spent 770.2 tons of dry cocoons, whereas in 2017, the production of the same amount of raw silk will be spent only 646.7 tons of dry cocoons that compared with 2013 decreased by 123.5 tonnes or 16%. Reduce the consumption of dry cocoons will reduce production cost of raw silk and increase production efficiency.

Finally, due to significant improvement of cocoon quality and the technological level of production, it will be possible to develop competitive raw silk of a class 2A, 3A, 4A, and also high-quality silk production and to leave on the world markets.

Table 12. Amount of gradable dry cocoons, produced in the country and imported in order to ensure the work of Sheki Ipak J.S.C. in full capacity and the raw silk production (2006-2015)

years	Produced in Azerbaijan			Imported			Total raw silk produc-tion, t	Total dry cocoons used, t
	Dry cocoons		Raw silk produc-tion, t	Dry cocoons		Raw silk produc-tion, t		
	Volu-me, t	Necessary to produce 1 kg raw silk, kg		Volu-me, t	Necessary to produce 1 kg raw silk, kg			
2013	76,8	2,70	25,8	693,4	3,30	191,1	216,9	770,2
2014	151,8	2,65	52,0	598,6	3,30	164,9	216,9	750,4
2015	239,2	2,60	83,6	483,9	3,30	133,3	216,9	723,1
2016	340,6	2,55	121,6	345,9	3,30	95,3	216,9	686,5

2017	439,1	2,50	159,7	207,6	3,30	57,2	216,9	646,7

Creation of required structures as well as performance of all actions stipulated in the national program of sericulture development, huge financial expenses which not under force to any joint-stock company, as though it was not strong economically demand, without the help of the state. Proceeding from this, we ask Executive Committee of the BACSA to address a letter on its own behalf to the Government of the Azerbaijan Republic with the following requests:

1) To discuss and ratify the national program of sericulture development in the Azerbaijan Republic as the state program and to render financial support for its realization; To exempt the mulberry seedling/sapling, silkworm eggs, cocoons and raw silk from all kinds of the tax for the period of 10 years and to give to them electric energy, natural gas, fuel and fuel materials under reduced rates in current 10 years;
2) To exempt from the customs materials imported in the country the equipment for the enterprises for silkworm egg production, primary processing of cocoons and manufactures of raw silk and also exported by the country silkworm eggs and raw silk.

5.Development Straregies

1. For sericulture development in region by joint actions our country is ready to cooperate with any of the countries - members of the BACSA in sphere of mulberry saplings and silkworm egg production;
2. That our association BACSA had an opportunity to carry out the certain projects on sericulture with participation of the several countries, it should have financial resources. Therefore we suggest to ask the government of all countries - members of the BACSA to pay a membership fee in the certain sum;
3. National coordinators of the BACSA should joint efforts to make various international projects on sericulture and to achieve their financing from the various international organisations, in particular at EU, ISK and FAO.

6.Follow-up activities of the 5th BACSA international conference "Sericulture for multi products – new prospects for development" – SERIPRODEV, held in Bucharest, Romania from 11 to 15 April 2011

After this international conference in Azerbaijan Scientific-Research Institute of Sericulture opened a new laboratory biotechnology and . beekeeping Department. Now employees of laboratory of biotechnology and beekeeping department conduct searches most vital topics for researches.

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Appendix 1

List of mulberry varieties, available at ASERI's germplasm

Azerbaijani varieties

1	Zarif-tut	30	Azerbaijan № 83	59	AzNİİSh-9
2	Sikhgoz-tut	31	----- / ------№ 85	60	İlyas-tut
3	Xanlar-tut	32	----- / -----№ 87	61	Nizami-tut
4	Zakir-tut	33	----- / ------№ 88	62	Nasreddin-tut
5	Toxumlu-tut	34	----- / -----№ 89	63	Bakhcha-tut
6	Rahim-tut	35	S-9	64	Kamil-tut
7	Tozlayan-tut	36	S-17	645	Füzuli-tut
8	Firudin-tut	37	S-23	66	Araz-tut
9	Emin-tut	38	S-58	67	Yunis-tut
10	Yaqub-tut	39	S-148	68	Faxralı-tut
11	Azerbaijan № 1	40	S-155	69	Qoşqar-tut
12	----- / ------ № 2	41	S-158	70	Kapaz-tut
13	----- / ------ № 3	42	K 1-50	71	Murov-tut
14	----- / ------ № 4	43	Shah-tut	72	Larisa-tut
15	----- / ------ № 9	44	Ganja-tut	73	Adila-tut
16	----- / ------ №10	45	Bidana-tut	74	Zumrud-tut
17	----- / ----- №21	46	Tehran-tut	75	Hasan-tut
18	Azerbaijan № 22	47	Khar-tut	76	Shamil-tut
19	----- / ------№ 23	48	Gozal-tut	77	Nagi-tut
20	----- / ------№ 24	49	Arzu-tut	78	Qadir-tut
21	----- / ------№ 25	50	Qalib-tut	79	Latifa-tut
22	----- / -----№ 27	51	AzNİİSh-1	80	Amina-tut
23	----- / -----№ 37	52	AzNİİSh-2	81	Sikhgoz-tut (autotetraploid)
24	----- / ------№ 41	53	AzNİİSh-3	82	Yaqub-tut (autotetraploid)
25	----- / ------№ 43	54	AzNİİSh-4	83	Firudin-tut (autotetraploid)
26	----- / ------№ 50	55	AzNİİSh-5	84	Db/N.1
27	----- / -----№ 63	56	AzNİİSh-6	85	Db/N.2
28	----- / -----№ 75	57	AzNİİSh-7	86	Db/N.3
29	----- / -----№ 79	58	AzNİİSh-8	87	Db/N.5

88	3-9/17	117	1-5/10	146	F x T - 1/20	175	AzT - 59-5
89	4-9/4	118	3-4/40	147	G x T - 3/1	176	AzT - 59-9
90	1-3/43	119	2-4/20	148	3-8/35	177	Vatan-tut
91	4-9/16	120	1-17/5	149	Samux-tut	178	Turshmaza-tut
92	4-9/17	121	1-15/18	150	Shamkir-tut	179	Dostluq-tut
93	4-12/51	122	1-15/14	151	Teymur-tut	180	Azerbaijan-tut
94	1-12/81	123	1-6/70	152	Qizili-tut	181	Ahmad-tut
95	1-12/14	124	1-5/71	153	Vaqif-tut	182	Sumqait-tut
96	1-12/18	125	3-17/13	154	AzT - 58-1	183	Absheron-tut
97	2-3/24	126	1-11/24	155	AzT - 58-3	184	Dovlat-tut
98	4-9/19	127	1-5/67	156	AzT - 58-6	185	Ana-tut
99	1-3/24	128	G x T - 2/12	157	AzT - 58-8	186	Qaragoz-tut
100	4-9/20	129	G x T - 2/15	158	AzT - 58-17	187	Xazar-tut
101	4-9/12	130	G x T - 2/21	159	AzT - 58-18	188	Mahsullu-tut
102	3-2/46	131	F x T - 1/6	160	AzT - 58-20	189	Moruq-tut
103	3-10/33	132	F x T - 1/10	161	AzT - 58-21	190	Shirvan-1
104	3-17/5	133	G x T - 2/3	162	AzT - 58-23	191	Shirvan-2
105	1-17/44	134	G x T - 2/7	163	AzT - 58-24	192	Shirvan-5
106	3-8/49	135	F x T - 10/4	164	AzT - 58-26	193	Shirvan-7
107	1-16/76	136	F x T - 2/9	165	AzT - 58-27	194	Shirvan-9
108	1-17/84	137	G x T - 2/5	166	AzT - 58-29	195	Shirvan-12
109	3-8/30	138	G x T - 4/6	167	AzT - 58-30	196	Shirvan-13
110	1-17/39	139	F x T - 1/5	168	AzT - 58-31	197	Shirvan-14
111	1-16/25	140	1-16/50	169	AzT - 58-32	198	Shirvan-18
112	3-10/40	141	3-1/30	170	AzT - 58-33	199	Shirvan-19
113	1-17/10	142	G x T - 2/2	171	AzT - 58-35	200	Shirvan-44
114	2-1/4	143	F x T - 8/15	172	AzT - 58-42	201	Shirvan-62
115	3-13/41	144	F x T - 19/3	173	AzT - 58-46	202	Shirvan-63
116	3-4/17	145	3-1/25	174	AzT - 59-4	203	Shirvan-21

Foreign varieties

Japanese varieties 28 Kosen 53 Indian-S-54

1	Kokuso-70	29	Boku-Vase		**Italian varieties**
2	Rulyardi	30	Entake	54	Aranchina
3	Osshiotanakida	31	Seydyuro	55	Limonchina
4	Kattaneo	32	Taka-Sen	56	İtalian № 2
5	Kubota	33	Fuso-Moru		**French varieties**
6	İosshino	34	Toqo-Vyase	57	Lu
7	Taka-isshi	35	Kayrio-Vase		**Bulgarian varieties**
8	Roquva	36	Akaqi	58	Bolq. mestn.uluch.№ 3
9	Nezu-kastshi	37	Riso	59	------ / ---- № 24
10	İchinose	38	Komaki	60	------ / --- № 47
11	Takeda-dziumondzi	39	Kayrio-Roso	61	------ / -----№ 57
12	Roso	40	Karioso	62	------ / ---№ 359
13	İtikhey		**Chinese varieties**	63	Bolqarskiy-106
14	Oshima	41	U-piy-san	64	Bolqarskiy qibrid-209
15	Dziumondzi	42	Kitayskiy	65	Vratza-1
16	Nezumi-Qaessi	43	Tsizin-quan-lu-san	66	Vratza-7
17	Tono-Rama		**Vietnamese varieties**	67	Vratza-17
18	Rokokouso	44	Bau-Den	68	Vratza-18
19	Kosuqa	45	Kue-Shon		**Ukrainian varieties**
20	Toko-Vase	46	Vietnam-1	69	Ukrainian № 1
21	Tuka-Sakuva	47	Vietnam-2	70	------ / ---- № 9
22	Senmatsu	48	Vietnam-3	71	------ / ---- № 107
23	Yaponskiy	49	Vietnam-13	72	------ / -----№ 510
24	Rokoko-Vase	50	Dalien	73	Kharkov № 3
25	Nakomaqi		**Indian varieties**	74	------ / ------ № 10
26	Kosoye	51	Kuspilla	75	----- / ------ № 11
27	Coko-Vase	52	Musijama		-

	Uzbekistani varieties	87	Letniy	99	Xurazme
76	Besplodnaya	88	Sterilnaya	100	Tadjik seedless
77	Osenniy 55-54	89	Pobeda	101	Maq-tut

78	Seleksiya - 49	90	Balxi-tut	102	Surx-tut
79	Uzbekskaya	91	Pozdniy-104	103	Yujnıy
80	SANİİSH-5	92	Oktyabr-26	104	SANİİSH-10
81	SANİİSH-14	93	44-3		**Georgian varieties**
82	SANİİSH-15	94	Mankentskiy	105	Qruziya
83	SANİİSH-17	95	Pionerskiy	106	Kutaturi
84	Seleksiya-69	96	K-9		**Russian varieties**
85	Seleksiya-86	97	Katlama	107	PS-9
86	Zimostoykiy	98	Pionerskiy № 2	108	PS-131

Appendix 2

Leaf yield in the most promising Azerbaijani mulberry varieties

Mulberry varieties	Mulberry leaf yield, kg		Inter-row and inter-tree distance m x m
	per one tree	per 1 ha	
1. Zakir-tut	4.87	3044	4 m x 4 m
2. Xanlar-tut	14.80	12300	4 m x 4 m
3. AzNIISH-7	7.30	4560	4 m x 4 m
4. AzNIISH-9	11.30	6810	4 m x 4 m
5. Nasreddin-tut	15.74	9835	4 m x 4 m
6. İlyas-tut	13.15	8221	4 m x 4 m
7. Qalib-tut	10.24	6400	4 m x 4 m
8. Qozal-tut	11,66	7290	4 m x 4 m
9. Arzu-tut	11.23	7020	4 m x 4 m
10. Fizuli-tut	2ş77	9221	3 m x 1 m
11. Bakhcha-tut	2.28	7600	3 m x 1 m
12. Kamil-tut	3.11	10921	3 m x 1 m
13.Kapaz - tut	1.50	940	3 m x 1 m
14.Adila - tut	2.32	1452	3 m x 1 m
15.Zumrud-tut	1.18	3944	3 m x 1 m
16.Nagi-tut	3.04	7600	4 m x 1 m
17.Qadir-tut	2.92	7300	4 m x 1 m
18.Latifa-tut	2.68	6880	4 m x 1 m
19.Amina-tut	3.45	8640	4 m x 1 m
20.Farash-tut	8.7	21750	4 m x 1 m
21.Shamkir-tut	2.57	3210	4 m x 2 m
22.Teymur-tut	2.50	3125	4 m x 2 m

Appendix 3

List of silkworm breeds, maintained at ASERI's germplasm and data about some their biological characters

	Name of the breed	Eggs hatchabiliy %	Larval duration, days	Pupation rate, %	Average weight of fresh cocoon, g	Average weight of cocoon shell, mg	Average shell percentage in fresh cocoons, %
1	2	3	4	5	6	7	8
			Azerbaijani breeds				
1.	Agbaramali 1	83,5	21,5	90,0	1,81	343	19,0
2.	Agbaramali 2	86,3	21,6	89,3	1,69	306	18,1
3.	Agbaramali 3	84,5	21,6	88,3	1,59	260	16,4
4.	Azerbaijan	95,2	22,6	91,7	1,84	353	19,2
5.	Azad	89,8	21,5	91,0	1,89	367	19,4
6.	Zarif	86,0	21,7	89,3	1,34	220	16,4
7.	Aran	96,8	22,8	90,0	1,82	333	18,3
8.	Şirvan	92,0	22,6	89,0	1,78	353	19,8
9.	Ganja 1	89,8	22,5	90,7	1,84	333	18,1
10.	Ganja 2	90,0	22,5	90,0	1,84	330	17,9
11.	Ganja 3	97,3	22,6	91,3	1,84	390	21,2
12.	Az.NİİŞ 1	85,0	22,6	91,2	1,80	357	19,8
13.	Az.NİİŞ 2	81,2	22,6	90,0	1,74	330	19,0
14.	Şeki 1	91,7	21,7	91,3	1,76	360	20,4
15.	Şeki 2	89,2	22,5	90,7	1,92	350	18,2
16.	Rahimli 1	93,2	22,6	91,7	1,92	387	20,1
17.	Rahimli 2	92,2	23,2	90,0	2,03	427	21,0
18.	Rahimli 3	93,5	23,1	90,7	1,86	373	20,1
19.	Rahimli 4	88,3	22,7	91,0	1,91	383	20,0
20.	Rahimli 5	93,2	22,7	90,0	1,70	340	20,0
21.	Yaşar	94,3	22,7	92,0	1,94	410	21,1
22.	Mahsullu 1	93,5	22,1	89,3	1,70	293	17,2
23.	Mahsullu 2	88,7	22,1	90,0	1,70	287	16,9
24.	Pioner 1	83,8	22,8	90,3	1,72	320	18,6
25	Pioner 2	79,2	23,1	90,0	1,75	327	18,7
1	2	3	4	5	6	7	8
26	Bahar	87,0	22,1	90,0	1,67	303	18,1

27	Yubiley	94,5	22,2	89,3	1,70	343	20,2
28	Ganja 5	90,7	22,7	90,3	1,79	357	19,9
29	Ganja 6	95,0	23,3	91,7	2,04	430	21,1
30	Ganja 7	82,8	22,7	90,7	1,96	393	20,0
31	Ganja 8	93,7	22,7	90,3	2,03	400	19,7
32	Almaz	91,0	22,7	88,3	1,90	387	20,4
33	Pioner 1 n.	89,8	22,7	92,3	1,85	353	19,1
34	Çinar	96,5	23,1	91,7	1,84	353	19,2
35	Murov	94,5	23,2	91,7	1,94	360	18,6
36	Qoşqar	92,2	23,2	91,0	1,91	377	19,7
37	Mayak 1	91,2	23,3	88,3	1,82	433	23,8
38	Mayak 2	96,7	23,3	92,3	1,89	410	21,7
39	Mayak 3	84,2	22,6	91,0	2,04	497	24,4
40	Mayak 4	87,0	22,7	90,0	2,18	443	20,3
41	Mayak 5	83,5	22,7	92,0	2,05	427	20,8
42	Mayak 6	93,7	23,2	92,7	1,94	430	22,2
43	Bahar n.	86,3	22,6	91,3	1,74	360	20,7
44	Ganja 6 n.	91,0	22,8	92,7	1,82	360	19,8
45	Xazar	77,5	23,2	89,3	1,74	387	22,2
46	Araz	91,7	23,2	92,0	1,76	370	21,0
47	Qabala	95,5	21,7	92,7	1,80	343	19,0
48	Ashrafi	91,2	22,7	92,3	1,88	363	19,3
49	Xatira	93,0	21,6	93,3	1,60	320	20,0
50	Sangar	97,0	21,6	92,7	1,85	393	21,2
51	S-6	79,7	21,7	91,3	1,71	390	22,8
52	Qalaba	91,3	22,5	92,3	1,77	377	21,3
53	Qafqaz	95,3	22,8	90,7	2,16	510	23,6
54	Namazli-1	96,0	22,6	92,7	1,92	427	22,2
55	Namazli-2	91,7	22,6	91,3	1,93	397	20,6
1	2	3	4	5	6	7	8
56	Namazli-3	89,7	22,1	91,0	1,78	390	21,9
57	Xayal	96,8	23,2	89,7	2,07	460	22,2
58	Ugur	98,2	23,3	90,7	2,11	453	21,5
		Foreign breeds					
1	Chinese-21	85,7	22,5	90,0	1,77	350	19,8

2	Chinese-29	91,2	21,5	89,3	1,47	233	15,8
3	Yuxan	77,2	21,2	92,3	1,12	147	13,1
4	Ulun	94,8	22,2	88,7	1,54	293	19,0
5	Tsnya Mayu2	87,2	21,5	90,0	1,30	180	13,8
6	Oro	93,2	21,2	91,7	1,47	247	16,8
7	Siçuan	90,2	21,5	90,0	1,28	153	12,0
8	Polivoltin 09	84,8	21,5	92,0	1,04	130	12,5
9	Aojiko	94,7	21,4	92,7	1,39	183	13,2
10	Bivoltin 114	94,3	21,5	90,7	1,45	237	16,3
11	Japanese 5	84,2	21,5	92,3	1,55	283	18,3
12	Japanese 120	87,5	21,5	90,7	1,36	203	14,9
13	Japanese green	94,0	21,5	91,3	1,39	180	13,0
14	Salpa	91,8	21,2	91,0	1,34	197	14,7
15	Askoli	94,2	21,2	92,7	1,41	183	13,0
16	Sferiko	86,3	21,2	91,0	1,43	190	13,3
17	Gulustan 2	95,0	23,0	90,3	1,89	367	19,4
18	BQ	95,3	22,5	91,7	1,59	300	18,9
19	Soviet 5	94,2	23,2	92,7	1,67	330	19,8
20	Soviet 8	93,2	23,2	92,3	1,76	373	21,2
21	Soviet 12	93,5	23,2	91,0	1,89	373	19,7
22	Us-4	82,5	22,7	90,7	1,73	327	18,9
23	Ukrainian-1	89,7	22,7	92,7	1,84	410	223
24	Ukrainian-2	88,0	22,6	92,7	1,71	337	19,7
25	Turkustan	98,0	22,5	90,3	1,48	237	16,0
26	Indian 4	88,8	23,1	90,7	1,65	290	17,6
1	2	3	4	5	6	7	8
27	Plovdiv 14	85,5	23,1	91,3	1,76	357	20,3
28	Plovdiv 15	80,3	23,1	91,7	1,71	360	21,0
29	Plovdiv 19	92,0	23,2	90,0	1,61	323	20,1
30	Plovdiv 20	93,8	22,5	91,7	1,71	347	20,3
31	Vratza 2002	88,3	22,5	90,3	1,71	350	20,5
32	Vratza 2005	93,8	21,6	91,0	1,66	317	19,1
33	Vratza 2007	85,8	22,2	90,7	1,84	397	21,6
34	Vratza 2003	96,3	22,2	92,7	1,93	407	21,1

35	Vratza 2012	98,7	22,2	92,7	1,88	377	20,0
36	Vratza 35/2	95,7	22,2	90,3	1,96	393	20,0
37	Hesa 2/1	95,2	21,8	90,7	1,85	430	23,2
38	Mziuri 1	98,0	23,2	91,3	2,03	447	22,0
39	Mziuri 2	98,2	23,2	91,7	2,12	463	21,8
40	Mziuri 3	97,0	23,2	90,0	1,87	433	23,2
41	Mziuri 4	98,2	23,2	91,7	2,08	467	22,4
42	Mziuri 5	98,5	23,2	90,3	2,08	437	21,0

Appendix 4

Reeling shop of Sheki-Ipak JSC

Appendix 5

Twisting shop of Sheki-Ipak JSC

Appendix 6

Spinning mill of Sheki-Ipak JSC

Appendix 7

Weaver's shop of Sheki-Ipak JSC

Appendix 8

Dyeing shop of Sheki-Ipak JSC

Appendix 9

Carpet shop of Sheki-Ipak JSC

SERICULTURE STATUS, PROBLEMS, ISSUES AND DEVELOPMENT STRATEGIES IN ROMANIA

By

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(ORAL PRESENTATION)

ABSTRACT: In Romania there are very favorable climatic conditions for the sericulture development. The first mulberry cultivation and silkworm rearing occurred in our country in the fourteenth century, first in Transylvania (1348 A.D.) and then in Banat. Basically, sericulture began to be spread in a larger scale over the Romanian lands in the seventeenth and eighteenth centuries. In the early twentieth century the first small factory for obtaining and selecting silkworm eggs was organized. After World War 1st, Romania largely organized and developed the sericulture by setting up new sericultural regions, as in Lugoj.

The city of Lugoj organized and natural silk processing factory, which still exists today as "Filseta Trading Company SA" as a result of sericulture extension in this region of the country. Romania is one of the founding members of the International Sericultural Commission in 1959. Production activity of biological material was held just within the company SERICAROM SA., equipped with equipment and plant material. In recent years it has been declining due to many reasons, one of them was the change of several company's directors who have led the company badly. Currently huge efforts are being made by the Ministry of Agriculture and the present director for socio-economic rebalancing of this company. Although Romania has the resources and manpower that would be able to produce more than 5000 tons of fresh cocoons annually in recent years production has decreased, in terms of both silk production and mulberry plantations. A lot of reasons caused the fall of cocoon production: economic instability characteristic of the transition period to a market economy, low purchase prices of cocoons, cocoons imported at prices lower than those prevailing in the country etc.. Romania has great development potential in sericulture, but must take measures to restore the field. Currently measures are necessary for the development of the private sector by attracting private farmers in sericultural activity. We have three possible ways to enhance the production of silk in Romania:

1. Traditional individual silkworm rearing;

2. Centralized method with modern technology, using improved varieties of silkworm eggs and mulberry.

3. Mixed methods of mulberry cultivation and silkworm rearing in less favored areas, where climatic conditions allow, it is a well known fact that mulberry can acclimate to some unfriendly conditions.

Current social and economic situation of farmers in Romania and legislation, that European Commission cut the subsidy for the Romanian sericulturists made this branch of agriculture in a big decline in the recent years. Sericulture launch in Romania is possible by reorganizing the distribution of silkworm eggs, cocoons collected by a private company or by a professional association of silkworm breeders. The current sericultural activities in Romania are:

- In cel Mare area there are several hectares cultivated with mulberry and having potential for silkworm rearing at a bigger scale;

- The private company NICULESCU SRL, Valcea county, dealing with all the sericulture value chain from mulberrry through silkworm rearing to production of woven silk handcrafts.

- SC SILKEST SRL village Bihor, Romanian Company formed an association in Italy, producing silk threads, founded in 2007, has over 60 employees and an annual turnover of 700,000 euros, which has a capacity of 25,000 kg / month processed silk. The entire production of the company is exported to Italy and sometimes in Austria

We could recommend:

- **Revitalization of sericulture activities in Romania by the superior biological resources and sericultural products available at the SC Sericarom S.A. Bucharest, even though located in a difficult economic situation, but currently managing national sericultural genetic resources.**
- **- Supporting and developing the international relations of economic cooperation and scientific professionals in the sericulture with sericultural countries in Europe and Asia through development programs with grants.**
- **Promotion of sericulture as a traditional activity in rural areas for artisanal crafts with high cultural and economic value, as a part of the national socio-cultural heritage, the beneficial impact on income of the residents of rural areas including the young generation.**

Chapter 1. Introduction

History of sericultural industry in Romania

In Romania there are very favorable climatic conditions for the sericulture development. The first mulberry cultivation and silkworm rearing occurred in our country in the fourteenth century, first in Transylvania (1348 A.D.) and then in Banat. In Moldova and Muntenia, sericulture was introduced by the Turks, in the eighteenth century, where we stayed the word silk (derived from the Turkish word "buriincuk"), old name for natural silk, which actually is untwisted wire, resulting in Drawing from silkworm donuts. Basically, sericulture began to spread over the Romanian lands in the seventeenth and eighteenth centuries, although there are opinions that plantations of mulberry and silkworm rearing concerns were much older. Undoubtedly, long time, these concerns were not organized and practiced on a small scale. Sericulture in Transylvania and Banat penetrated the West and especially in Italy, where the occupation was already well known and developed. Development of sericulture in Banat was favored by climate suitable growth mulberry trees in this part of the Romanian countries in addition to the "laws" given by the German Roman Empire Empress Maria Theresa (1740-1780), during 1764-1765, the application of which many roads were planted with mulberry trees, părți.Trebuie both pointed out that in the nineteenth century occurred publications (books, articles) which are brought to the attention of a wider audience, the need to develop sericulture and its advantages. An example is the translation of the Book of Louis Mitterparcher 1823, entitled "teaching about culture or growth of mulberry and silkworm." Also in 1823, John Tomic a work published in Transylvania deal about agriculture and increasing silkworm rearing. Moreover, in 1846, the journal "village teacher" articles were published which gave indications of multiplying mulberry trees and silkworm rearing. A year later, so in 1849, Petrache Poenaru (1799-1875), one of the editors of the paper "village teacher", a book published in Bucharest on sericulture, which emphasizes the importance of planting mulberry trees and silkworm rearing. During the same year an another book was printed in Bucharest on "teaching to increase upon raising mulberry trees and silk beetles, collected and compiled the Romanian country from clucerul climate and Peter Knight Poenaru." In order to spread sericulture, some measures have been taken in Moldova, as in 1845, which were distributed free by the state, a total of 60,000 mulberry trees, which were planted in villages in the southern province. It is said the concern quite old, establishing nurseries and plantations of mulberry importation of eggs and silkworm, Bombyx mori the species of sericulture developed countries, such as France, Italy or Japan. These nurseries were organized in Pantelimon, and later, in 1864, they set up other mulberry nurseries in Iasi, Braila, Giurgiu and Calandra, each paying significant areas of land. They distributed free saplings of mulberry and silkworm eggs imported. In the early twentieth century were organized first small factory for obtaining and selecting silkworm eggs. After World War I, which disturbed and Romania largely organizing and developing sericulture, resumed this activity by setting up new sericultural regions, as in Lugoj. The city of Lugoj organized and natural silk processing factory, which still exists today as "Filseta Trading Company SA" as a result of sericulture extension in this region of the country.

Chapter 2. Summary Review of Sericulture

Romania is one of the founding members of the International Sericultural Commission in 1959. Production activity of biological material was held just within the company SERICAROM SA., equipped with equipment and plant material. In recent years it has been declining due to many reasons, one of them change several directors who have led the company badly. Currently huge efforts are being made by the Ministry of Agriculture and Mrs. Elena Pau for socio-economic rebalancing of this company. Although Romania has the resources and manpower that would be able to produce more than 5000 tons of fresh cocoons annually in recent years production has decreased, in terms of both silk production and mulberry plantations. A lot of reasons caused the fall of cocoon production: economic instability characteristic of the transition period to a market economy, low purchase prices of cocoons, cocoons imported at prices lower than those prevailing in the country etc..

Chapter 3. Major Problems Issues, and Recommendations

For a community to grow and develop, to be sustainable requires a local development strategy that meets real needs identified. And as we are European country, all this development should reflect and identify with EU requirements. Romania has great development potential in sericulture, but must take measures to restore the field. Currently measures are necessary for the development of the private sector by attracting private farmers in sericultural activity.

Chapter 4. National strategy for sericulture revival and development in Romania

Romania has the ability to produce silk cocoons. There are, however, some technical and organizational measures need to be taken to revitalize and stabilize the industry.
We have three possible ways to enhance the production of silk in Romania:
1. Traditional individual silkworm rearing;
2. Centralized method with modern technology, using improved varieties of silkworm eggs and mulberry.
3. Mixed methods of mulberry cultivation and silkworm rearing in less favored areas, where climatic conditions allow, it is a well known fact that mulberry can acclimate to some unfriendly conditions.

Due to its specificity, sericulture protect may also improve the environment, because this activity does not use substances that might taint, silk fiber is a green product, superior to all other natural and artificial fibers. Romania was one of the renowned manufacturers in art handicraft artisans, exporting clothes and scarfs. Current social and economic situation of farmers in Romania and legislation, that European Commission cut the subsidy for the Romanian sericulturists made this branch of agriculture in the recent years in a big decline. Sericulture launch in Romania is possible by reorganizing the distribution of silkworm eggs, cocoons collected in a privately or by a professional association of silkworm breeders. This new concept of organization in our country is used with remarkable results in countries with a tradition of sericulture. Development is necessary for the production of donuts silkworm producers can receive grants. Another solution would be that small businesses have access to credit microindustrie and access to European and international programs.

Chapter 5. Development Strategies

Sericulture activity is a specific component in rural development. Should pursue several goals:

¬ ensuring stable and equitable levels of farm income;
¬ environment;
¬ complementary and alternative development activities generating jobs,
¬ improve working and living conditions in rural areas and promoting equal opportunities

For reinvigorating economic activities in rural areas and diversification of sericulture activities required to support the increased production of handicraft activity that can be performed by women, children and the elderly. An important part of the strategy development of sericulture activity is to increase company initiatives to implement grant projects by developing partnerships between companies from different regions from Europe and Central Asia Region. Achieving this goal can be achieved by implementing the following years several projects. Project financing will be done, on the part of the grant from the state budget and the sectoral operational programs, and on the other from its own funds.The most important objective is to attract both reimbursable financial assistance from EU funds and other grants.

Chapter 6. Follow-up activities of the 5th BACSA - SERIPRODEV

Activities at the governmental level

Ministry of Agriculture and Rural Development through ongoing programs specifically supports agriculture through measures:

112-Setting up of young farmers

121-Modernization of agricultural holdings

122-Improvement of the economic value of forests

141-Supporting semi-subsistence farms

142-Setting up producer groups

221-First afforestation of agricultural land

312-Support for the creation and development of micro-enterprises.

The situation would be better if subsidy would apply for sericulture. A lot of young people in rural areas could become sericulturist farmer.

Activities at the level of research institute

Research during the period 2008-2013 was conducted nationwide research projects - development as follows:

1. S.C.BIOING S.A., in partnership with other companies, developed and led research project in "Phytoremediation of lead contaminated soils using plants of the genus Morus."
2. S.C. BIOING S.A. has developed and conducted bilateral project Romania - Bulgaria for 2008-2009 "Application of modern methods for processing the products and sweepings resulted from sericulture in order to Obtain new food organic agriculture"
3. S.C. BIOING S.A. has developed and conducted bilateral project Romania - China in 2009

"Biotechnological the application of the products and methods for processing sweepings resulted from sericulture in order to obtain phytotherapeutic new food and agriculture products”.
4. ICPA Bucharest, in partnership with other companies, has developed and led research project "Interdisciplinary research on the use of Morus SP. poultry production ".

Activities at private business and field level.

Following my hobby site for sericulture in Calarasi County is in the southern part of the country a sunny area, with a favorable environment for growth of mulberry I contacted several mayors, where I tried to create a strategy for the future and to cultivate mulberry trees. Thus mayor Stefan cel Mare area several hectares cultivated with mulberry owns a building that we can help silkworm rearing. You must remember about the company NICULESCU SRL, Valcea county family which is an association that developed on their own, from silkworm rearing to making crafts. Another company is SC SILKEST SRL village, Bihor, Romanian Company formed an association in Italy, producing silk threads, founded in 2007, has over 60 employees and a turnover of 700,000 euros, which has a capacity of 25,000 kg / month processed silk. The entire production of the company are exported to Italy and sometimes in Austria

National meetings and conferences

Conclusions:

- Revitalization of sericulture activities in Romania by the superior biological resources and sericultural products and indirect support of SC Sericarom S.A. Bucharest, located in a difficult economic situation, but currently managing national sericultural genetic background.

- Supporting and developing the international relations of economic cooperation and scientific professionals in the sericulture with sericultural countries in Europe and Asia through development programs with grants

- Promotion of sericulture that traditional activity in rural areas for artisanal crafts with high cultural and economic value, that part of the national socio-cultural heritage, the beneficial impact on income residents of rural areas including the young generation.

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CURRENT STATE IN SERICULTURE OF GEORGIA - PROBLEMS AND STRATEGY OF DEVELOPMENT

By

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(ORAL PRESENTATION)

ABSTRACT: Sericulture is one of the oldest branches of agriculture in Georgia. In the 30-ies of the last century we observed intense building of solid thread dying-twisting factories, silk combinates, grainage factories and relevant infrastructure, the capacity of which was designed for production of 10 thousand ton live cocoon/annually. Much work had been done by Caucasus Sericulture Station (1887) and its legal successor Scientific-Research Institute of Sericulture in a matter of creation-preservation of rich genofund of mulberry

and mulberry silkworm in Georgia. The following enterprises worked to render their services to sericulture.

1) **5 thread dying-winding factories of 450-500 ton raw silk thread annual production capacity;**
2) **2 silk-weaving groups of enterprises of 4.5-5.0 million meter natural silk fabric annual capacity;**
3) **6 grainage factories of 4.5-5.9 ton silkworm eggs annual production capacity;**
4) **2 mulberry state nursery economies, of 1 million grafted sapling annual capacity;**
5) **2 sericulture selection stations of annual capacity of 80,0 kg P_2 silkworm eggs production.**

In all (42) sericulture regions the regional departments were functioning with agro-service and initial cocoon processing bases. 100-120 thousand families were employed in sericulture, while in silk industry – 5-6 thousand persons. Today, sericulture, as the significant branch of national economy is destroyed and is to be formed anew. It is abandoned and it exists just thanks to efforts of some enthusiasts and researchers, but irrespective of this fact, sericulture is so deeply and strongly rooted in everyday life of a Georgian man, that even the slightest support from the state would enable the branch to occupy deserved place in the economy of independent Georgia. In the future, alongside with retaining strategic directions of sericulture development the following should be developed:

- **Production of silkworm eggs of local highly productive mulberry silkworm breeds (Mziuri-1, Mziuri-2, Digmuri-1 and Digmuri-2) for export,**
- **Revival of natural silk primitive trade by the use of colored cocoon breeds existing in collection.**
- **Strengthening of nutrition base should be realized mainly by planting unit mulberry plants, by scion/bud grafting in the crown of non-quality plants, within the frames of possibility, by planting of low intensive plantations;**
- **To facilitate production of mulberry planting material it is necessary to organize small size thermal sites at the expense of warm waters (springs) existing in the country and rearing saplings with their own root. Time needed for growth of standard saplings by the use of this method decreases, while the self-cost decreases 2.5-3.0-times. This problem has been studied thoroughly and is approbated in industry;**
- **We have to care to keep the branch at the level, which will enable us to rehabilitate it completely in the future.**
- **At the first stage final product of sericulture will be raw thread, while at the second stage – fabric and ready articles.**

In connection with transition to market economy we consider that creation of sericulture amalgamations, cooperatives, economies and other organizational forms, deepening of integration, creation of joint ventures with foreign companies and resolution of problems connected with the above stated will be most important. In the last period, the public showed interest to the branch, but relevant ministries and authorities failed to support demand of people. Irrespective of it, in 2010, on the basis of silkworm eggs, imported from Bulgaria at the initiative of the Patriarchate of Georgia silkworm feeding was organized, which incited great interest among population. Desire to speed up rehabilitation of the branch and return to it the previous fame – was clearly observed. Today scientific activity is extremely limited at the Institute of Sericulture, but preservation of unique silkworm breeds and collection is somehow managed. Definite works are carried out also in moriculture. Scientific research work became especially difficult when Agrarian University

passed into private ownership (2010). Scientific personnel was decreased sharply, to its minimum (by 92-95%), experimental and selection mulberry plantations were annihilated, premises for silkworm breeding were destroyed and it is planned to transfer premises for silkworm breeding/feeding to absolutely inappropriate place. To prevent the above stated it is necessary to isolate the Institute from Agrarian University and subordinate it to the Ministry of Agriculture or Academy of Agrarian Sciences. Selection activity and costs for care and preservation of collection of mulberry varieties and silkworm breeds should be funded by the state.

The strategy for sericulture revival in Georgia plans at the first stage 180-200 thousand saplings (hybrids) annually will be produced, while at the second stage 140-150 thousand saplings. In 2020 total number of mulberry trees will reach 9-10 million plants, which will enable to feed 50-55 thousand silkworm egg boxes and to produce 2,5 -3,0 thousand ton of fresh cocoons. On the second stage it will be increased up to 4,0-4,5 thousand ton. Only spring feeding will be performed in order to decrease harmfulness of mulberry disease "leaf curl". At the first stage annually at about 70-80 thousand farmers will participate in silk cocoon production, while at the second stage –more than 100 thousand. Silkworm eggs, raw silk, articles of primitive trade produced at the first stage are designed mainly for the local market, while at the second stage it will occupy the corresponding segment of international market.

Introduction

Sericulture is one of the oldest branches of agriculture in Georgia, It was always considered as the source of strengthening of economics of the country, rational application of labor resources and monetary incomes, as an example of cultural heritage of the nation and the object of permanent care. Production and procession of silk cocoon and knitting was considered as the most prestigious occupation; high quality Georgian silk enjoyed great authority at the world market. Big Silk Road transected territory of Georgia. Silk cocoon, grain, fabric and other products were exported.

In 1850, in Torino and in 1862 at the International Exposition of London Georgian silk was awarded the medals. In 1998 fabric made of silk of mulberry silkworm of Georgian breeds (Mziuri 1 and Mziuri 2) received the highest quality award of Europe – platinum star. Mulberry plantations of the country attracted attention of organizers of exhibitions.

In 30-ies of the last century we observed intense building of solid thread dying-twisting factories, silk combinates, grainage factories and relevant infrastructure, the capacity of which was designed for production of 10 thousand ton live cocoon.

The following enterprises worked to render their services to sericulture.

6) 5 thread dying-winding factories of 450-500 ton raw silk thread production capacity;
7) 2 silk-knitting groups of enterprises of 4,5-5,0 million meter natural silk fabric capacity;
8) 6 grainage factories of 4,5-5,9 ton grain production capacity;
9) 2 mulberry state nursery economies, of 1 million grafted sapling capacity
10) 2 sericulture selection stations of annual capacity of 80,0 kg super elite grain production.

In all (42) sericulture regions the regional departments were functioning with agro-service and initial cocoon procession bases.

In the 60-ies of the twentieth century Georgia produced 4,5-5,0 ton industrial grain, 4,0-4,4 thousand ton raw silk thread and 4,5-5,0 million linear meter natural silk fabric. Income gained from realization of live cocoon equalled to 21,0-21,5 million dollars. 100-120 thousand families were employed in sericulture, while in silk industry – 5-6 thousand persons. Powerful intellectual resources and solid capital investments were concentrated in this branch of economy. Unfortunately it was namely at this stage that mulberry micoplasma disease – "leaf curl" was spread in Georgia and destructed more than 15 million mulberry trees, which together with other reasons, resulted in final fall of the branch; 15-16 thousand working places were lost.

Today, sericulture, as the significant branch of national economy is destructed and is to be formed anew. It is abandoned and it exists just thanks to efforts of some enthusiasts and researchers, but irrespective of this fact, sericulture is so deeply and strongly rooted in everyday life of a Georgian man, that even the slightest support from the state would enable the branch to occupy deserved place in the economy of independent Georgia.

In future, alongside with retaining strategic directions of sericulture development (nutritive/fodder base strengthening, production of grain, cocoon, raw thread and fabric) the following should be developed:

- Production of grain of local highly productive mulberry silkworm breeds (Mziuri-1, Mziuri-2, Digmuri-1 and Digmuri-2) for export,
- Revival of natural silk primitive trade by the use of colored cocoon breeds existing in collection.
- Strengthening of nutrition base should be realized mainly by planting unit mulberry plants, by scion/bud grafting in the crown of non-quality plants, within the frames of possibility, by planting of low intensive plantations;
- To facilitate production of mulberry planting material it is necessary to organize small size thermal sites at the expense of warm waters (springs) existing in the country and rearing saplings with their own root. Time needed for growth of standard saplings by the use of this method decreases with three year, while the self-cost decreases 0 2,5-3,0-times. This problem has been studied thoroughly and is approbated in industry;
- We have to care to keep the branch at the level, which will enable us to rehabilitate it completely in future.
- At the first stage final product of sericulture will be raw thread, while at the second stage – fabric and ready articles.

In connection with transition to market economy we consider that creation of sericulture amalgamations, cooperatives, economies and other organizational forms, deepening of integration, creation of joint ventures with foreign companies and resolution of problems connected with the above stated -will be most important.

CHAPTER 1
BRIEF REVIEW OF CURRENT STATE IN SERICULTURE

Georgia is the ancient country leading sericulture activity. It has rich traditions and ample possibilities. In 1964, 8499 ha mulberry plantations and 7,2 million unit mulberry plants were registered in Georgia. Annually up to 7 million mulberry saplings were produced. In the last twenty years, due to the reasons considered in the first chapter, sericulture, silk industry and scientific potential were practically annihilated and now everything is to be started anew.

In the last period, the public showed interest to the branch, but relevant ministries and authorities failed to support demand of people. Irrespective of it, in 2010, on the basis of grain imported from Bulgaria at the initiative of the Patriarchate of Georgia feeding was organized, which incited great interest among population. Desire to speed up rehabilitation of the branch and return to it the previous fame – was clearly observed.

Table 1. Indices of development of sericulture in Georgia

#		years							
		1964	1984	1990	2000	2005	2010	2011	2012
1.	Mulberry plantation (thousand ha)	8.5	9.2	10.0	0.4	0.2	-	-	-
2.	Unit plants (mln plants)	7.2	6.5	8.0	4.0	3.5	-	-	-
3.	Sapling production (thousand plants)	7200	3450	2660	6.0	7.0	1.0	1.0	1.2

4.	Production of breed and hybrid grain (thousand kg.)	3.8	2.4	1.7	0.2	-	-	-	-
5.	Number of cocoon producing farmers (man)	120.3	119	100	3.6	-	0.1	-	-
6.	Quantity of produced cocoon (t)	4382	1998	1557	9.2	-	1.1	-	-
7.	Raw silk production (t)	450	382	268	-	-	-	-	-
8.	Production of silk fabrics (mln linear meter)	5.0	3.0	3.2	-	-	-	-	-
9.	Live cocoon yield per gram grain (kg)	1.9	2.0	1.9	1.4	-	3.2	-	-

STARTING CONDITIONS FOR REHABILITATION

Current situation in sericulture is extremely heavy in Georgia, but new government has political will for its revival. Demand on natural silk is increasing in the world

1. China loses its monopolistic role, which creates favorable condition for silk production in alternate countries;
2. Great love to the branch, desire to restore fodder base, local specialists, experienced sericulture specialists, enthusiasts to restore sericulture and researchers still exist in the country.
3. Revival of the branch will contribute to mass employment of rural population, increase of incomes, improvement of family budget of silkworm breeders, slowing of migration processes and others.

Natural conditions of Georgia, ancient history in silk production, most important and valued silk gloss inherent to Georgian silk; alongside with raw silk produced in Georgia that completely yields to factory treatment – fabric making are advantages. Awards received thanks to the above stated advantages at the world exhibitions and geographical position, create favorable conditions for attraction of investments to Georgian sericulture.

Considering the situation created in sericulture, shifting to production of final product (raw thread, fabric, grain) will be realized in stages.

Preference in silk cocoon production will be granted to “family” production of cocoon, and gradually progressive methods and technologies of feeding will be inculcated.

The main organizational form for silk cocoon production will be cooperatives, amalgamations and other unions created at various levels.

At the initiative of cooperatives (amalgamations) territorial integrated enterprises (homestead sericulture + regional reeling of thread) will be created and thus economic interest of sericulture will be bound to production of final product, by issuing part of income gained from thread realization to silkworm breeders.

Much work had been done by Caucasus Sericulture Station (1887) and its legal successor Scientific-Research Institute of Sericulture in a matter of creation-preservation of rich genofund of mulberry and mulberry silkworm in Georgia. At the current stage mulberry genofund is presented containing Morus alba Linn (2n, 3n, 4n), Morus bombycis (2n), Morus Kagayamae Koids (2n), Morus nigra Linn (22n),, many local forms and endemic varieties (MMorus multicaulis Perr (2n).

In 1945-2012, in Georgia as a result of selection activity 31 mulberry breeds were revealed and 19 of those breeds were inculcated in industry.

Table 2. Selective mulberry breads obtained and zoned in Georgia

#	Breed and hybrid	Year of breeding	Year of zoning
1.	Sakartvelo	1945	1950
2.	Breeds: hybrid Gruzniish-7, Tbilisuri, Kutaturi, Gruzniish-4, Gruzniish-5, Kartli, Adreuli, Iveria, Kolkheti	1950-2007	1955-2007
3.	Aisi	1998-2008	2011
4.	Fazisi	"_"	2010
5.	Tvaltai	2001-2008	2010
	Revealed through passive selection		
6.	Oshima	1974-1995	1998
7.	Nezumegaesi	1975-1998	2001
8.	Kutaisuri 1	1971-1983	2010
9.	Kutaisuri 2	1981-1990	2010
10.	Egrisi	1981-1993	2012

At present 2 breeds are submitted for registration. In the 80-ies of the last century there were up to 140 breeds in the collection of the Institute of Sericulture, today only up to 20 breeds are preserved.

Genetic resources of mulberry silkworm are of two kinds:

- Old breeds, withdrawn from industry (there were up to 170, remained 73), which are kept at the Kutaisi Zonal Experimental Station.
- Newly zoned perspective breeds, which are protected and kept at the Institute (till starting the enterprise).

For preservation of live silkworm collection mostly non-relative propagation methods are used, while protection and preservation of the zoned and perspective breeds is made at the Institute, at family nutrition and non-relative propagation method, at strict rejection conditions.

The Institute, in parallel with some perspective breeds (Mziuri 3, Mziuri 4, Mziuri 5, line 1, line 2. Digomi 2, Digomi 4 and Digomi 5) (in connection with stopping of industrial feeding) preserves early zoned breeds (Mziuri 1, Mziuri 2, Digmuri 1, Digmuri 2, Parthenoclone PK-36) till present and these breeds are under real threat of destruction (because of non-funding).

The issue of preservation of genetic heritage and that of selection activity became extremely acute when the Institute of Sericulture passed to private ownership (2011) and if nothing is changed, the result will be deplorable.

CHAPTER II
MAJOR PROBLEMS AND RECOMMENDATIONS

At current stage agriculture is considered the priority branch and the much work is carried out for its revival.

Simultaneously with realization of solid projects it is planned to build small and average size farm produce processing factories, to improve services and to realize other measures, which, naturally will cover sericulture too. Although, as it was stated above, this branch is brought to the level that its revival without application of protectionist policy, investment attraction and starting of joint companies will not be managed. We can consider also the fact that in the post-soviet states, in connection with transmission to market economy, sericulture suffered most.

During the last fifteen years silk industry objects suffered such destruction that there were even no attempts to create joint companies on their basis. Weakening of interest to this branch was followed by mass annihilation of mulberry varieties resistant to a disease- leaf curl, which still lingered on the privatized land plots, and production of grafting material became a problem too. .

Taking into consideration the real situation that was created in sericulture the Academy of Agrarian Sciences considered the issue on development of measures for rehabilitation of sericulture in Georgia and its scientific provision and it made the corresponding resolution.

On the basis of the above stated “Conception of Development of Sericulture in Georgia – 2012-2025” was developed, in which the main directions (strategy) of sericulture development, criteria and expected results are analyzed thoroughly.

The main goal of the conception is stage-wise restoration of historical traditions of sericulture:

- At the first stage – rehabilitation of the branch, restoration of forgotten traditions of primitive trade, creation of small joint companies, preparation of conditions for grain production on the basis of highly productive local breeds of mulberry silkworm (Mziuri 1, Mziuri 2, Digmuri 1, Digmuri 2) etc.
- Final product will be raw silk thread and handicraft wares.
- At the second stage – restoration of the branch, increase of cocoon production, perfection of processing capacities, and regulation of other problems. Export of grain, fabrics, ready product.

At the current stage at the background of support of the government to sericulture, interest shown by local businessmen, attempts to attract investments and desire to create joint ventures will significantly speed up a matter of revival of the branch.

CHAPTER III
REHABILITATION OF SERICULTURE IN GEORGIA – REHABILITATION STRATEGY AND EXPECTED RESULTS

At the current stage restoration of the ruined fodder base and revival of the branch asks for new approaches. In 1991 there were 9,0 thousand ha mulberry plantation and more than 8 million unit plants in Georgia, which significantly exceeded the indices observed till disease spreading (1964). But privatization of land plots and weakening of attention to the branch was followed by repeated destruction of the fodder base. Alongside with it, in the main regions of sericulture, where mainly high quality plants were spread, the situation was worse than in those regions, where low quality trees dominated. Therefore, considering the present day reality we have to define directions of strengthening of both the fodder base as well as cocoon production-procession.

In the second half of the last century mulberry plantations (3X3) were presented in the form of intense massifs, but at the current stage, this can’t be managed. Therefore in future we have to grant priority to unit plantings, which will be planted on homestead land plots, along rivers, channels, roads, on eroded slopes where it will fulfill earth protection functions too. Simultaneously, within the frames of possibilities small size intense plantations will be built and specific attention will be paid to a matter of diverse application of unique properties of mulberry plant. Especially important is preparation of the so-called “nekeri” (coarse sprouts and leaf gathered in autumn) in autumn, from coarse leaf of specially selected mulberry variety Triploid-13, for its application in stock raising as fodder.

Strategic directions of the branch development considers also the issues of spreading of initial cocoon treatment points, organization of thread reeling-twisting factories and capacity optiomization.

Today there are only some ten hectare mulberry plantations and few number of quality plants. Although solid number of low quality plants is still observed in the form of unit plants, which is the basis for speeding up of the branch rehabilitation.

At the first stage mainly unit (linear) plants will be planted at the expense of grafted and selected hybrid saplings, considering their further grafting with quality buds. Special attention will be paid to grafting of the existing low grade plants in the crown, with high grade bud.

Within the frames of possibility small size intense plantations will be organized in experimental economies as well as on land ploys of farmers and land users.

Specific attention will be paid to multipurpose application of unique properties of mulberry plant. Production of saplings of recommended mulberry varieties in farm economies is considered and production of self-root saplings on small size (from 100 to 1000 m2) thermal sites organized on naturally warm sources (springs).

At the first stage annually 180-200 thousand saplings (hybrids) will be produced, while at the second stage 140-150 thousand saplings. In 2020 total number of mulberry trees will reach 9-10 million plants, which will enable to feed 50-55 thousand box worm and produce 2,5 -3,0 thousand ton cocoon. On the second stage it will be increased up to 4,0-4,5 thousand ton. Only spring feeding will be performed in order to decrease harmfulness of mulberry disease "leaf curl".

At the first stage annually at about 70-80 thousand farmers will participate in silk cocoon production, while at the second stage –more than 100 thousand. Each farmer will receive at about 10 gram worm..

The project covers a locked cycle of the branch development, although problems associated with raw material production are wider elucidated than indices of fabrics and primitive trade, which will be précised gradually, considering attraction of investors and the attitude to the branch.

Grain, raw thread, articles of primitive trade produced at the first stage - are designed mainly for local market, while at the second stage it will occupy the corresponding segment of international market.

CHAPTER IV
DEVELOPMENT STRATEGY

Strategic directions (conception) of development of sericulture in Georgia was developed according to the principle of coordination with high competitive, profile braches. At the same time, as it was stated above, rehabilitation of the branch annihilated in a half-century period is a rather long process. With this in view, simultaneously with mobilization of inner resources of the country, it is necessary to attract foreign investments and to start joint ventures.

Now the situation has changed. Revival of the branch is considered within the frames of the state interests. There is a conception of development and the work is in progress on investment programs (in regional specter), where the main aspects of the branch development and main indices of economic efficiency are given. Thus, e.g. investor is able to get familiar with investment programs "Development-rehabilitation of sericulture in Khoni region, stage-wise restoration of ruined fodder base, cocoon production and revival of abandoned traditions of primitive trade".

The main idea of the program is:

- Restoration of rich traditions of sericulture development, starting of rehabilitation works, economic strengthening of villages; improvement of ecological environment and regaining old fame of the branch.
- Starting of mulberry silkworm feeding from 2014 by means of search and finding of still preserved fodder base industrial means, intellectual resources, according to inhabited places, production of cocoon and its reeling, realization of raw thread and fabric and development of primitive trade.

Date of starting of the stage 1 of the Project: 2014

Date of completion: 2020

Main final product: raw thread

Date of starting of the stage II: 2021

Date of completion: 2025
Main final product: grain, raw thread, fabric, and other goods.

The summary gives briefly materials depicting past of sericulture, current situation and development prospects. In the next chapters materials about breeding of mulberry planting material, provision with grain, live cocoon production-treatment, raw thread reeling and the indices determining their economic efficiency are considered. .

Familiarization with the above stated material will enable concerned persons (organizations) to find out the profitableness of investment in sericulture and to get corresponding decision. Integration with the countries of the region is available in many spheres of science together with practical activity. At the same time, at the terms of globalization, with the view of human resources management (HRM) in the process of employment in the branches of host country (joint ventures) the main accent will be made upon four type groups –women, minority group, persons with restricted abilities and local aboriginal population. With this in view, sericulture satisfies the demands of HRM and creates good conditions for creation of joint ventures.

With the scientific point of view, according to our opinion, cooperation with the countries of the region will be interesting:

- For spreading-generalization of very interesting results of completed works in the study of mulberry anatomy.
- For generalization of approved methods of prevention of mulberry disease “leaf curl”.
- At the Agrarian University of Georgia it is planned to study genotype and phenotype properties of silkworm breeds of Georgian origin and their labeling by molecular-biological methods (genetic passport system);
- At the current stage, with the view of practical activity, the integrated activity will be profitable:
- For restoration of bases of live cocoon production and initial treatment;
- In 2013-2017 joint ventures can be created:
- On the basis of still preserved grainage factories, which mainly produced grain of local high-productive breeds.
- Renovated enterprise can be created on the basis of Telavi thread-dying-twisting factory for treatment of local raw material.

On the base of the silk factory group of enterprises “Tsisartkela” (Rainbow) natural silk fabric shops can be restored by joint efforts and forces, of the capacities which will be enough for treatment of local raw material mainly.

CHAPTER V
INFORMATION ABOUT WORK IMPLMENTED AFTER BACSA 5th INTERNATIONAL CONFERENCE (Bucharest , 2011)

Today scientific activity is extremely limited at the Institute of Sericulture, but preservation of unique silkworm breeds and collection is somehow managed. Definite works are carried out also in moriculture.

Scientific research work became especially difficult when Agrarian University passed into private ownership (2010). Scientific personnel was decreased sharply, to its minimum (by 92-95%), experimental and selection mulberry plantations were annihilated, premises for worm breeding were destructed and it is planned to transfer premises for silkworm breeding/feeding to absolutely inappropriate place.

To prevent the above stated it is necessary to isolate the Institute from Agrarian University and subordinate it to the Ministry of Agriculture or Academy of Agrarian Sciences. Selection activity and costs for care and preservation of collection of mulberry varieties and silkworm breeds should be funded by the state.

Lately, desire to revive sericulture was shown by the society, but relevant authorities were not ready to meet it duly and all initiatives died in their root.

Irrespective of the above stated, to attract interest of the population to a matter of sericulture rehabilitation, fruitful work is carried out by the Patriarchate of Georgia and some non-governmental organizations, including :Union of Young Agrarians", "Foundation for Revival of Agriculture". They enjoy strong support of Academy of Agrarian Sciences and the Institute of Sericulture.

"Foundation for the Revival of Villages" developed a program "Securing???, Revival and Development of Georgian Sericulture", together with relevantsub-programs, which was approved by corresponding departments of the Patriarchate. The Foundation performed significant works in some regions. Thousands and thousands of mulberry trees were planted on homestead lands of farmers and experimental lots of mulberry silkworm were fed. At the same time, organizational issues were developed dealing with planting mulberry trees in farm economies and dealing with mulberry silkworm feeding. But lately because of financial difficulties this work was stopped.

Proceeding from the above stated we can conclude that the life itself demands rehabilitation-revival of sericulture and if we will not hinder it artificially, Georgian silk will regain its old fame.

SERICULTURE STATUS, PROBLEMS, ISSUES AND DEVELOPMENT STRATEGIES IN BULGARIA

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(ORAL PRESENTATION)

ABSTRACT: The peak of cocoon production in Bulgaria was reached in 1953, when 3019 t of fresh cocoons were produced by a national country's population of about 7 million inhabitants. During the period 1950-1990 the sericulture farmers in Bulgaria received from the government in free of charge the mulberry saplings, newly brushed silkworm larvae, chemicals for disinfection, and some other materials. The bigger part of the costs for cocoon purchasing from the farmers were paid by the government as subsidy, resulting in a comparatively cheap and stable price of the raw silk, fabrics and garments. With an average annual production of 1200-2000 t fresh cocoons during the period of 1975-1990 Bulgaria used to occupy the first place in Europe and 7th–8th place in the world. However, after the change of political and economical system the cocoon production declined sharply. The main reasons for the dramatical decline of the production were the too low price of raw silk at the international market and the destroy of East European and national economics during the transitional period.

Present sericulture situation: Now there are available about 1.3 million single mulberry high/middle stem trees all over Bulgaria. These trees are enough to produce around 500 t

fresh cocoons annually. There also are in Bulgaria many farmers, having experience and tradition in this activity, which are ready to take up sericulture again, the well developed science in the field of sericulture, provides own production of mulberry saplings and silkworm eggs.

In Bulgaria, relevant R & D work in sericulture is conducted by the Sericulture and Agriculture Experiment Station (SAES) in Vratsa, Plovdiv Agriculture university, Thracian university in Stara Zagora and Forestry University in Sofia. During the last two years the Sericulture and Agriculture Experiment Station in Vratsa has continued and expanded its activities in conducting complex researches in sericulture, national silkworm and mulberry germplasm maintenance, production of mulberry saplings, silkworm eggs, dry cocoons, raw silk and ready silk commodities. The station appears to be the biggest mulberry sapling and silkworm egg producer in Europe presently. It produces about 3000 boxes of silkworm eggs annually. The average annual production of mulberry saplings for the last few years in Bulgaria has been about 90000 pieces. The new mulberry saplings are planted almost entirely as plantations, having about 3000 trees per 1 ha. The productivity of mulberry leaf of these varieties is estimated at 10 - 13 tons per ha/year under rain-fed conditions while it is 20-25 tons under irrigated conditions.

The Bulgarian private company Svila J.S.C. in Haskovo has Keinan and Nissan fully automatic silk reeling machines with a total annual capacity of about 90 tons 20/22 denier, 2 A – 3A raw silk. Unfortunately for the last several years the company's production has been far below its maximum capacity.

The Bulgarian private company Bulsilkmill Ltd has a silk twisting plant with an annual capacity of about 30 t of raw silk. All the raw silk is imported, mostly from China and the ready product is exported to Italy.

The Bulgarian private company "Silk Cluster" has ambitious plans for planting over 8000 ha mulberry plantations all over the country and starting a big cocoon and silk production, but so far the activities are restricted to negotiations with several municipalities for renting some land and buildings.

Due to the SAES – Vratsa efforts the sericulture has been included in the measures of the EU Programme for rural areas development 2007 – 2013. Unfortunately the direct subsidies system per ha of agricultural land presently adopted in Bulgaria does not benefit most of the cocoon producers. The reason is that most of the sericulture farmers use single trees, planted along the streets of the villages and the share of compact plantations is very small. On the other hand the EU and national subsidies, paid per ha of land are not very beneficial for all the agriculture intensive crop branches, including the sericulture as well.

Many farmers in Bulgaria have traditionally sufficient experience with silkworm rearing for cocoon production. In Bulgaria about 70 years ago the centralized silkworm egg incubation and delivery to the farmers of newly brushed larvae received one feeding was adopted. The farmers usually grow the larvae in their living rooms in the house during the young stage. In general, the grown larvae are reared in old living houses, penthouses, cattle sheds, attics etc., re-constructed for the silkworm rearing needs, usually at room temperature which in the end of May and first half of June is the optimal one for 4th and 5th instar larvae. The last instar larvae are commonly reared on two or three floor racks and fed by mulberry leaves, shoots or whole branches 2-4 times a day. The spring cocoon crop is purchased from the farmers around 18th-June – 5th July and the autumn crop cocoons are purchased from 5th – 20th October. Farmers' average cocoon yield per box is comparatively low: 15 -20 kg due mainly to inappropriate management/technical practices. However, some good sericulture farmers obtain up to 35-38 kg of fresh cocoons per box of silkworm eggs. Presently approximately 10000 sericulture farmer's households still have preserved their mulberry trees, rearing houses and equipment, waiting for better economical conditions for cocoon production.

Major problems and issues: Lack of sufficient government's financial supports; The majority of sericulture farmers in Bulgaria rely on traditional tall mulberry trees for the feed of silkworms; At the field level some of the silkworm rearing houses and equipment are unsuitable, the silkworm rearing technology practiced is traditional and primitive, both leading to low cocoon yield per box, low cocoon quality and too high labour expenses; The cocoon producers expect to have a fresh cocoon purchasing price not less than about 6 Euros/kg, but the raw silk price at the world market is still too low to allow such a cocoon price, thus most of the farmers are not interested. If pay this price the companies restrict the amount of egg boxes distributed because the costs return may be possible if produce/sell high additional value products only; the European Union subsidy in amount of 134 Euros/box of silkworm eggs reared has not been allowed for Bulgaria; the direct subsidies system presently adopted in Bulgaria does not benefit enough the cocoon producers.

The preconditions/prospects for sericulture revival and development:

As it has been already mentioned the current fresh cocoon purchasing price in Bulgaria is around 6 Euros/kg. At this price of fresh cocoons the dry cocoons cost about 18 – 20 Euros/kg and the raw silk costs are about 55 Euros/kg. These prices of dry cocoons and raw silk are not competitive presently at the World market. The solution is to decrease the cocoon production costs by: adopting more widely to the field level the highly productive mulberry varieties, planted as low stem plantations and labor saving silkworm rearing technologies and providing sufficient European and national subsidies for the sericulture farmers;

In addition it is necessary to improve the silkworm rearing infrastructure and extension services, the cocoon and silk quality, and to attract foreign private investors.

Now the agricultural producers in Bulgaria receive an annual direct (EU + national) subsidy per 1 ha processed land (including mulberry) of about 130 – 140 Euros. Until 2016 this subsidy will arise to about 220 Euros/ha. Presently it is still not clear whether after 2014 Bulgaria will be allowed by the European commission to receive 134 Euros EU subsidy per each box of silkworm eggs reared. In 2012 the Bulgarian Ministry of Agriculture and Food requested the European commission to permit notification to the Government to pay national subsidies to the producers of several agricultural crops, including the cocoons. From the Ministry they expect to have a positive European commission decision, so that after the beginning of 2014 the sericulture farmers to start receiving national subsidy per kg of fresh cocoons produced in amount of about 3.5 Euros/kg.

By this way the fresh cocoon purchasing price, payable by the cocoon processing companies may be about 3 Euros/kg only, which along with the subsidy will provide 6.5 - 7 Euros/kg – a satisfactory enough for the producers high price. In the same time the dry cocoon actual costs will be about 15 Euros/kg and the raw silk costs – around 38 Euros/kg. These costs will allow production and selling silk in bigger quantities if the World silk prices remain like now or go up.

Even some Bulgarian investors could have the money, they don't have enough markets for raw silk/silk allied products. Therefore, some foreign investors, who need of raw silk/silk yarn/silk allied products and have the markets for them should be attracted to invest their money in Bulgarian silk industry development.

Strategy for sericulture revival and development during the period 2014-2018: The key technical point of this strategy is the using of institutional capacities of SAES – Vratsa and the Universities for extension service and own production of mulberry saplings and silkworm eggs. The key economical point of this strategy is that it is expected the fresh cocoon purchasing price in amount of 6.5 EUR/kg to be formed by 46 % contribution of the private purchasing companies and 54 % contribution of national and EU subsidies.

The strategy aims to reach in 2018 in Bulgaria an annual production of about 600 t of fresh cocoons, 55 t raw silk, quality 2A – 4 A and 17 t thick denier raw silk. The possible financial sources to realize the strategy could be the following: EU Programme for rural areas development 2014 – 2020; EU Operational Program "Development of the Competitiveness of the Bulgarian Economy"; Direct EU and national subsidies for the sericulture farmers; Loans from banks which interest is partly covered by the state fund “Agriculture”; Foreign and/ or Bulgarian private investors.
The strategy activities with the necessary investments will be: Creation of a country network for silkworm larvae incubation, distribution, cocoon purchasing, drying, assorting and storage and silk reeling - 1 142 000 EUR; Gradual renovation of mulberry plantations - 1 030 000 EUR; Improvement of the silkworm rearing facilities and technology - 19 500 000 EUR; Establishment of an effective extension service system for sericulture - 922 000 EUR; Establishment of comparatively bigger sericultural farms - 13 000 000 EUR. The total necessary investments will be 35 594 000 EUR. Out of this sum the money which should be provided by some private investors will be about 1.5 million EUR only and all the rest will be provided by the EU programmes and the farmers.
After a successful implementation of this strategy we expect to achieve the following economical parameters in year 2018: farmer’s total costs: 744 250 EUR, farmers gross incomes: 3 900 000 EUR, payment of the farmers labor: 3 155 750 EUR, farmer’s average labor payment per 8 h: 16.83 EUR while the minimal salary in Bulgaria in 2013 is 7.23 EUR/man day, silk companies production costs: 2 775 000 EUR and incomes: 3 170 000 EUR.
Possible Bulgarian contribution to the regional international cooperation in Europe and Central Asia: Presently Bulgaria exports silkworm eggs, mulberry saplings, cardboard frame mountages, some dry cocoons and twisted raw silk. The scientific teams from Bulgarian Agricultural Academy/Universities participate in bi and multilateral research and technical international projects. The SAES – Vratsa and the Universities conduct sericulture training courses, including PhD courses. If the cocoon/silk production in Bulgaria will be increased the country may supply the Italian and other EU countries silk industry with high grade raw silk and silk allied products.

1. Introduction.

It has been historically proved that the sericulture was practiced during the times of the first Bulgarian kingdom (7th–11th century AD), however it had an especially strong development in the middle of 19th and the first half of the 20th century. The peak of cocoon production was reached in 1953, when 3019 t of fresh cocoons were produced by a national country’s population of about 7 million inhabitants.
In 1896 a Sericulture Experiment Station (SES) was established in the city of Vratsa. This station appears to be the first research unit in agriculture, established in Bulgaria. SES–Vratsa is also one of the oldest sericulture stations in the world. After 1930 many silk reeling factories were opened in Bulgaria and nearly all the cocoons produced started to be reeled locally. For a period of less than 10 years a comparatively huge silk industry has been established, including 1,500 silk reeling basins (8-10 ends per basin), 480 mechanical looms, twisting machines, having 10,000 spindles and 15 silk-knitting “kotton”-type machines.
After 1944 when the political system in Bulgaria had been changed the cocoon production still remained in the hands of small farmers but the mulberry saplings and silkworm eggs production, cocoon purchasing/processing and the silk reeling/processing were taken completely by the government.
During the period 1950-1990 the sericulture farmers in Bulgaria received from the government in free of charge the mulberry saplings, newly brushed larvae, chemicals for disinfection, and

perforated paper for bed cleaning. The bigger part of the costs for cocoon purchasing from the farmers were paid by the government as subsidy, resulting in a comparatively cheap and stable price of the raw silk, fabrics and garments. This low price allowed selling huge amount of silk products not only at the local, but at the international market as well.

With an average annual production of 1200-2000 t fresh cocoons during the period of 1975-1990 Bulgaria used to occupy the first place in Europe and 7^{th}–8^{th} place in the world.

However, after the change of political and economical system the cocoon production started to decline sharply. For example in a period of 10 years (1985-1995) the amount of fresh cocoons, produced in Bulgaria was decreased from 1467 t/year to about 150 t/year, or nearly 10 times. During the same period the number of sericultural farmer's households was decreased from 28646 to only about 2800. The main reasons for the dramatical decline of the production were the too low price of raw silk at the international market as well as the changes of the political and economical system in Bulgaria. As a factor, additionally badly influencing the situation in Bulgarian sericulture was the wrong way of privatization of the state companies, dealing with cocoon purchasing and processing, namely Sirma J.S.C.–Plovdiv and Svila P.L.C. in Haskovo in 1997. After the privatization, those companies gradually stopped to purchase any cocoons from the farmers. At present, the absence of commercial company, capable to purchase and process big amount of fresh cocoons from the farmers, appears to be the main critical limiting factor for the increase of silk production. Even though the Sericulture and Agriculture Experiment Station (SAES) in Vratsa has recently been transformed as a state commercial enterprise it is capable to buy from the farmers small amounts of cocoons only. The main reason is that as the station's property is completely state it can not be used as bank guarantee in order to take loans for cocoon buying and processing.

In spite of the many constraints, facing Bulgarian sericulture industry development during the recent 20 years, the sericulture still appears to have a big potential for revival and bright prosperities for development.

After the raw silk price at the international market reached its bottom of 18 US$/kg in 1995 it started gradually to increase, reaching about 30-34 US$/kg for 3A grade raw silk in 2001, but in 2002/2003 the Chinese started again selling raw silk at a price of 16-18 US$/kg. Recently however the raw silk price increased very much and now it's price inside China is around 60 $/kg. Some European countries like Italy and France, whose silk textile industry is dependant completely on the import of raw silk and silk yarn from China might be interested in finding some alternative silk producers, who could provide a stable supply with high grade raw silk at reasonable prices.

It is considered that out of the all European countries, Bulgaria has the highest and the most qualitative potential for sericulture development. Since in most of EU member countries the sericulture is not practiced, the Bulgarian sericultural farmers will not be in strong competition with the farmers from the other EU member states. On the contrary, Bulgaria could supply raw silk for the textile industry of Italy as an alternative source to the import from China.

Now there are available about 1.3 million single mulberry high/middle stem trees all over Bulgaria. These trees are enough to produce around 500 t fresh cocoons annually. There also are in Bulgaria many farmers, having experience and tradition in this activity, which are ready to take up sericulture again, the well developed science in the field of sericulture, could provide own production of mulberry saplings and silkworm eggs.

In Bulgaria the cocoon production is practiced as additional agricultural activity, where one farmer's family usually grows 1-4 boxes of silkworm eggs per one stage. The large-scale silkworm rearings had been practiced very few because they appeared to be less economically effective, compared with the small–scale silkworm rearings. The big-scale rearings require comparatively large rearing rooms for a short period of time, more expensive equipment and a lot of workers. The small–scale rearing is more adaptable, because it could be practiced by the farmer's family members only (including retired and children), using the buildings, available at

the farm and mulberry leaves from own plantation or single trees. In the small-scale silkworm rearing the inputs and risk are less and the incomes are safer.
Taking the above into account we consider that for the Bulgarian conditions in short and medium term, efforts must be made to adopt the following two types of sericulture farms:

- 0.2 ha mulberry plantation or 150 high–stem mulberry trees, rearing 5 boxes of silkworm eggs annually, 3 of them during the spring season and 2 of them in the autumn season, or all together 5 boxes in the spring season only, 40 m^2 silkworm rearing house, annual fresh cocoon production 150 – 200 kg .

- 0.5 ha mulberry plantation, rearing 15 boxes of silkworm eggs annually in 3 stages, 75 m^2 silkworm rearing house, annual fresh cocoon production 450-500 kg.

The strategy for Bulgarian sericulture revival and development, worked out includes to attract private foreign or/and Bulgarian investors in the sericultural industry, to reach in 2018 an annual production of about 600 t of fresh cocoons, 55 t raw silk, quality 2A–4 A and 17 t thick denier raw silk, providing annual incomes to the sericulture farmers in amount of 3.5 million EUR.

2. Summary Review of Sericultural Statistics 2008 ~ 2012 (Annex 1)

2.1.Institutes and government offices engaged in sericulture development.

In Bulgaria, relevant research work on sericulture is conducted by the Sericulture and Agriculture Experiment Station (SAES) in Vratsa, Plovdiv Agriculture university, Thracian university in Stara Zagora and Forestry University in Sofia. Sericulture is taken as a separate subject for the university students of the existing three national universities.
Established in 1896, the **Sericulture and Agriculture Experiment Station - Vratsa** is now the biggest centre in the country conducting various activities for sericulture industry development. Its main activities on research work are related to the genetic research on breeding technology for improvement of new silkworm lines/races and hybrids; silkworm egg production technology; silkworm rearing technology; prevention and silkworm diseases and pests control; mulberry selection and cultivation; cocoon and silk processing; sericulture economics and management.
The Station maintains more than 140 mulberry varieties and silkworm over 200 lines which have been collected from internal and external resources and bred for further improvement of their genetic characters. Mulberry saplings are multiplied by cuttings in order to supply more recommended mulberry varieties to sericulture farmers for further expansion, which are processed with the following steps such as preparation of selected cuttings, preservation at the electrically incubated chamber within 15 days for further development of rooting system and transferring to the field for plantation during the following spring season. One of its important mandates was assigned to breed and multiply silkworm eggs. Its maximum capacity of silkworm egg production was approximately 60 000-70000 boxes per year in the past, now the station produces about 3000 boxes annually, having a maximum capacity of around 5000 boxes of eggs.
In addition, SAES - Vratza has another very important mandate to process farmers' fresh cocoons: cocoons produced by farmers are purchased and either used in the egg production or dried/stored and processed into raw silk yarn/ thrown silk/silk garments by SAES. Even though it operates in a comparatively small scale, SAES-Vratsa is multi-functioned to run overall integrated activities such as research and development (R & D) activities, production of raw materials such as mulberry saplings and silkworm eggs and market-oriented business activities to successfully rehabilitate its traditional sericulture industry as an economically viable sericulture industry at the regional level and /or the national level.
During the last two years the Sericulture and Agriculture Experiment Station in Vratsa has continued and expanded its activities in conducting complex researches in sericulture, national

silkworm and mulberry germplasm maintenance, production of mulberry saplings, silkworm eggs, dry cocoons, raw silk and ready silk commodities. The station appears to be the biggest mulberry sapling and silkworm egg producer in Europe presently. SAES – Vratsa incubates the silkworm eggs and distributes to selected farmers newly hatched silkworm larvae. Upon the larval distribution the station makes a contract with each farmer, taking the obligation to buy his cocoons produced. After cocoon harvesting the farmers bring them to the station where the staff makes their evaluation and the cocoons are purchased, based on their quality. During the last two years the fresh cocoon purchasing price has been 6 Euros per kg. The station uses about 70 % of the cocoons purchased for egg production and the rest are sold either as dry cocoons or processed to raw silk and silk commodities. SAES – Vratsa has also it's own mulberry plantations and silkworm rearing houses for cocoon production. Presently the station has cocoon drying machines capacity for processing about 20 t of fresh cocoons annually.

The **Agronomy faculty**, **under Agricultural university of Plovdiv** was founded in 1945 and now it is the biggest one in the structure of the University. The main five departments in its structure are Botany, Genetics and Breeding, Animal Husbandry, Farming and Crop Science.The Agronomy faculty of Plovdiv Agricultural University, which is situated at the center of one of the majors sericulture areas of Bulgaria has more than 50 years experience in research, training and extension in the sericulture, as well as highly experienced research and technical staff. The faculty maintains its own mulberry and silkworm germplasm, used as valuable source for selection - breeding work. Several commercial silkworm hybrids have been created at the Agronomy faculty and recognized by the government.

The **Agrarian faculty of Tharacian University in Stara Zagora** has more than 40 years experience in research, training and extension in the sericulture, as well as highly experienced research and technical staff. The faculty maintains its own silkworm germplasm, used as valuable source for selection - breeding work.

The **Agronomy faculty of Forestry University in Sofia** has sericulture department for teaching students and some research work.

The **Genetics department of Plovdiv university** conducts research in the field of silkworm molecular genetics.

The SAES-Vratza and the Universities are fully state owned.

The Bulgarian **private company Svila J.S.C. in Haskovo** has Keinan and Nissan fully automatic silk reeling machines with a total annual capacity of about 90 tons 20/22 denier, 2 A – 3A raw silk. Unfortunately for the last several years the company's production has been far below its maximum capacity.

The Bulgarian **private company Bulsilkmill Ltd** has a silk twisting plant with an annual capacity of about 30 t of raw silk. All the raw silk is imported, mostly from China and the ready product is exported to Italy.

The Bulgarian **private company "Silk Cluster"** has ambitious plans for planting over 8000 ha mulberry plantations all over the country and starting a big cocoon and silk production, but so far the activities are restricted to negotiations with several municipalities for renting some land and buildings.

2.2.General information and data on sericultural industries at the national level

2.2.1.Background

Bulgarian geographic position is located between 41 - 44 north latitude and 22 - 28 east longitude which are characterized with typical temperate climatic conditions having four distinct seasons: Spring, Summer, Autumn and Winter.

Sericulture industry is one of the long traditional agro - industry in Bulgaria, which could produce **1800 tons** fresh cocoons/**200 tons** raw silk annually and to provide rural areas with more than **half million** job opportunities and good income resources in **1950's and 1980's.**

Rainfall is not sufficient for mulberry cultivation in bush - form while it is good enough to meet the minimum requirements for the growth of tree-type mulberry. Considering the present situation of national mulberry resources with the prevailing about 1.3 million high stem trees in the country, however, insufficient precipitation can not be considered as one of the serious difficult obstacles in sericulture development.
Bulgaria has a total area of 110,993 square kilometres and is populated with approximately 8 million people. The share of urban population accounted for more than 70 % and nearly 50 % of the land is located in the hilly and mountain areas where 40 % of the population inhabited.
Many industrial private companies in Bulgaria have been closed for the last 22 years due mainly to lack of markets and government supports. This has resulted in making more than 20 percent of the active population in the rural area unemployed.
In the past, more than 30 000 farmers were engaged in sericulture, producing approximately 1800 tones of fresh cocoons annually. However, most of these farmers have given up sericulture because the political, economical and social systems have been changed to adversely affect sericulture development.
There are also additional negative factor such as the big decrease of silk price at the World market in 1990's and beginning of 21st century. Until 1990 the government supported directly sericulture development by paying 90 percent of the costs to Sirma state company to purchase the fresh cocoons from sericulture farmers. Based on such a local marketing system the price of cocoons at the internal market was not influenced very much from the external market prices and their fluctuations. During the period the quality and quantity of their products were not so much critical for potential external market development. Under the present free – market system, however there are no other way to solve the market problem unless the government or private sectors could assist sericulture farmers to provide them with reliable market for their products such as cocoons/silk yarn or other silk allied products.
However, the sericulture industry has been declined very rapidly every year to have consequently deprived the job opportunities and income resources from small farmers in rural areas because new potential markets could not be explored to consume the cocoons/silk with newly developed economic system. Such a situation was getting worse after the strong cooperational relationships between Bulgaria and Ex-Soviet Union block were broken down for cocoon/ silk markets.
Unlike any other sericulture developing countries however Bulgaria has already had three major advantages to have its own superior silkworm inbred lines and hybrid eggs, valuable natural resources of existing mulberry trees and farmer's long traditional technology/experience on sericulture. Even though the country has such advantages it could not have enough external market for the products of sericulture because the advantages of the three components, mentioned above have not been integrated to produce high quality silk products at reasonable prices. The silk products of Bulgaria have been not so attractive to buyers who need high quality and a certain amount of the quantity for their business.
From the above-mentioned various favourable agro-climatic and socio-economic conditions, Bulgaria has still a high potential for rehabilitation of sericulture industry.
Due to the SAES – Vratza efforts the sericulture has been included in 4 measures of the EU Programme for rural areas development 2007 - 2013, namely

- Professional training, informational activities and scientific knowledge dissemination;
- Establishment of farms by young farmers;
- Modernizing the agricultural farms;
- Semi-subsistence farms development.

There are some current projects financed through the measures for young farmers because the support, provided by this measure is as a grant, while in the Modernizing the agricultural farms measure only 50 % of the support is paid by the Pogramme as a grant. The sericulture farms are small and the owners are comparatively poor, so for them it is too difficult to get loan from the bank in order to cover all the investment costs and then after the project is completed to receive

reimbursement of 50 % of the investment costs from the Programme. Even though the measure for Semi-subsistence farms provides 1500 Euros every year for totally 5 years as a grant the interest in this measure is still too low, not only among the sericulture farmers, but among the agriculture farmers in general.
Unfortunately the direct subsidies system presently adopted in Bulgaria does not benefit the cocoon producers. The reason is that national subsidies for the cocoon producers have not been authorized by the EU, so the EU subsidy per ha can not be utilized because most of the sericulture farmers use single trees, planted along the streets of the villages and the share of plantations is very small. On the other hand the EU and national subsidies, paid per ha of land are not beneficial for all the agriculture intensive crop branches, including the sericulture as well.

2.2.2. Disease-free silkworm egg multiplication.
The Pasteur cellular method is still being used as one of the leading technology for prevention of pebrine disease in the process of mother moth examination.
The present silkworm egg production activities are practiced twice a year, during the spring and autumn crops and afterward the produced eggs are preserved at different air temperature regimes, according to their kind. Presently the only one producer of commercial silkworm eggs in Bulgaria is SAES – Vratsa. The station produces about 3000 boxes of silkworm eggs annually and it's own capacity is up to about 5000 boxes. This capacity may be increased if necessary for a period of 3 years so that the annual egg production may reach about 15000 boxes. Now at any moment of the year the station has available for sale high quality silkworm eggs which are directed mostly for export.

2.2.3.Mulberry cultivation
Bulgaria has approximately 1.3 million mulberry trees all over the country which were planted as high stem single trees on both sides of streets in villages and also in marginal land such as mud area, banks of channel/paddy field and railway track sides which supplied mulberry leaves to sericulture farmers for their cocoon production during the last several decades.
Major varieties of the existing mulberry trees are hybrid, but there are also trees of the highly productive varieties Vratza 1, Vratza 18, Vesletz, №24, Kinriu, Kokuso 20, Kokuso 27, № 106 and Tbilisuri. Now the major producer of mulberry saplings is SAES – Vratsa. The productional method is by rooting hardwood cuttings and the productional process takes about 9 months from February to October. The average annual production of mulberry saplings for the last few years in Bulgaria has been about 90000 pieces. The new mulberry saplings are planted almost entirely as plantations, having about 3000 trees per 1 ha.
The productivity of mulberry leaf of these varieties is estimated at 10 - 13 tons per ha/year under rain-fed conditions while at 20-25 tons under irrigated conditions. In reality, however, mulberry plantation at both the institutional and the field level are not located under irrigated conditions. The main reason is that for the spring rearing which is prevailing, the rain fed mulberry leaf yield is sufficient.
The presently available mulberry trees in Bulgaria are sufficient for production of about 500 t fresh cocoons/year, what is a huge potential for cocoon production increase for a very short time, without any big additional investments.

2.2.4. Silkworm rearing/cocoon production.
Many farmers in Bulgaria have traditionally sufficient experience with silkworm rearing for cocoon production. Unlike prevailing practices in some far eastern Asian countries such as Japan and Korea, a cooperative young silkworm rearing system has not been operated in the mass production to deliver young silkworm larvae at 2^{nd} or 3^{rd} instar in the country. However in Bulgaria has been adopted about 70 years ago the centralized silkworm egg incubatories and delivery to the farmers of newly brushed larvae, received one feeding. The farmers usually grow the larvae in their living rooms in the house during the young stage. The reason is that during the

young instars the larvae occupy small space, but require higher air temperature, so the living rooms can be heated very cheaply. In general, the grown larvae are reared in old living houses, penthouses, cattle sheds, attics etc., re-constructed for the silkworm rearing needs, usually at room temperature which in the end of May and first half of June is usually the optimal one for 4th and 5th instar larvae. The last instar larvae are commonly reared on two or three floor racks and fed by mulberry leaves, shoots or whole branches 2-4 times a day. At the research institutions the spring silkworm rearing starts usually in the end of April/beginning of May, having several stages, let's say beginning from 1st May, 6th May and 12th May respectively. The silkworm rearing at the farmer's level begins in the middle of May due to two main reasons: In the different regions of the country, which have different microclimates the mulberry leaves sprout differently, but around the middle of May everywhere mulberry has been sprouted enough to start the silkworm feeding. The other reason is that usually in Bulgaria during the first half of May the weather is rainy and the air temperature is too low, thus the costs of larval heating are too high and some of the farmers save heating which results in the cocoon crop. The autumn rearing at the SAES – Vratsa begins in the middle of August having 3 stages, let's say beginning from 15th August, 22nd August and 30th September. The silkworm larvae are distributed to the farmers around 20-25th August. The spring cocoon crop is purchased from the farmers around 18th-June – 5th July and the autumn crop cocoons are purchased from 5th – 20th October.
About 2 - 4 boxes of silkworm eggs are reared by one sericulture farmer. Farmers' average cocoon yield per box is comparatively low: 15 -20 kg mainly due mainly to inappropriate management/technical practices. However, some good sericulture farmers obtain up to 35-38 kg of fresh cocoons per box of silkworm eggs.
Presently approximately 10000 sericulture farmer's households still have preserved their mulberry trees, rearing houses and equipment, waiting for better economical conditions for cocoon production.

2.2.5.Silk reeling and processing
After 1998 all the state institutes and silk reeling/weaving companies have been privatized except for the SES-Vratza and the Universities which are still under state operation. The former state group called "Sirma", dealing with cocoon purchasing and processing has been divided into three new companies.

- **Cocoon and raw silk quality control system practiced in Bulgaria.**

A Bulgarian Governmental Standard 2052 - 76 should be applicable to evaluation of fresh cocoon quality. Sampled cocoons are assorted based on the 1st, 2nd, 3rd grade, unreelable and double cocoons.After the cocoon assorting, the weight of cocoons in each grade is multiplied by the price respective and after that the average price for whole lot is calculated.
The dried cocoon quality is controlled by the Bulgarian State Standard 538 - 80.
According to this standard the cocoons are assorted manually into 3 grades, unreelable and double cocoons based on their obvious defects.
High quality raw silk evaluated based on to the International standardя is produced only by Svila J.S.C. in Haskovo in the country. This company has a laboratory for raw silk quality control following the internationally approved standard procedure, namely making whole lot test for uniformity, general finish & nature as well as sample test including winding test, size deviation test, evenness test, cleanness test, neatness test, tenacity and elongation, cohesion and conditioned weight tests.

- **Silk reeling and processing in Bulgaria.**

In 1892 the first silk reeling factory, having 1000 ends was established in South Bulgaria. It was equipped by comparatively modern for that time Italian multiends reeling machines, Batalia system.
After Bulgarian silk reeling industry was expanded, it grew very fast reaching about 1500000 ends in 1930.The Italian multiend silk reeling machines were used till the end of 70's and after that they were gradually shifted by Japanese Keinan and Nissan automatic silk reeling machines.
Svila J.S.C. in Haskovo is only the factory which has fully automatic silk reeling machines in the country. The company has two models of fully automatic Japanese silk reeling machines, namely Keinan - 2 sets of 400 ends and Nissan - 2 sets of 240 ends each. The machines were bought in 1985-1988. They have also machines for silk throwing, doubling, twisting as well as power looms.The maximum capacities for production of Svila J.S.C. are as follows: raw silk by Keinan reeling sets - 50 ton/year, raw silk by Nissan sets - 40 ton/year, thrown silk - 20 ton/year, silk fabrics(loom state) - 100,000 linear meters/year
The main markets of Svila's production before 1990 were Japan, Greece, Turkey, Netherlands, and Italy. At nowadays Svila sells its silk products mainly in Bulgaria and Greece.
The silk knitting unit at the SAES – Vratsa is equipped by especially designed sets for reeling thick denier, coarse silk, suitable for knitting. The average denier of this silk is 150-200.Then the raw silk is processed through the operations of winding, twisting, degumming and dyeing in order to produce silk yarn on cones, ready for the knitting process. There are several comparatively modern knitting machines which are Swiss made, computerized and having more than 600 patterns in their memory. The machines are specially designed for home use and production of boutique garment, namely they have small capacity of production, but allow making a huge varieties of patterns. The knitting machines have the ability to accept new patterns in their memory by an outside computer. The unit is equipped also with the necessary sawing machines used for tailoring the ready for the market garments. The unit produces not only pure silk knitted goods but also blended with cotton and wool.

3. Major Problems and Issues, and Recommendations

3.1.Major problems and issues

- One of the big constraints is the lack of sufficient government's financial supports since the sericulture industry is taken into account as one of the minor sectors in agro-industries with recent industrialization and urbanization.

- The majority of sericulture farmers in Bulgaria rely on traditional tall mulberry trees for the feed of silkworms instead of the cultivated low-stem type mulberry plantations. Most of the trees are wild or hybrid, having much inferior quality and quantity of the leaves compared to those of the cultivated trees thus require higher labour costs.

- In Bulgaria the cocoon/raw silk production has declined to a critical stage.

- At the field level some of the silkworm rearing houses and equipment are unsuitable, the silkworm rearing technology practiced is traditional and primitive, both leading to low cocoon yield per box, low cocoon quality and too high labour expenses.

- The cocoon drying and fully automatic silk reeling machines remained in the country have very big capacity and can not be used economically effective in processing the comparatively small amount of cocoons produced now.

- The cocoon producers expect to have a fresh cocoon purchasing price not less than about 6 Euros/kg, but the raw silk price at the world market is still too low, thus not allowing paying a so high price for the fresh cocoons and as a consequence the cocoon production is low.

- The European Union subsidy in amount of 134 Euros/box of silkworm eggs reared has not been allowed for Bulgaria even though the Bulgarian Government sent an official request to the EC for solving this problem.

- The direct subsidies system presently adopted in Bulgaria does not benefit the cocoon producers. The reason is that national subsidies for the cocoon producers have not been authorized by EU, so the EU subsidy per ha can not be utilized because most of the sericulture farmers use single trees, planted along the streets of the villages and the share of plantations is very small. On the other hand the EU and national subsidies, paid per ha of land are not beneficial for all the agriculture intensive crop branches, including the sericulture as well.

- At present, the absence of commercial company capable to purchase and process bigger amounts of fresh cocoons from the farmers appears to be the main critical limiting factor for the increase of silk production.

3.2. The preconditions/prospects for sericulture revival and development and importance of sericulture in the country.

It is considered that out of the all European countries, Bulgaria has the highest and the most qualitative potential for sericulture development. The country is also situated very near to the Western Europe countries, which are one of the biggest market for silk and its allied products. As in most of EU member countries the sericulture is not practiced, the Bulgarian sericultural farmers are not in strong competition with the farmers from the other EU member states. On the contrary, Bulgaria could supply raw silk for the textile industry of Italy and France as an alternative source to the import from China.

Now there are still available about 1.3 million single mulberry high/middle stem trees all over Bulgaria. These trees are enough to produce around 500 t fresh cocoons annually. There also are in Bulgaria many farmers, having experience and tradition in this activity, who are ready to take up sericulture again, the well developed science in the field of sericulture, could provide own production of mulberry saplings and silkworm eggs.

As it has been already mentioned the current fresh cocoon purchasing price in Bulgaria is around 6 Euros/kg. At this price many farmers wish to produce cocoons, but the companies who buy fresh cocoons restrict the amount purchased due to different reasons. The main reason however is that at this price of fresh cocoons the dry cocoons cost about 18 – 20 Euros/kg and the raw silk costs are about 55 Euros/kg. These prices of dry cocoons and raw silk are not competitive presently at the World market. The solutions are in two main directions:

- To adopt more widely to the field level the highly productive mulberry varieties, planted as low stem plantations and labor saving silkworm rearing technologies;
- To provide European and national subsidies for the sericulture farmers;

Implementing the above two measures we expect to achieve decreased costs per 1 kg fresh cocoons from 5 Euros to 3.5 Euros and to provide 3.5 Euros subsidies per 1 kg of fresh cocoons. By this way the fresh cocoon purchasing price, payable by the cocoon processing companies may be about 3 Euros/kg, which along with the subsidy will provide 6.5 - 7 Euros/kg – a satisfactory enough for the producers high price. In the same time the dry cocoon actual costs will be about 15 Euros/kg and the raw silk costs – around 38 Euros/kg. These costs will allow production and selling silk in bigger quantities.

3.3. Recommendations

- **Improvement the silkworm rearing infrastructure and extension services:**

The problem with the improvement of existing silkworm rearing houses and equipment is very complex, because the sericulture is an old and traditional activity in Bulgaria, therefore it is too difficult to change the mind of sericulture farmers, inherited the skill for silkworm rearing generation from generation. Since nearly all the farmers grow the silkworm larvae in their living houses, especially during the young ages, it is too difficult to improve the larval rearing conditions. For effective and economic cocoon production, a few model rearing houses should be designed and recommended for them to adapt such a practically designed models for field application with less cost-materials for construction of rearing houses. Such a model rearing house for 9 boxes from the beginning of the 3rd instar until cocoon harvesting was established in 2009 at the Sericulture and Agriculture Experiment station in Vratsa and for already 4 years had been producing spring and autumn crops, demonstrating a labour saving technology which provides less than 2 hours labour costs per 1 kg of fresh cocoons.
The government should make efforts in establishment of a network of demo farms in order to demonstrate the modern and commercially oriented technologies to the sericulture farmers. Demo farms could be established also by the private enterprises, engaged with sericulture.

Mulberry cultivation technology at the field level should be also developed to reduce labours and production costs of mulberry leaves by means of application of semi-mechanization, including improvement of planting methods, harvesting of mulberry leaves and transportation of mulberry branches to silkworm rearing houses, etc.
Other methods for adoption of the improved techniques at the field level could be by organizing workshops, training courses, publishing instructions, giving lectures by the local radio and TV, internet etc. Through the EU Programme for development of rural areas, measure 121 “Modernizing of agriculture farms” are provided funds to plant new mulberry plantations, innovate the rearing houses, to buy better equipment for silkworm rearing and even cocoon drying machines. The programme pays about 50 % of the installation costs, but after the investment has already been made. However through the measure 112 “Creation of farms of young farmers” the beneficent receives up to 25000 Euros as a full grant and the measure 141 “Support to semi-subsistence farms” the beneficent receives 7500 Euros as a grant. Of course the candidates to get these subsidies should submit the projects respective and all the other documents required to be approved.

- **Measures in improvement the cocoon/silk quality:**

The unsuitable rearing houses, equipment and technology for silkworm rearing result in bad cocoon and raw silk quality. For these comparatively low quality dried cocoons and raw silk the prices at the international market are usually lower than the production costs made.
In order to improve the raw silk quality Bulgaria needs first to improve the cocoon quality and secondly to improve the cocoon processing and silk reeling technologies. In order to improve the cocoon quality we could recommend the following technology for production of stable cocoon crop with lower cost:

- Using only high quality silkworm eggs, produced by the SAES – Vratsa which are obligatory with high hatchability, disease free of pebrine, disinfected by 2 % formaline solution.
- The silkworm hybrid must be comparatively tolerant to adverse rearing conditions and with moderate productivity. We could recommend the Bulgarian four-way hybrids H1xKK x G2xV2 and SN1xI1 x M2xN2 and the single hybrid Super1 x Hesa2
- To disinfect the incubation and rearing rooms and rearing equipment by the so called "Four step disinfection method", comprising **1st step**-spraying (or painting by brush) with lime powder milk on the walls and ceiling; **2nd step**-spraying 25 % sodium hypochlorite

solution on the walls, ceiling and rearing equipment; **3rd step**-spraying 5 % formalin solution; **4th step**-fumigation with formaline. It's better the sprayer to be motorized.

- Since the rearing house is very important to provide optimal temperature, it should have good insulation, but also ventilation.
- The beginning of silkworm rearing in Bulgaria, should be as follows: SPRING REARING-not earlier than 28-30th April and not later than 15th May; AUTUMN REARING-not earlier than 15th August and not later than 30th August. In some very dry regions/years the autumn crop is impossible without irrigation.
- To provide mulberry trees/ low-cut plantation with highly productive varieties, giving 16,000 kg fresh leaf yield per 1 ha and 12-15 kg of leaves per high stem single tree under normal agrotechnics and rain fed conditions.
- To maintain the following conditions during the larval rearing: 1st-2nd instar-25-27 ^{o}C, 75-80 % RH; The larvae should be fed by cut, tender leaves, and covered by polyethylene sheet in order to maintain easier higher humidity. After the 2nd moult the larvae are reared in special constructions having a size of 11.00 m/1.35m/ 0.80 m each for one box of silkworm eggs. Every construction has 15 m^2 of rearing space for 1 box of eggs, movable tray for feeding by mulberry branches and nylon net around the rearing bed in order to prevent larvae, leaf, remnants of excrement's dropping. The temperature and relative humidity are 24-25^{o} C, 60-65 % during the 3rd instar, 23-24^{o} C, 50-65 % in the 4th instar and 18-26^{o} C, 45-70 % in the 5th instar with feeding by whole branches/shoots and permanent ventilation. During the whole larval period 2 feedings per day are given.
- Cocoon spinning: 24-27^{o} C, 60-70 % RH, permanent ventilation; Cardboard mountages are put on the beds immediately after the last feeding, directly on the larvae and arranged like tiles.
- After cocoon harvesting to clean the room and paint the walls and ceiling with lime powder milk.

Following this technology in the spring season the larval period could be 27-32 days, fifth instar duration-7-10 days, fresh cocoon weight 2-2.3 g, shell weight 0.440-0.500 g, shell ratio 22-23 %, fresh cocoon yield by one box of eggs 32-38 kg. In the summer–autumn season the parameters achieved could be cocoon weight 1.5-1.8 g, shell weight 0.315-0.380 g, shell ratio 21 %, cocoon yield 25-32 kg. The labor expenses are less than 2 hours per 1 kg of fresh cocoons.

❖ **Providing national and EU direct subsidies to the sericulture farmers:** Now the agricultural producers in Bulgaria receive an annual direct (EU + national) subsidy per 1 ha processed land (including mulberry) of about 130 – 140 Euros. Until 2016 this subsidy will arise to about 220 Euros/ha. Now it is still not clear whether after 2014 Bulgaria will be allowed by the European commission to receive 134 Euros EU subsidy per each box of silkworm eggs reared. In 2012 the Bulgarian Ministry of Agriculture and Food requested the European commission to give notification to the Government to pay national subsidies to the producers of several agricultural crops, including the cocoons. From the Ministry they expect to have a positive European commission decision, so that after the beginning of 2014 the sericulture farmers to start receiving national subsidy per kg of fresh cocoons produced in amount of about 3.5 Euros/kg.

❖ **Attraction of foreign private investors:** For making improvements in cocoon/silk processing technique as well as for working capital, a comparatively huge financial resource is necessary in Bulgaria. Since the country is situated in the temperate belt, and usually the spring cocoon crop is more than 90 % out of the total cocoon production, comparatively big money are necessary at one short period of only 20 days for cocoon purchasing from the farmers. For example if Bulgaria produces 500 t fresh cocoons by the spring crop, for their purchasing the processing companies should have about 1.5 million EUR and pay them from 10th to 30th June. Other problem is that from the moment of cocoon purchasing to the time when the raw silk is sold, 6 months to 1 year time pass. Even some Bulgarian investors could have the money, they don't have enough markets for raw silk/silk allied products. Therefore, some foreign investors, who need of raw silk/silk yarn/silk allied products and have the markets for them should be attracted to invest their money in Bulgarian silk industry development.

4. Development Strategies

Strategy for sericulture revival and development during the period 2014-2018 (5 years):

4.1. Rationale, backgrounds and justification of the strategic approach

The key technical point of this strategy is the using of institutional capacities of SAES – Vratsa and the Universities for extension service and own production of mulberry saplings and silkworm eggs. The key economical point of this strategy is that it is expected the fresh cocoon purchasing price in amount of 6.5 EUR/kg to be formed by 46 % contribution of the private purchasing companies and 54 % contribution of national and EU subsidies.

PURPOSES OF THE STRATEGY:

- To reach in 2018 in Bulgaria an annual production of about 600 t of fresh cocoons, 55 t raw silk, quality 2A – 4 A and 17 t thick denier raw silk.

- To decrease the unemployment and migration in the rural areas by opening new working places and providing additional annual incomes to the sericulture farmers in amount of about 3 900 000 EUR.

- To stabilize the rural economics and communities and improve the conditions for work and life.

- Improvement of the ecological environment by development of an ecologically clean and nearly wastes-free industry such as sericulture.

- Creation of technical basis and human resources for further increase of fresh cocoon production to 1500 t and high grade raw silk production to 150 t after 2018 in Bulgaria.

4.2. Possible financial sources to realize the strategy

- EU Programme for rural areas development 2014 – 2020.
- EU Operational Program "Development of the Competitiveness of the Bulgarian Economy".
- Direct EU and national subsidies for the sericulture farmers.
- Loans from banks and interest partly covered by the state fund “Agriculture”.
- Foreign and/ or Bulgarian private investors.

4.3. National implementing agencies

- Private investors.
- Agricultural producers.
- Ministry of Agriculture and Food (including SAES – Vratsa).
- Ministry of Economics and Energetics.
- The Agrarian University in Plovdiv, the Thracian University in Stara Zagora and the Forestry University in Sofia.

- The provincial administrations.
- The mayors.

4.4. Strategy activities (what and how should be done) and budget estimation

1. Creation of a country network for silkworm larvae incubation, distribution, cocoon purchasing, drying, assorting and storage and silk reeling.

One or several private companies will operate at the country level, having local branches in the regions with significant cocoon production. These companies will do the cocoon purchasing and processing and also they will organize the centralized egg incubation/silkworm larvae distribution to the farmers and organize a network of cocoon purchasing centers in the main production regions during the silkworm rearing seasons. Each company will be equipped with incubatories, cocoon storage houses, cocoon drying machines, deflossing machines, and the relevant equipment, such as trays, cages etc. The companies will appoint extension service technicians who will assist the sericulture farmers.

The same companies will deal also with the silk reeling. They could either hire the existing fully automatic silk reeling facilities, available in the Svila company in Haskovo city or to establish a completely new silk reeling mill.

2. Gradual renovation of mulberry plantations.

It is necessary to change gradually the type and the varieties of mulberry plantations from high stem single trees of hybrid variety to low stem, high density, garden type, easy for harvest, and labour saving.

In order to improve gradually (for a period of 10 years) the varieties and the proportion between high stem single trees : low-cut plantations it is necessary to have an annual production of about 130 000 mulberry saplings of highly productive varieties, such as Kinriu, Kokuso 20, Kokuso 21, Kokuso 27, Vratza 1, №24, Tbilisuri, Vratza 18 and some other Bulgarian varieties. This production can be realized, following the technology of hardwood cutting method of mulberry propagation. Since the SAES-Vratza does not have a so big production capacity, some private producers may also be engaged.

The newly established mulberry plantations should be low-stem (0.5-0.7m stem of the tree height), with 1 m inter-tree and 3 m inter-row distance. One big resource for mulberry leaf yield nearly double increase is the grafting of old mulberry trees, which is practiced in order to improve the yield quantity and quality of old hybrid mulberry trees. For the purpose the farmers could be trained to make the grafting by themselves or in each region a working group of 2-3 skilled workers may be appointed by the silk companies to graft gradually the old trees.

3. Improvement of the silkworm rearing facilities and technology.

Now many farmers and other people have plenty of empty buildings in the villages, which after some minor reconstruction could be successfully adapted as silkworm rearing houses. By the technical help of R&D units most of the farmers could make by themselves the rearing equipment, such as rearing trays, straw bottle brush mountages etc. In order to improve the cocoon reelability the sericulture farmers can be supplied with better mounting frames. For the purpose an annual production of 200 000 cardboard frame mountages may be realized. To adopt a labour saving technology from the beginning of the 3rd larval instar to cocoon harvesting at the field level in order to decrease the labour expenses from 5-6 h/kg fresh cocoons to less than 3 h/kg. .

4.Establishment of an effective extension service system for sericulture

This system may include the Sericulture and Agriculture Experiment Station in Vratsa and the National state universities in Plovdiv, Stara Zagora and Sofia, having sericulture sub-divisions as well as extension workers, appointed by the private cocoon/silk processing companies. For that purpose 15 state extension workers may be appointed at the SAES – Vratsa and the Universities and another 30 extension workers could be appointed at the private companies. During the period 2014-2020 the station and universities may conduct training courses in order to train the extension service workers (45 persons) and 300-400 farmers in the modern techniques of mulberry and silkworm rearing, cocoon production and processing and the management of sericultural farm. The training courses financing may be provided through the EU Programme for rural areas development 2014 – 2020. During the same period and with the financial help of the EU programme about 200 model demofarms may also be created.

5. Establishment of comparatively bigger sericultural farms.
The main purpose of these farms is to provide stable supply with high quality cocoons at lower production costs.
For establishment of a sericultural farm, having 0.5 ha mulberry plantation and 85 m^2 rearing house, the following investments are necessary:

Mulberry saplings: 2200 EUR

Mulberry planting and cultivation up to the 4^{th} year: 800 EUR

Reconstruction of the building, supply with rearing equipment: 3500 EUR

TOTAL: **6500 EUR**

The farm may grow 15 boxes of silkworm eggs annually, in 2 stages, namely spring (May/June, 10 boxes), and autumn (August/September, 5 boxes), producing 450 kg fresh cocoons/year. For establishment of 2000 such a farms during the period 2014 – 2018 about 3 300 000 mulberry saplings should be produced, what makes 660 000 saplings/year. Obviously the SAES – Vratsa's productional capacity will not be able to fulfill these needs, so it is expected to be undertaken by some private nurseries. For such a big number of mulberry saplings there aren't enough "mother" tree plantations for cutting collection at the country level that means they can not be produced by the hardwood cutting method. This production can be realized by involvement of private nurseries for fruit tree sapling production, if they use the grafting method of mulberry propagation.

NECESSARY INVESTMENTS:

1. Creation of a country network for silkworm egg incubation, larvae distribution, cocoon purchasing, drying, assorting and storage and silk reeling. (funded by the private investor/s + EU programmes).

- **Silkworm egg incubatories: 4 x 15 000 EUR =60 000 EUR**
- **Cocoon deflossing machines: 18 x 2000 EUR = 36 000 EUR**
- **Cocoon drying machines: 200 000 EUR**
- **Equipment for cocoon storage and assorting: 20 000 EUR**
- **Automatic cocoon cooking machines: 4 x 16 500 EUR = 66 000 EUR**
- **Fully automatic silk reeling machines (400 ends): 4 x 155 000 EUR = 620 000 EUR**
- **Boilers for industrial steam: 4 x 10 000 EUR = 40 000 EUR**
- **Equipment for raw silk bundling, packing and storage: 15 000 EUR**
- **Erection of the silk reeling machines: 15 000 EUR**

- **Rent for the buildings: 50 000 EUR**
- **Miscellaneous: 20 000 EUR**

TOTAL: 1 142 000 EUR

2. Renovation of mulberry plantations.

- **520 000 saplings x 1.5 EUR = 780 000 EUR (paid by the farmers and EU programmes)**
- **planting and cultivation up to the 4th year: 250 000 EUR (paid by the farmers and EU programmes)**

TOTAL: 1 030 000 EUR

3.Improvement of the silkworm rearing facilities and technology.

- **Silkworm rearing houses reconstruction and equipment: 7000 rearing houses x 2500 EUR = 17 500 000 EUR (paid by the farmers and EU programmes)**
- **Cardboard frame mountages: 800 000 pieces x 2.5 EUR = 2 000 000 EUR (paid by the farmers and EU programmes)**

TOTAL: 19 500 000 EUR

4.Establishment of an effective extension service system for sericulture (paid by the Bulgarian government, private investors and EU programmes)

- **45 extension service workers x 450 EUR x 36 months = 729 000 EUR**
- **Expenses for the extension service (travel, stationer, communication etc.): 85 000 EUR**
- **Training courses: 6 courses x 60 participants x 300 EUR = 108 000 EUR (entirely from the EU programmes)**

TOTAL: 922 000 EUR

- **5. Establishment of comparatively bigger sericultural farms. (paid by the farmers through the EU programmes)**

- **2000 farms x 6500 EUR = 13 000 000 EUR**

TOTAL: 13 000 000 EUR

GRAND TOTAL: 35 594 000 EUR

WAYS OF STRATEGY FUNDING:

Activities	**Source of funding**	**Budget in EUR**
Creation of a country network for silkworm egg incubation, larvae distribution, cocoon purchasing, drying, assorting and storage and silk reeling	Private investor/s and EU programmes	**1 142 000**

Renovation of mulberry plantations	Farmers and EU programmes	**1 030 000**
Improvement of silkworm rearing facilities and technology	Farmers and EU programmes	**19 500 000**
Establishment of an effective extension service system for sericulture	Bulgarian government, private investors and EU programmes	**922 000**
Establishment of bigger sericultural farms	Farmers and EU programmes	**13 000 000**
TOTAL		**35 594 000**

3.4.5. Workplan

Activities	**2014**	**2015**	**2016**	**2017**	**2018**	**TOTAL**
Creation of a country network for silkworm egg incubation, larvae distribution, cocoon purchasing, drying, assorting and storage and silk reeling.	creation	creation	creation	created	created	created
Renovation of mulberry plantations (number of new saplings produced and planted)	104 000	104 000	104 000	104 000	104 000	520 000
Improvement of silkworm rearing facilities and technology (number of silkworm rearing houses reconstructed and equipped, 1 house for 3 boxes of eggs)	1400	1400	1400	1400	1400	7000
Extension service system for sericulture (number of extension technicians appointed)	0	5	15	25	45	45
Framer's training courses, each course with 60 participants	1	1	1	1	2	6
Establishment of bigger size sericultural farms	10	300	500	500	690	2000
Silkworm egg production (boxes)	3500	11 000	20 000	20 000	25 000	79 500
Fresh cocoon production (t)	70	150	300	500	600	1620
High grade raw silk production (t)	6	13	27	45	55	146
Low grade raw silk production (t)	2.3	5	10	10	17	16.3
Number of sericultural households	875	1875	3300	5000	5000	5000
Gross incomes of sericulture farmers (EUR)	455 000	975 000	1950000	3250000	3900000	10530000
Net incomes of sericulture farmers (EUR)	364 000	780 000	1560000	2600000	3120000	8424000

3.4.6. Annual economical analyses on the sericultural production at the end of development period: at the levels of farmers and commercial enterprises dealing with cocoon and silk.

1.Sericulture farmers.

EXPENSES (the labor not included):

1.Mulberry cultivation: the old single trees do not need of any cultivation. The new plantations annual cultivation costs will be paid by the EU direct subsidy per ha.
2.Silkworm eggs: 25 000 boxes x 9.00 EUR = 225 000 EUR
3.Formalin for disinfection: 38 500 l x 0.50 EUR=19 250 EUR
4.Heating of the rearing house, paper, mulberry leaf transportation: 25 000 boxes x 20 EUR = 500 000 EUR

TOTAL: 744 250 EUR

INCOMES FROM THE COCOON SELLING: 600 000 kg x 6.5 EUR = 3 900 000 EUR
The fresh cocoon purchasing price per kg is formed as 3 EUR, paid by the commercial company, plus 3.5 EUR, provided as subsidy.

Positive financial result (payment of the farmers labor): 3 155 750 EUR

The labor expenses for production of 1 kg fresh cocoons in the project end are expected to be about 2.5 h: 2.5 h x 600 000 kg = 1 500 000 h : 8 h = 187 500 man days.
3 155 750 EUR : 187 500 man days = **16.83 EUR/ man day** (the minimal salary in Bulgaria in 2013 is 7.23 EUR/man day).

2. Commercial companies, dealing with cocoon purchasing, processing and silk reeling.

Production costs:

- Cocoon purchasing: 600 000 kg x 3 EUR = 1 800 000 EUR
- Cocoon drying, preservation and assorting (including the companies operational costs): 400 000 EUR
- Silk reeling of 1st grade cocoons and production of raw silk 2A – 4 A grade: 420 000 EUR
- Reeling 2nd and 3rd grade cocoons and production of grade less raw silk: 85 000 EUR
- Rent for temporary buildings for cocoon purchasing-1500 м ^{2} x 2 EUR x 5 months = 15 000 EUR
- Miscellaneous: 55 000 EUR

TOTAL: 2 775 000 EUR

INCOMES:

RAW SILK 2A-4A GRADE: 55 000 kg X 46 EUR = 2 530 000 EUR

GRADELESS RAW SILK: 17 000 kg X 35 EUR = 595 000 EUR

DEFFECTIVE COCOONS AND SILK WASTES: 15 000 kg X 3 EUR = 45 000 EUR

TOTAL: 3 170 000 EUR

RESULT: PLUS 395 000 EUR FOR PAYING BANK LOANS AND SOME PROFIT IF ANY.

5. Possible Bulgarian contribution to the regional international cooperation in Europe and Central Asia.

Presently Bulgaria exports silkworm eggs, mulberry saplings, cardboard frame mountages, dry cocoons, and twisted raw silk. The scientific teams from Bulgarian Academy/Universities participate in bi and multilateral research and technical international projects. The SAES – Vratsa and the Universities conduct training courses, including PhD courses.
If the cocoon/silk production in Bulgaria will be increased the country may supply the Italian and other EU countries silk industry with high grade raw silk and silk allied products.

ANNEX 1. Summary Review of Sericultural Statistics 2008 ~ 2012

Table 1. Relevant Data on Various Components of **Bulgarian sericulture industry.**

Item/year	**2008**	**2009**	**2010**	**2011**	**2012**
Fresh cocoon production (t)	48	51	75	49	63
Raw silk production (t)	7.5	6.3	9.4	6	7.7
Number of sericulture households	800	850	1250	817	1050
Number of silkworm egg boxes reared	2400	2833	4688	2579	3000
Production of mulberry saplings (pieces)	32973	45014	69066	37874	115012
Production of silkworm eggs (boxes)	1350	1515	1500	3000	3000

ANNEX 2.

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Country Report Switzerland 2013

By

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(ORAL PRESENTATION)

ABSTRACT: Background: Silk production in Switzerland has a long tradition and dates back to 1250. The last cocoons were produced 100 years ago. The association Swiss Silk, founded in 2009 as a private initiative, aims at reintroducing silk production in Switzerland. Today 36 farmers, 5 silk processors along the chain of production and 100 private persons and institutions are members of the association. Swiss Silk does not receive any support by the Swiss government.
Production: So far 4'200 mulberry trees have been planted. The main variety is Kokuso 21, trimmed as low stem cut (50 – 60 cm). Swiss Silk is still in the testing and pilot phase of the silk worm rearing. In 2012 the production was 1¼ box; in 2013 the envisaged production is 3 - 4 boxes. The eggs are purchased from the Agricultural research station Padua (Dr. Cappellozza).
The training of the farmers is paramount. At least twice a year Swiss Silk organises peer learning events for farmers. Swiss Silk has also produced a producer's manual.
Seven women have been trained in silk reeling on a "cottage type" silk reeling machine (12 ends). We produce mainly 30/33 denier raw silk, which is used entirely for tests in the silk

industry, allowing us to improve the quality of the raw silk. Raw silk processing is so far limited to weft yarn production for weaving tests. The overall results of final products are so encouraging, that the market partners intend to launch first products in the course of 2014.

Market Potential: The market potential, based on consumer research and assessments by the silk industry, is maximum 5% of the Swiss silk market. The silk production in Switzerland will therefore remain a profitable niche for innovative farmers and stakeholders in the silk industry.

Contact: Swiss Silk – Producers Association, Hinterkappelen, Switzerland www.swiss-silk.ch and www.facebook.com/pages/Swiss-Silk/

Introduction

Silk was for Switzerland a very important good. The first known silk production dates back to 1250, when in Zurich a flourishing silk production and manufacturer cottage industry has been established. It is reported, that in the year 1856, 560’000 mulberry trees were planted in Switzerland. Before World War 1 the last cocoons were produced in the southern part of Switzerland. After a break of 100 years, the project Swiss Silk aims at reintroducing the silk production in Switzerland.

Project Overview

Aims

- The silk production in Switzerland shall be reintroduced.
- Main aims are the creating of side income for Swiss farmers and at the same time strengthening the Swiss textile industry.

Project Characteristic:

- Decentralised Production of Biovoltine Cocoons
- Centralised cocoon drying and silk reeling.
- Manufacturer of Silk accessories such as ties and shawls by the Swiss textile industry
- Marketing by Swiss high end brands with as strong emphasis on Swissness and ecology.

Project History

In 2003, the project idea was developed by Mr. Ueli Ramseier. First contacts with the textile industry were established and first mulberry trees multiplied.

In 2009 the Swiss Association of Silk Producers “Swiss Silk” was founded as a private initiative including farmers, representatives from the Swiss textile industry and other interested persons.

Today 36 farmers, 5 silk processors along the chain of production and 100 private persons and institutions are members of the association.

Swiss silk does not receive any support by the Swiss government. All the operations are financed by the members of the association and for training purposes of the farmers also by the Zürcher Seidenindustrie Gesellschaft” ZSIG. The investments remain therefore comparatively small and the growth of the operation remains quite slow, but steady.

The Structure of the Project

The project has a modular structure. A „central unit“ is responsible for the extension work, the silk worm nursery, the cocoon drying (2 locations) and the silk reeling. The activities to coordinate the project are done on a voluntary basis; no paid labour is involved so far.

The silk worms are reared by individual farmers. They deliver the cocoons to the “central unit” and get paid per weight.

A board consisting of 5 people is overlooking and coordinating the project.

Persons and Network

All the stakeholders along the supply chain are involved in the project:

Board Members

- Ueli Ramseier, farmer, textile engineer — President, Secretariat, PR
- Ursula Knuchel Streit, farmer — Vice –President, Producer relations
- Oliver Weisbrod, Silk Manufacturer — Relation Textile Industry
- Petra Widmer, Program Manager — Special projects
- Max Leuzinger — Finances and special tasks

Other selected Resource Persons

- Mathias Camenzind — Silk Manufacturer
- Henri Brion — Resource person silk worm rearing
- Salome Ramseier — Communication
- Patrick Koch — Auditor
- Heinz Wenger — Auditor
- Andrea und Tobias Vollprecht — Public Appearance

The networking is an important success factor of this young initiative. The knowhow and experience of other countries shall be included in the constant learning process of the association. The membership at BACSA is an important step in this networking activity.
Together with the association IP Suisse, the biggest farmers association for eco-friendly farming, a production standard for silk production has been developed, as the consumers demand an ecological production.
With an institution involved in fish breading in the Swiss Alps, a project has been launched, to use the pupas for fish farming feed. Contacts with the Swiss College of Agriculture SHL (part of Bern University of Applied Sciences), the Ministry of Agriculture as well as with other organisations in Switzerland have been established.

Production

Mulberry Trees
During the last 6 years Swiss Silk has planted just over 4'000 mulberry trees. The main variety is Kokusa 21. A total of 30 varieties are planted to broaden the genetic basis. The majority of the trees are planted between 500 and 700 meters above sea level. The cut of the trees is low stem (50 – 60 cm).
Together with ProSpeziaRara, a private organisation dedicated to biodiversity, Swiss Silk identified over 60 old mulberry trees from Switzerland, used 100 to 150 years old for silk worm rearing. They are now multiplied and cultivated on a trial basis, to test their productivity.

Silk worm rearing
Swiss Silk is still in the testing and pilot phase. Only a few thousand silk worms have been raised so far. 2011: ¼ box, 2012: 1¼ boxes; forecast 2013: 3 - 4 boxes.
Farmers entering the system are given a sample of a few hundred eggs in order to get first experience in silk worm rearing. With the growth and extension of their plantations, they also will raise more silk worms. The rearing takes place in the houses of the farmers. The rearing rooms are equipped with low cost rearing equipment. For the spinning, Japanese cartons are used to get good quality cocoons.
The eggs are purchased from the agricultural research station Padua (Dr. Cappellozza).

Training and extension work
The training of the farmers is paramount, however very labour intense and costly. With the help of the "Zürcher Seidenindustrie Gesellschaft" ZSIG, Swiss Silk has edited a training manual for cocoon production on a farm level, adapted to the central European context. The author is Henri Brion. A silk worm rearing expert from France. At least twice a year Swiss Silk organises peer learning events, where farmers can exchange and get practical exposure to silk worm rearing.

Cocoon drying
The association has purchased two hot air drier from Arya Silk (India), with a capacity of 50 kg fresh cocoons each. For our small production this will be sufficient for the next few years.

Silk reeling

A "cottage type" silk reeling machine has been purchased from Arya Silk (India) with a total of 12 ends, together with a re-reeling machine, a vacuum cooking machine, a two pan cooker and the other needed equipment. Since winter 2010/2011 seven women have been trained in silk reeling. Swiss Silk produces mainly 30/33 denier raw silk. The raw silk is used entirely for tests in the silk industry. The total production of raw silk so far is around 7 kg only, allowing us however to test and consequently improve the quality of the raw silk.
Raw silk grading tests in 2012 have shown good evenness end strengths, but weak elongation figures. We are currently improving this with soaking of the raw silk in additives.

Raw silk processing
So far only weft yarn is produced and tested. For warp the quantity and quality of the raw silk is not yet sufficient. The overall results are so encouraging, that the market partners are envisaging launching a first line of products in the course of 2014.

Market Potential and Business Case

The market potential has been elaborated based on consumer research and assessments by the silk industry. The anticipated potential has been reduced during the last two years. In any case the production will remain a niche for innovative farmers.
Intense calculations are a constant activity of Swiss Silk to back up the business case for farmers and the textile industry. The business case is designed to operate outside the frame of the "world market" allowing to compensate the comparable high labour costs in Switzerland. The business case operates without any subsidies and is entirely market based.

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⇒ For further information please see **www.swiss-silk.ch** and **www.facebook.com/pages/Swiss-Silk/**

State of sericulture, problems, issues and strategy development in Ukraine

By

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(ORAL PRESENTATION)

The beginning of sericulture development in Ukraine accounted for during the Middle Ages. In the 30th years of the twentieth century were adopted government regulations on the further development of sericulture in the Soviet Union. Sericulture was a strategic industry. Sericulture Industry in Ukraine in the 70-80s of the last century reached its highest level of development. In the 80s Ukraine annually produced more than 1300 tons of high quality fresh cocoons and 500-600 kg silkworm eggs. Due to continued growth in energy prices, auxiliary materials, excessive tax burden and the abolition of state subsidies to the industry since 1991 sericulture became unprofitable for both producers of cocoons and silk processors. Therefore the majority of collective farms and private sector virtually stopped their sericultural activities, the industry found itself on the brink of destruction and state farms - under bankruptcy. Despite the difficult state of the industry, in Ukraine Scientific Research Institute of Sericulture maintained a unique collection of silkworm breeds and varieties of mulberry. Irrespective of the crisis in Ukraine there are still preserved the specialized enterprises for cocoon production/primary processing which have about 3000 ha mulberry plantations. At the country level, the still preserved mulberry plantations occupy around 15000 ha which allows begining the silkworm rearing without any big additional investments. The limiting factor however is the absence of silk reeling and processing enterprises. The necessary measures to revive the sericultural industry in Ukraine would be modernization of the production and decrease the productional costs, establishment of silk reeling and processing enterprises, improvement of the state support, creation of a specialized sericultural institute, creation of a union of the cocoon producing enterprises, attracting the farmers and rural population in the silkworm rearing, finding markets for the silk products through the regional association BACSA activities.

Sericulture status, problems, issues and development strategies in Greece

By

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(ORAL PRESENTATION)

ABSTRACT: Sericultural activities represent a long tradition in Greece and raw cocoon production and silk processing had been familiar activities of all the Greek territory since very early periods. Production and home processing in some Greek areas, had already around year 1750-1770, reached high levels and more remarkable ones up to 1938, after the silkworm's pebrine disease appearance in France, which lead to the complete collapse of the French cocoon production. This is considered as the "golden period" of Greek sericulture. Dry cocoon production reaches 1.149 tons around 1934 and for the same period the national silk industry develops rapidly, processing yearly around 1.200 tons of dry cocoons yearly. In the same period, the Greek silkworm egg production reaches 145.000, boxes yearly, each of 25 gr., the biggest part of which is exported, mainly to Persia and Syria. Later on, facts like the Second World War, the development and dominance of synthetic fibers, the rapid growth of the heavy industry and the follow up urbanization, the gain of new crops, especially industrial ones, direct sericulture internationally to a dramatic decrease and Greek sericulture follows the same way. Mulberry plantations remain for long without any cultivation, and start gradually being replaced by other more competitive crops, leaving the few maintained sericultural activities to rely upon scattered mulberry trees. For some period in the last few years, a regain tendency had been observed for the Greek sericulture, deriving mainly from the membership of the country to the European Union and the after that developed socioeconomic conditions, with the additional

fact of the particular climatic conditions of Greece. In that period the number of silkworm farmers, the yearly reared silkworm egg boxes and the fresh cocoons produced, increased significantly, reaching 245 farmers involved, 3900 boxes reared and 70 tons of fresh cocoons produced. There after and due to several factors, among the most important being the outbreak of the economic crisis, the lack of a strategic plan for sericulture and some wrong central decisions concerning the field, these figures remained unchanged or even decreased, especially in number of farmers involved. The yearly reared silkworm egg boxes dropped to 2700, the involved farmers to only 50 and the fresh cocoon yearly production to 50 tons. This extend of the Greek sericulture, compared to other sericultural countries, appears of minimal significance. In relation though to the rest of the European countries, the Greek raw cocoon production holds the highest share, almost compared with that of Turkey, which is far bigger country. As a conclusion Greece, despite its favourable climatic and economical conditions, failed to develop sericulture to a significant extend, mainly due to lack of governmental technical support by specialized personnel and Institutes, lack of sufficient information to the farmer level, slow application of modern technology, absence of well organized state, cooperative or private mechanisms for the absorption and processing of the produced cocoons and complete absence of any use of existing own mulberry and silkworm genetic resources.

Recently some significant changes in the agriculture's scenery might affect sericulture and create promising opportunities for it. Among them predisposing the fall of cotton international prices, the increasing cost of inputs to agriculture, the tobacco's problems, either as crop or as processing industry and the dramatic decrease of E.U. subsidies for the main country's crops after year 2014, according to the new C.A.P.

Besides that tourism seems to gain bigger shares and bigger importance in the national Greek economy, predicting the development and increase of small handcrafts industries. All these combined to the increasing rates of unemployment, direct many people, especially young, to seek various activities for the creation of some income.

In addition cocoon production in traditionally leading countries, like China, Korea and India, are steadily falling due to the rapid industrialization, having as a result the incomplete coverage of their industry's demands for raw cocoons and raw silk, a situation directly reflecting to the international cocoon and raw silk demand and prices. Considering all the above facts in combination, it comes out that there could be presumed an opportunity for sericulture's implication in solving some of the described problems, by means of efficient land and labor use, income sufficiency, rural development and export possibilities. Of course this opportunity should be urgently covered by some central, national and European structures, for an efficient coverage of the cocoon farmers with training, technical support, disease control and besides all cooperative organization for cocoon trade, cocoon reeling, silk processing and silkworm egg provision.

For the time being, due to the expanding to almost all European countries crisis, it is really difficult to speak about such national and European strategies for the sericulture's development. The next few years are going to be very critical, and the only certain thing is that there are going to be realized many big changes in the agricultural, processing and trade reality of many countries. The direction and the magnitude of these changes will create the future of sericulture in tomorrow's Europe.

Chapter 1. Introduction

1.1 Brief historical backgrounds of sericultural industries

Sericultural activities represent a long tradition in Greece and raw cocoon production and silk processing had been familiar activities of all the Greek territory since very early periods. Henry Barham already in 1719 describes in his book "An Assay Upon the Silkworm", a very high

sericultural activity in the Greek regions, giving accurate information about the quantities and the quality of the produced silk and mentioning that *“without doubt great quantities of Silk have been, and are now made there, which is the case of most parts of Greece”.*
Production and home processing in some Greek areas, already around year 1750-1770, reaches high levels, giving the impression of the beginning of industrialization and at that time Greece exports raw silk to France, Germany, Venice, Tunis and Turkey. All the produced raw silk though, was home processed by traditional techniques, of a not so acceptable quality, having the same characteristics of the Turkish one. In year 1837 a first attempt was made in Greece, for the establishment of a silk processing factory, adopted to the Italian technology, an attempt which failed but left to the involved people enough knowledge and experience about the modern industrial way of processing. The appearance of the silkworm’s pembrine disease in France lead to the complete collapse of the French cocoon production around year 1850-1860, causing the complete change of the silk production activities in the entire Mediterranean basin. The French silk industry became completely depended on imports of raw cocoons, raising their prices and increasing all the producing countrie’s cocoon exports, causing in this way their sector’s development. Since that period and up to 1938, the Greek sericulture and silk processing industry shows a continuous development and reaches remarkable levels, with an exception for the period 1860-1880, when the country was also affected by pembrine disease.
Recovery of the Greek sericulture started, like in all south Europe, in 1880, after the Pasteur’s technique was established in the silkworm egg production. So fresh cocoon production increases again and reaches peak values around 1934-1938, holding a reasonable share among the other producing countries. This period had been considered as the "golden period" of Greek sericulture. Dry cocoon production reaches peak levels and stays continuously around 1.000 tons yearly, a very high figure for such a small country, reaching its peak in 1934 with a production of 1.149 tons of dry cocoon. For the same period the national silk industry develops rapidly, creating a continuous increasing of the local dry cocoon consumption and reflecting to decreased cocoon exports. Yearly dry cocoon consumption by the local industry reaches 1.200 tons in 1934, while dry cocoon exports fall to 2 tons in 1937, combined to a rapid increase of dry cocoon imports, reaching 300 tons in 1931. In the same period, as a reflection to the international sericultural circumstances, the Greek silkworm egg production increases up to 1935 and reaches 145.000, boxes yearly, each of 25 gr. The biggest part of these boxes is exported, mainly to Persia and Syria. Accordingly, a continuous selection on a farm basis was applied on the existing local breeds, having as a result the improvement of them.
The above described situation is given in details in the following tables 1-5.

Table 1
Development of the Greek cocoon reeling industry

Year	Total number of silk factories	Total number of reeling basins	Total power consumed (HP)	Total workers employed
Up to 1876	---	---	---	---
1876	12	523	---	---
1923	15	327	178	1.027
1930	30	1.168	615	3.617

Table 2
Fresh cocoon production, 1896-1934. (Tons)

Country	Year							
	1896	1904	1908	1912	1915	1922	1931	1934
France	9.318	7.889	8.409	6.234	1.727	2.500	966	970
Italy	41.182	56.641	53.193	47.470	33.897	30.000	34.458	28.839
Spain	1.231	993	1.015	1.030	735	900	---	---
Austria-Hungary	3.599	3.756	3.953	3.482	1.730	1.500	---	---
Turkey	7.572	9.203	10.951	8.588	3.130	10.000	---	---

Greece	180	808	840	635	1.347	2.029	1.690	2.569
Syria	4.860	5.119	5.641	4.660	4.050	5.500	2.815	3.310

Sources: F.O. Diplomatic and consular reports, L'economiste Francais, L'economista, Economical reports of Greece.

Table 3
Raw silk production, 1896-1934. (Tons)

Country	Year							
	1897	1904	1908	1911	1917	1922	1931	1933
France	620	623,6	656	402	205	198	80	76
Italy	2.916	4.889,7	4.486	3.490	2.820	3.735	3.286	3.403
Spain	73	76,8	75	88	70	77	44	38
Turkey	429	751,4	900	1.120	1.040	---	---	---
Greece	43	65	65	62	60	56	200	215
Syria	490	469	490	525	---	---	230	116

Sources: F.O. Diplomatic and consular reports, L'economiste Francais, L'economista, Economical reports of Greece.

Table 4
Dry cocoon production, exports, imports in Greece for the period 1920-1938, kg

Year	Dry cocoon production	Dry cocoon consumption	Dry cocoon exports	Dry cocoon imports
1920	325.124	---	109.718	9.484
1921	460.944	140.000	282.350	---
1922	735.653	224.000	70.728	---
1923	693.043	230.000	513.000	15.758
1924	869.748	230.000	320.694	1.859
1925	1.056.000	350.000	573.900	1.197
1926	875.411	400.000	326.600	---
1927	837.586	500.000	152.808	---
1928	859.718	700.000	308.655	---
1929	842.200	700.000	208.600	---
1930	628.000	700.000	86.785	104.200
1931	557.852	800.000	31.269	303.750
1932	615.995	860.000	2.200	124.167
1933	716.206	860.000	4.881	192.970
1934	847.885	1.200.000	14.010	216.314
1935	910.086	1.040.000	---	153.516
1936	897.056	1.000.000	---	158.000
1937	990.509	980.000	2.000	5.880
1938	1.149.227	1.000.000	30.808	2.608

Sources: Statistics of the Greek commerce, National Statistics Secretariat of Greece

Table 5
Silkworm egg production, exports, imports in Greece for the period 1920-1938
(25 gr boxes)

Year	National production	Exports	Imports
1920	33.386	---	12.124
1921	53.041	---	21.363
1922	48.055	---	32.932
1923	143.882	77.700	24.085
1924	241.892	145.608	19.205

1925	288.824	79.067	18.605
1926	184.569	141.731	16.820
1927	170.288	94.055	21.889
1928	130.284	69.202	14.305
1929	139.513	59.400	13.085
1930	149.679	86.477	6.560
1931	121.700	60.793	2.190
1932	141.350	68.629	2.820
1933	151.869	75.655	---
1934	146.809	52.481	---
1935	140.142	---	---
1936	65.000	---	---
1937	70.089	---	---
1938	70.000	---	---

Sources: Statistics of the Greek commerce, National Statistics Secretariat of Greece

The above described situation lasted nearly up to 1940, followed after that by a dramatic decreasing caused by a combination of facts and coincidences us:

- The Second World War and its dramatic socioeconomic effects.
- The Greek civil war, right after the Second World War, and its dramatic effects to the Greek economy and social construction.
- The development and dominance of low price synthetic fibers in the international market, and their effect upon the decrease and instability of cocoon and silk prices.
- The rapid growth of the heavy industry and the follow up urbanization.
- The gain of new crops, especially industrial ones like cotton, sugar beet, maize and others, which provided higher mechanization and incomes, leading to the replacement of the mulberry plantations

The Greek mulberry plantations, left during this period for long without any cultivation, started gradually being replaced by other more competitive crops, since the income from sericulture was continuously decreasing, until they were almost disappeared up to 1970. All the well organized mulberry fields gradually disappeared in this way and the few maintained sericultural activities relied upon the numerous scattered mulberry trees existing all over the country.

1.2 Current issues in sericultural industries and silk enterprise development;

In the last few years, initially, a regain tendency had been observed for the Greek sericulture. This tendency derived as a result of the described below coincidences:

- **Greece became a full member of European Union (EU) and silkworm rearing activity within its Common Agricultural Policy, had been considered for some member countries, such as Greece, as one of the protected and promoted agro-industry components, being subsidized by around Euro 132 per box of 20.000 eggs reared.**
- **Due to its particular climatic conditions, Greece can be considered as one of the most suitable for silkworm rearing European regions.**
- **A significant part of traditional annual crops, mainly industrial ones, like cotton, sugar beet, tobacco, maize, etc, has been replaced by perennial ones, like trees, including mulberry, as a result of the Common E.U. Agricultural policy which provided a subsidy to all installation costs and to the calculated loss of income for twenty years.**
- **The above two subsidies for some period provided a combined support for silkworm rearing, both as direct rearing and as mulberry cultivation as well. This combined support stimulated the interest of some farmers to combine the replacement of their annual crops with sericulture.**

- **Silk reeling and processing industry could be subsidized as well, within national development programs, especially in convergence regions where the subsidy could reach 65% of the total installation cost. This fact actually caused the initiation of some efforts in Greece, including the development of a cocoon reeling plant in Northern Greece.**
- **The established economical standards of the European population permitted the consumption of more luxury products, such us silk products, even in high prices. For a quite long period has been observed in the E.U. an increasing demand for natural and biological products. The silk products consumption steadily increased and for the same period also remarkably increases in Greece**
- **For the same period he silk products importation also steadily increased within the European Union and also in Greece, since the local productions could not cover the demand.**
- **The high industrialisation and rapid development of some traditionally silk producing countries, like China, India and Korea, directed many farmers to industry and accordingly decreased the raw cocoon production, increasing simultaneously the demand of such countries for raw silk materials.**
- **Sericulture recently started being practiced also for the production of different than the traditional, high added value bio-products, like pharmaceuticals, cosmetics and other biological substances, a fact creating more opportunities for its future.**

Within these frames it appeared that sericulture farmers, especially in traditional sericulture areas could re-gain the ground of cocoon production and ensure a reasonable income through it. Simultaneously there could also be provided to the silk processing industry satisfactory high quality raw material under reasonable prices.

The above facts for some period created an increasing interest among Greek farmers for a further involvement in sericulture, or an increase of their cocoon production, using modern technology, since the mentioned subsidies approximately duplicate their total income, compared to any other annual traditional crop. As it appears in the following in chapter 2 review of Sericultural Statistics, this interest was steadily increasing up to year 2005, both in number of farmers, boxes reared and cocoons produced, and there after remained unchanged or even decreased, especially in number of farmers involved. Various reasons lead to this change of the initial tendency, the most important among them being the next:

- **The outbreak of the economic crisis in Greece and other E.U. countries as well, created an environment not suitable at all for business expanding, something which directly reflected on sericulture as well.**
- **The, years ago, started being developed cocoon reeling plant in northern Greece was never completed, leaving behind the same difficulties to the Greek silkworm farmers.**
- **The energy cost increased dramatically the last few years, affecting negatively the silkworm farmers, especially the modern ones, which invest a lot of energy in their rearing facilities, for heating, cooling, ventilation and cocoon coocking and drying.**
- **The Greek Ministry of Agriculture decided some changes in its policy for central silkworm egg provision, and through them left this task to the responsibility of the farmers, individually or cooperatively. This fact stopped the activities of many small farmers, since they could no obtain by themselves their necessary silkworm eggs.**
- **By this way even the bigger farmers have difficulties in obtaining their eggs due to complications in the provision by themselves and the cost coverage. There appeares a lack of interest from the suppliers to deal with many people and small quantities. Besides that the farmers have to overtake the importation formalities, something very difficult for them, since in many cases the imported eggs are shipped to central ports or airports, far away from their locations.**

- **In addition to the above, it has also to be mentioned that due to the described changes to the manner of silkworm egg provision, there involves a very long time consuming central egg quality control. Samples of the purchased by the farmers eggs have to be sent in Athens in order to be examined for pembrine spores and hatchability and after that to be approved for rearing. This process in the most of the cases lasts more than 15 days and during this time the eggs have to be stored under proper conditions, something very difficult for the farmers.**

Besides all the above, there have to be under consideration some other factors, also affecting negatively the sericultural activity, as:

- **The uncertainness for the oncoming changes in the E.U. Common Agricultural Policy, reflecting to the possible loss of existing subsidies for certain crops, which might include sericulture as well.**
- **The dramatic changes in the E.U. textile industry, which was heavily ffected in all E.U. countries and almost disappeared from dome ones, like Greece. The situation reflects to all of E.U. more or less, where most of the industry stopped operating or moved to other counties with more favourable conditions.**
- **The outbreak of the economic crisis lead to a decreasing demand for luxury products, which directly affects the demand for silk products.**
- **Considering specifically the Greek reality, there appears a complete lack of governmental support to silkworm farmers by means of specialized scientific personnel, specialised laboratories and advisory services. This situation exists for the last years and seems not able to change in the short future.**
- **The outbreak of the economic crisis, besides all other effects, resulted to a diminished economic support to all existing advisory and research structures, including the only specialised in sericulture institution, The Komotini Agricultural research Station, which activates in Sericulture for the last 20 years, maintaining and improving genetic resources of silkworm and mulberry. The same of course happens to all research institutes and the result is the every day declining activities, the loss of specialised personnel which is not replaced and the risk of complete inactivity or even stop of existence.**
- **The small number of farmers involved in sericulture and their scattered locations affect also negatively the activity, since it is difficult for them to get organised in effective cooperatives, covering their demands and promoting their products.**

1.3 Brief suggestions for future directions and strategies in promotion of sericulture and silk enterprises in Greece, and also introductory suggestions for regional cooperative activities in the near future in the Europe and Central Asia Region.

The failure for a further development of sericulture in Greece, apart of the recently created international circumstances, was mainly affected by national defections, like lack of governmental technical support through specialized personnel and Institutes, lack of sufficient information to the farmer level, slow application of modern technology, absence of well organized state, cooperative or private mechanisms for the absorption and processing of the produced cocoons and complete absence of any use of existing own mulberry and silkworm genetic resources. Thus any national strategy, designed to cure the situation and promote sericulture, should target to these defects, supplying to the recent and potential future cocoon farmer, the necessary tools to plan and organise his activities under a secure cover of a national strategy, providing the necessary information and technical support. Besides that it seems to be necessary the development of serious and adequately organised cooperative structures, in order to make efficient use of such a strategy, especially in the field of the marketing of the products. As a regional strategy, a lot of attention should be given by all the involved in sericulture European countries, to present and promote the advantages and the problems of it, at a central, decision making level, in order to put it at consideration in a E.U. level and draw any possible support to all directions, from rearing to market. Such an activity should be strongly adopted by all sericultural countries and expand out of the E.U. borders in all BACSA members.

Chapter 2. Summary Review of Sericultural Statistics 2008 ~ 2012

2.1 Mulberry areas

As it was described in the introduction, the Greek mulberry plantations, during the sericulture's declining around 1940-1970, had been left for long without any cultivation and started gradually being replaced by other crops, until they were almost disappeared up to 1970. All the well organized mulberry fields gradually disappeared in this way and the few maintained sericultural activities relied upon the numerous scattered mulberry trees existing all over the country.
In the last few years, in parallel to the appeared interest for cocoon production and in combination with the obtained E.U. subsidies, some effort was observed for the installation of new mulberry fields, with imported high productive mulberry varieties, under new technology. Within the E.U. subsidies the one which mostly contributed to new mulberry field installation was the support of the replacement of annual crops with perennial ones, especially with tree species, including the mulberry tree.
In this respect there had been installed in northern Greece around 500 hectares of modern mulberry fields, planted with imported mulberry varieties recommended for sericulture, mainly from China and Bulgaria.
These plantations still exist and support the sericultural activities in this area, which remains the only actually activated in the field of sericulture. Apart of this area, the any existing minimal activities rely upon the numerous scattered mulberry trees. As a conclusion, it may be said, that the organized mulberry field surface, remains the same and without any significant changes for the last five years, thus around 500 hectares.
In this point it has to be mentioned the activity of the Komotini Agricultural Research Station, which through its bilateral cooperation with Bulgaria and China, has established a field with mulberry genetic resources, maintaining 42 mulberry varieties, among them included the most known sericultural ones.

2.2 Cocoon farmers, cocoon production

As it was previously mentioned, Greek sericulture appeared regenerated through the E.U. subsidies, and reached some peak around year 2000-2005, approaching roughly 100 tons of fresh cocoon yearly. After year 2005 started a gradual declining of the Greek Sericulture, especially in numbers of cocoon farmers, a situation deriving absolutely from the changes in the policy of silkworm egg provision.
As it was already mentioned in the last two years the whole Greek sericultural situation faced a sudden change, deriving from some changes in the policy of the Ministry of Agriculture, in relation to the silkworm egg provision. Up to year 2009 the Ministry of Agriculture was holding centrally the provision of the silkworm eggs for all the country needs, purchasing the necessary amount through an international tender and distributing them, under a very low – almost symbolic - price, to the farmers. It has to be emphasized in this point that there does not exist local silkworm egg production in Greece, in vice of the efforts placed by the Komotini Agricultural Research Station to this direction. Although this station holds the genetic resources and the knowledge to produce the necessary for the local needs eggs, it was never appointed and financed for this purpose, and the whole country needs are still covered by imports.
It has to be mentioned though that the central distribution of the silkworm eggs, through imports, although simplifying the process to the benefit of the farmers, in many cases created problems,

due to delayed provisions and mainly to the every year changes of the purchased silkworm hybrids, many times driving to some not tested at all for their adaptability and suitability for the Greek rearing conditions.

In 2009 it was announced that the farmers had to buy their silkworm eggs by themselves and cover the real cost of them. This decision directed immediately to the complete disappearance of the small scale silkworm farmers, due to the fact that they were not able to deal with silkworm egg imports in such small quantities and besides that they were not organized in cooperatives. The ones who could overcome this difficulty were the big scale farmers, rearing around 100 boxes per year and the organized in cooperatives which could go to massive imports. The affect of this situation on the Greek sericulture is shown in the following tables and figures.

As it comes out from the data of table 1 and figures 1 and 2, having as reference year 2005, the total number of the involved farmers decreased from 245 to only 50 after year 2010, when the described changes started being applied. Simultaneously to that the yearly reared total silkworm egg boxes decreased from 3920 to 2732 in year 2012, representing a loss of 1188 boxes, or otherwise of 157.000 euro of subsidies. The fresh cocoon amount, yearly produced, decreased from 69 to 50 tons, resulting a loss of 19 tons, an actually small amount, but very significant for the mentioned local silk handcrafts industry. The situation was somehow compensated by some further activation of the new modern farmers, which gradually raised their mean yearly reared egg boxes from 14,15 in 2005 to 54,64 in 2012. This further activation directed to the actually small declining in the total amount of fresh cocoons produced and to slight improvement of the mean cocoon quantity produced per box, which increased from 17,60 kg in 2005 to values around 20 kg for the period 2010-2012. This most possibly becomes from the higher experience obtained by the modern farmers, indicating the existence of a high potential for significant cocoon production by the involvement of well organized and with modern technology silkworm farmers.

The fact that there was observed only a small decrease of the mean cocoon quantity produced per box, indicates again that there could be a further improvement of the total cocoon output through more detailed selection of the used silkworm hybrids in farm scale, directed to the specific condition of each sericultural region.

Table 1
Fresh cocoon production in the period 1995 – 2005

Year	Silkworm egg boxes reared	Cocoon farmers involved	Boxes reared per farmer	Fresh cocoon production tons	Mean cocoon prod/n per box
2005	***3920***	***277***	***14.15***	***69***	***17.60***
2008	3742	245	15.27	66	17.63
2009	2988	200	14.94	60	20.08
2010	3002	218	13.77	65	21.66
2011	2899	53	54.68	60	20.69
2012	2732	50	54.64	50	18.30

Source: In the ISC web site does not appear data for the Greek fresh cocoon production in the period 2008-2012, the last existing report being that of year 2007, giving a production of 104 tons. The data presented here are drawn from the Greek division of EU subsidies control (OPEKEPE).

Figure 1

Evolution of fresh cocoon production for the period 2008-2012

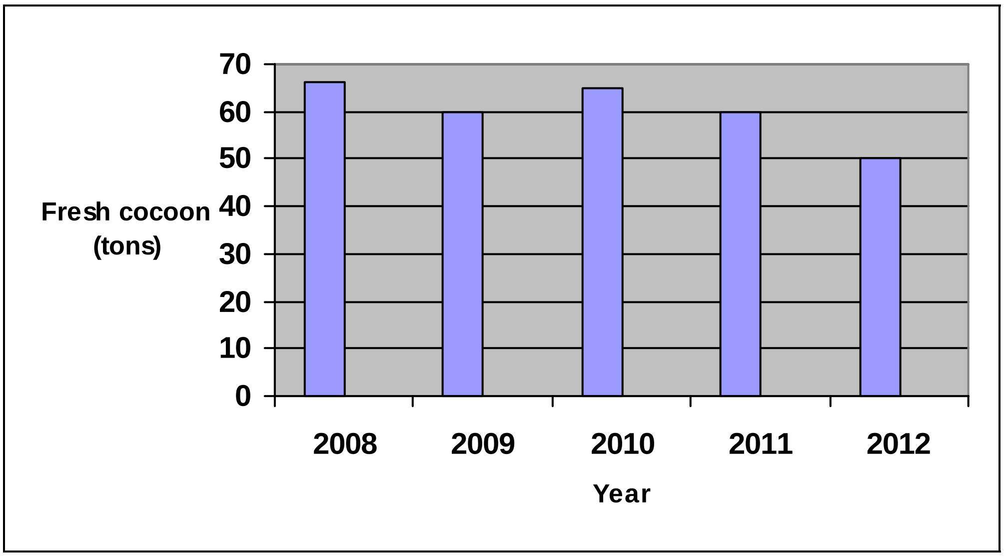
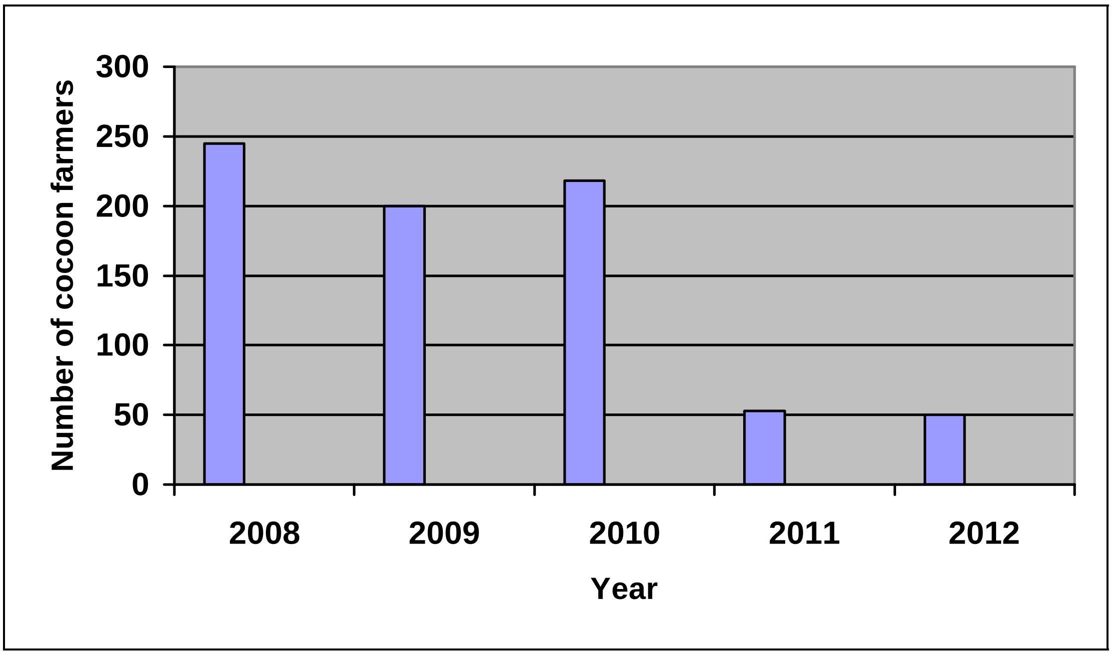


Figure 2

Number of silkworm farmers for the period 2008-2012



Obviously the above described production levels, compared to the data of other countries, appears of minimal significance. It has though to be taken in consideration that the Greek sericulture had reached zero points in the last period and any recovering is difficult and time consuming. So the achieved level of production can be considered as a success and a promising start for possible future further expanding.

In relation though to the rest of the European countries, the Greek raw cocoon production, as it appears in table 2, holds the highest share, almost compared with that of Turkey, which is far bigger country.

Table 2
Raw cocoon production of European countries (tons)

Country	2007	2008	2009	2010	2011
Bulgaria	55	48	51	75	49

Greece	**69**	**66**	**60**	**65**	**60**
France	**0**	**0**	**0**	**0**	**0**
Italy	**6**	**0**	**0**	**0**	**0**
Romania	**4**	**5**	**25**	**0**	**0**
Turkey	**130**	**126**	**140**	**129**	**151**

Source: ISC statistical data (except for Greece who's data are drawn from the Greek division of EU subsidies control - OPEKEPE).

The described changes in the Greek sericulture, as it was already mentioned, mainly affected the small cocoon farmers in the Greek islands. All the small cocoon farmers from the Creta and Lesvos completely disappeared, due to their difficulties in fulfilling their silkworm egg demands, removing from the activity around 200 small farmers and leaving the local silk handcraft industry without raw materials as it appears in table 3.

Table 3

Distribution and activity of cocoon farmers in Greece for the period 2009-2010

Area of the country	**Number of farmers involved in sericulture**		**Total Number of silkworm egg boxes reared**		**Mean Number of silkworm egg boxes reared per farmer**	
	Year 2009	Year 2011	Year 2009	Year 2011	Year 2009	Year 2011
Creta island (Chania)	34	0	54	0	1.58	0
North Greece (Orestiada)	8	10	549	527	68.62	52.7
North Greece (Evros)	33	28	902	897	27.33	32.03
North Greece (Kavala)	3	3	300	345	100.0	115.09
North Greece (Serres)	13	12	929	1130	71.46	94.16
Central Greece (Evia)	1	0	20	0	20.0	0
Greek islands (Lesvos)	126	0	248	0	2.96	0
Totals	218	53	3.002	2.899	13.77	54.68

Source Greek division of EU subsidies control (OPEKEPE).

2.3 Raw silk production,

The lack of cocoon reeling facilities in Greece does not permit local raw silk production. As mentioned an initiated reeling plant in Northern Greece, was never completed and its expected contribution to all Greek sericulture was never realized. The only existing raw silk production is practiced by some small scale silk enterprises in Soufli town in northern Greece, reeling, deguming and spinning small quantities, absolutely directed to a part of their needs, for local silk products. Their activity processes around 5 tons of raw cocoons yearly. Recently there appeared an interest from the Bulgarian side, for a cooperation targeting to the completment of this plant, something which could significantly help the sericulture of both neighboring countries.

2.4 Silk fabrics, silk import/export, (tons)

The Textile and Clothing sector in E.U. represents a very a very significant share of all E.U. industries. The bigger producers in this field are Italy, Germany, France, Spain and U.K. These countries share almost 75% of the total E.U. activity. In some other countries, like Portugal, Greece, Lithuania, Poland, Slovakia, Romania, Bulgaria and Czech Republic, the sector has been playing an important role in the economy, accounting in the past 5-15% of the employment and around 10% of total exports of manufactured products. The sector in 1998 amounted a turnover of 198 bn euros, and accounted 2,3 million workers employed in 150.000 small and medium enterprises. Up to 2009 due to the economic crisis, the sector's turnover dropped to 167bn, decreasing by 28%, and the people employed by it almost halved. Since 2009 the sector's tendency generally in E.U. is a slow recovering, but in some countries, like Greece, it is still very severely affected. Among all sector's activities silk derived products hold a significant share, as waving but mainly as yarn and fabrics import and processing. Nowadays the total processed raw silk and twisted silk is imported, mainly by Italy and France, (table 4), as it appears in the statistical base of the International Sericultural Commission. In the rest of the other E.U. countries import-export activity is minimal and their needs are covered by intra-E.U. trade. In this direction Italy and France play the role of the main E.U. distributors.

Table 4
Silk imports-exports by E.U. countries

Country	Year 2011					
	Dry cocoon exports tons	Raw silk exports tons	Twisted silk exports tons	Dry cocoon imports tons	Raw silk imports tons	Twisted silk imports tons
Bulgaria	--	--	17	--	9	--
France	--	--	--	--	108	--
Italy	--	357	393	--	699	1764
Switzerland	--	--	2	--	5	3
Turkey	68	19	8	--	93	86

Source: ISC statistical data

Apart of raw and twisted silk, the silk product share in the E.U. market is mainly covered by silk yarn, silk garments and silk clothing imports, the mentioned countries playing again the dominant role in imports, trade, and processing.

Among all E.U. countries Greece has a small share of the total activity in this sector, an activity which has been dramatically affected by the crisis since 2009. A few activities still remain in action. There are reeled by small enterprises in Soufli area about 5 tons of cocoons, producing around 2 tons of raw silk, which is also locally degumed, twisted, dyed and waved, being directed completely to the local silk items production. There are also imported yearly, mainly from Italy, about 15 tons of silk yarn, which are waved in various areas to silk garment. In addition there are imported around 800 tons of silk garment (from pure silk and silk by products) and ready made silk clothing of a total value 36 mln euros. Of course the today appeared situation in Greece cannot be characterized as representative, since it has been and it is still heavily affected by the economic crisis, which is not yet stabilized. Thus, for the time being, it is very difficult to go through any predictions for the future of this sector in the country.

2.5 Organization and development strategy of sericultural institutes and government offices in charge of cocoon and silk production, including for the research and extension systems.

As it was previously described the ongoing economic crisis has as a side result the diminished financing of all existing advisory and research structures of the country. The already, for long time existing, lack of governmental support to silkworm farmers by means of specialized scientific personnel, specialised laboratories and advisory services, became even worse and today there is not absolutely any structure existing, able to support and promote sericulture. The activities of all research institutes are every day declining, their specialised personnel is directed to unemployment and is never replaced and there is obvious the risk of complete inactivity or even complete disappearance.

- **The only specialised in sericulture institution, the Komotini Agricultural research Station, who's the activities were previously described, has already left without researchers, with diminished financing and unable to maintain even its routine activities.**
- **The peripheral divisions of the Ministry of Agriculture undergo the same situation. Their support to sericulture was already of no significance, dealing only with administration routines around the E.U. subsidies. Their only sericultural activity was transferred to a general administration and control service (OPEKEPE), and there after there isn't any other ministry's activity directly connected to advise, aid and promotion of sericulture.**
- **The still existing ''Sericultural Laboratory of Athens'', a branch of the Ministry of Agriculture hosted by the Agricultural University of Athens, according to the existing law since 1910, only deals centrally with the quality control of all the imported silkworm eggs in all areas of Greece, an activity which as already described is complicated, long time consuming and causing numerous problems to the farmers.**

As it comes out of all the above facts, today there aren't actually any significant and sufficient structures in the country, targeting to a strategy for the development of sericulture. The existing farmers remain without specialised scientific and technical support, relying absolutely upon their experience and the aid of the very few existing specialised scientists.

2.6 Natural and socio-economic feasibility of rehabilitation/expansion of sericultural industries and silk enterprise development in the country.

For the last years the primary agricultural production in Greece has been absolutely influenced by the E.U. C.A.P. and directed to crops with the higher subsidizing and the higher mechanization, giving to the farmer opportunities for the easy cultivation of larger areas and higher incomes. This tendency combined with the high international prices of some products for some years lead to the absolute dominance of them, as cotton, wheat durum, tobacco and maize. In areas suitable for such crops, thus good quality irrigated lowland in the cotton zone; sericulture remained out of the interest of farmers even though subsidized adequately, the situation being also negatively affected by the high cost of the initial mulberry field installation, the time overlapping until the first harvest and the high initial cost of rearing facilities. So the any sericultural activity remained actually out of the cotton zone, in areas with lower quality of land and in some areas where some silk processing activities existed, especially by means of small handcrafts industries, where the produced cocoons could be sold locally.

Recently some significant changes appear in the agriculture's scenery which might affect its structure and create some opportunities for sericulture. These changes mainly concentrate to the following points:

- The international prices of cotton steadily fall the last years, something which combined with the increasing cost of inputs to this crop, affects negatively its future.
- Tobacco faces grate problems, either as crop or as processing industry. Its prices continuously fall and its high labor demand makes it very unattractive for the farmer.
- E.U. subsidies for the main country's crops will dramatically decrease after year 2014, according to the new C.A.P., reflecting negatively to their income.
- Tourism seems to gain bigger shares and bigger importance in the national economy, predicting the development and increase of small handcrafts industries.
- The increasing rates of unemployment, due to the economic crisis, direct many people, especially young, to seek various activities for the creation of some income.
- Cocoon production in traditionally leading countries, like China, Korea and India, are steadily falling due to the rapid industrialization of them, the result being the incomplete coverage of their industry's demands for raw cocoons and raw silk. This situation directly

reflects to other silk processing countries, especially those dealing with carpet production and there appears an increasing demand for raw cocoons.

Considering all the above facts in combination it comes out that there could be presumed an opportunity for sericulture's implication in solving some of the existing problems, by means of efficient land and labor use, income sufficiency, rural development and export possibilities. Of course this opportunity should be urgently covered by some central services for an efficient coverage of the cocoon farmers with training, technical support, disease control and besides all cooperative organization for cocoon trade, cocoon reeling, silk processing and silkworm egg provision.

2.7 Current status/level of systems and bases of cocoon and silk production for: Research and development (institutes, contact details)

As mentioned previously in Greece operate very few structures dealing with sericulture, their contacts and activities described below:

1. Komotini Agricultural Research Station, under National Agricultural Research Foundation (NAGREF), Merarhias Serron 18, Komotini 69100, Greece (Tel:00302531022731, email: nagrefk@otenet.gr). This station represents actually the only activated in the field of sericulture institution, being involved in various sericultural research projects. It maintains silkworm and mulberry genetic resources and practices a continuous selection and improvement of its silkworm lines. The recent economic problems of the country reflect to the institution's activities as well and they have been previously described.
2. Agricultural University of Athens, Apiculture and Sericulture department. Iera odos, Athens. This structure deals with basic student training on sericulture, which is a selection, non obligatory lesson, for them.
3. Aristotle University of Thessaloniki, School of Agriculture, Apiculture and Sericulture department, dealing as well with basic student training on sericulture, here as well as a selection, non obligatory lesson.
4. Ministry of Agriculture, Sericultural Laboratory of Athens, Iera odos, Athens. This laboratory, as explained, is hosted by the Apiculture and Sericulture department of the Agricultural University of Athens and directed by the ever head of it. Its responsibility is the hygiene and quality control of the any silkworm eggs used by the cocoon farmers.

2.8 Maintenance of mulberry and silkworm genetic resources, silkworm egg production, area of mulberry plantations

As previously described, the Komotini Agricultural Research Station, under NAGREF, maintains the only existing in the country silkworm and mulberry genetic resources and goes to a continuous selection and improvement of its silkworm lines. This station has the necessary resources, the technology and the knowledge to produce and provide to the Greek cocoon farmers quality and easy available silkworm eggs, but as mentioned it was never officially appointed for this task.

2.9 Number of cocoon farmers, facilities for cocoon and silk processing, silk marketing, internal and external markets, etc

The statistics about cocoon farmers have been described in chapter 2, paragraph 2.1.3. The facilities which are used in silkworm rearing vary from very simple agricultural storage rooms, occasionally used for sericulture, up to modern special installations, realizing two to three progressive rearings per year, providing automatic environment control. Cocking and drying of the cocoons is made either privately by the farmers or by cooperatively operating facilities. Silk processing facilities in the country include adequate and modern twisting, dying and waving facilities, the most of them though remaining closed and inactive due to the general decline of the sector in E.U. and to the running economic crisis of the country.

2.10 Current production levels of fresh cocoon, raw silk, silk fabrics and (kind of) silk final products

The statistics on current production levels of fresh cocoons were given in chapter 2, paragraph 2.1.3 and 2.1.4 and for raw silk and silk fabrics in chapter 2, paragraph 2.4.
Concerning the final products produced in Greece, the main share is held by clothing and household items. Locally in Soufli area are produced, apart the above, various house decoration items and handcrafts, items which attract the interest of many tourists.

2.11 Sericultural science and technology in various fields and steps for cocoon and silk production

Apart from the described in paragraph 2.7 existing scientific structures which deal with sericulture and cover the silkworm rearing's and mulberry cultivation's parts, there aren't existing in the country any other structures specialized in sericultural technology around various field of silk production.

Chapter 3. Major Problems and Issues, and Recommendations

From all the above it comes out that even though Greece has favourable climatic and economical conditions for sericulture development, there are still existing the previously described serious constraints, affecting negatively it, and these presumably are:

- Lack of governmental technical support given by specialized personnel and Institutes
- Lack of sufficient information to the farmer level concerning the benefits of sericulture
- Slow application of modern technology for silkworm rearing and breeding
- Lack of sufficient well established and organized mulberry fields
- Absence of well organized state, cooperative or private mechanisms for the absorption and processing of the produced cocoons
- Absence of any use of own mulberry and silkworm genetic resources
- Absence of relevant technologies and information, on the farmer's level, on effective preventive and successful control of various infectious diseases.

Chapter 4. National strategy for sericulture revival and development in the country

It becomes obvious that all the above described constraints have to be faced through a long term, carefully planed national programming. Under the today formed situation through and the appeared economic crisis, it seems to be more than optimistic to expect such actions and hope sericulture to grow soon in Greece. It is certain that there are some favourable conditions promising a potential for sericulture's development in the country. For sure the next few years will form new frames in the economic reality of Greece and other European countries as well. It is desirable of course to study in advance the formed situation and predict future actions, but this seems today extremely difficult, especially concerning the future of sericulture. There are arising questions very difficult to be answered, like:

- What will be the economic situation for the next years?
- Which will be the changes in the E.U. Common Agricultural Policy?
- Which will be the priorities on national and international level?
- Which will be the energy cost development for the next years?
- Which will be the share of luxury silk products in a world under crisis?

Taking such questions in consideration it is really difficult to speak about national or even European strategies for the sericulture's development. The next few years are going to be very critical, and the only certain thing is that there are going to be realized many big changes in the agricultural, processing and trade reality of many countries. The direction and the magnitude of these changes will create the future of sericulture in tomorrow's Europe.

Chapter 5. Development Strategies

Despite the above described uncertain future of the whole Greek and E.U. agriculture, it has to be admitted that Greece holds the most suitable position in E.U. for sericultural activities, being the southern E.U. member and holding a lot of marginal land, suitable for mulberry cultivation. Besides that the existing and future tourism activities combined with its long tradition in sericulture and silk items production, give the hope for a future role of the Greek sericulture and silk enterprise. Under any circumstances though, the any expected sericulture's development should be followed and supported by some central actions, either governmental or cooperative like:

- Development of governmental technical support mechanisms given by specialized personnel and Institutes
- Support to specialized Institutes in order to provide to the farmer own silkworm and mulberry genetic resources
- Provision of sufficient information upon modern technology for silkworm rearing
- Promotion of the further establishment of organized mulberry fields
- Support of cooperative or private mechanisms for the absorption and processing of the produced cocoons
- Development of mechanisms for the effective preventive and successful control of various infectious diseases.
- Systematic promotion of sericulture's advantages and problems to central E.U. decision centres.
- Development of a detailed and continuously informed data base – most possibly based upon the BACSA efforts – in order to provide continuous and relevant information to people from industry and trait.
- Wide promotion of any sericultural activity, advisably through a periodical published magazine, possibly through BACSA, given in two languages (English and each member country's local language, under the responsibility of each country). This publication could give simultaneously all the relevant technical information around sericulture, in an applied form, easily used by the farmers.
- Active support by all participants to all BACSA activities.

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The National Strategy for the revival and development of Sericulture in Tajikistan

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(ORAL PRESENTATION)

ABSTRACT: The sericulture in the Republic of Tajikistan is a special branch, having deep historical roots, our country is one of the leading countries in Central Asia in the production of cocoons. The 90 years of the XIX century were the beginning of a new period in the development of sericulture in Central Asia, particularly in Tajikistan. Historical information on the export of silk goods from the region claims that the silk fabrics and high quality silk paper made from waste cocoons were exported from Tajikistan in the countries of Central Asia, Afghanistan, Iran, India, the Caucasus, Russia and Europe. In order to improve the indigenous production and business activities of the silk industry according the decision of the Government of the Republic of Tajikistan from 31 January 2001, № 54, and the subsequent decision of the Government of the Republic from April 30, 2004 № 183 "The measures of the further management improvement of the silk industry of the country", the ministry, previously occurring in representations of Agriculture republican

production Enterprise «Pilla» was included to the Ministry of Energy and industry of the Republic. The association includes 59 enterprises engaged in the preparation and initial processing of cocoons, 3 regional associations, including 42 companies in the primary processing of cocoons, two plants for preparation of silkworm eggs, 1 breeding station, two joint ventures for processing cocoons, two auto companies, silk - weaving Mill, as well as Tajik Academy of Agricultural Sciences, Institute of Agriculture Experiment Station operates sericulture. Our country is one of the leading countries in Central Asia in the production of cocoons, which has performed more than 3 thousand tons of fresh cocoons per year. At the same time, unfortunately, in recent years, production of silkworm eggs in the plants and cocoon production decreased. In recent years, for various reasons, mulberry food supply of the sericulture was significantly reduced, leading to a decline in the quality of cocoons and the volume of their production. Domestic industry for processing of cocoons is in a crisis. The main reason for the decline is the lack of production of own silkworm eggs, adapted to the conditions of the republic, lack of sufficient money in processing plants and a lack of interest of the peasants in silkworm rearing.

The biggest harvest of fresh cocoons in the country had been received in 1991, which amounted to 4528 tons. In 2005, production of cocoons was 3244 tons, and in 2012, 1341.5 tons. First of all, there should be a qualitative improvement in mulberry trees, based on the introduction of a high-yielding varieties of mulberry and prospects of expansion of plantations on them. As can be seen from the facts, the average yield of cocoons is not more than 51.6 kg, with each box of silkworm eggs (29 g), respectively, the weight of one of the cocoon is not more than 1.10-1.30 g at the field level. For processing of cocoons in the country there are 67 drying equipment, including SK-150K -38 pieces, CSC-4, 5 - 25 pieces, 4 mechanical desk and 4 Japanese cocoon dryer. Based on our analysis, we believe that the revival of sericulture in Tajikistan in the near future to implement the following:

- **restore the pure breeds and hybrids of silkworm egg production in the station and adjust the industrial production of silkworm eggs in the plants and the first 4-5 years funding should be by the government;**
- **organize a public company for the preparation and processing of cocoons, which will act as the organizer of the industrial processing of silkworm cocoons and mediating between producers. The first 4-5 years of a majority of the company should be the government, and then fully privatized the restoration and establishment of new nurseries for production of mulberry saplings;**
- **create favorable conditions for producers (seedlings, cocoons and raw silk), attracting foreign investors to short-term and medium-term loans.**
- **compliance with technical measures for cultivation and exploitation of mulberry trees, the implementation of measures to protect them from pests;**
- **creation of seeds and the mother of the graft plantations implement various changes: the replacement of low productive varieties to more productive varieties, replacing less productive stands of tall trees line the high productive plantation of mulberry;**
- **restoration and implementation of technical modernization of the base cocoon-processing enterprises;**
- **creation and development of specialized farms on production cocoon and conditions for the development of handicraft production of silk (cocoon production, their winding and production of traditional domestic products of silk);**
- **full implementation of scientifically based program development for the next few years.**

Chapter 1. Introduction

Sericulture in the Republic of Tajikistan is a special branch of which has historical roots, our country is one of the leading countries in Central Asia in the production of cocoons.

Mulberry sericulture and silk processing was one of the oldest occupations of the population, and always has been important to the economy of the region.

It should be noted that in the old Khujand were ancient caravan route from China to the Mediterranean countries - to Greece, Rome, Arabia and Egypt. It was a great "silk road."

Conquest of Central Asia by Russia, the establishment of military and political dominance in the second half of the XIX century. also contributed to the development of scientific research works on the study of resources of the productive forces in the territory occupied by Tajiks. Therefore, at the end of XIX early XX centuries. authors had different specialties, particularly remarkable galaxy of representatives of Russian scientific and technical intelligentsia, has created a huge number of excellent works on silk, the economy, which will eventually become important source. Therefore, some measures taken by the Russian merchants and institutions in order to raise the Central Asian silk. Large proportion of the country's economy was playing silkworm rearing cocoons.

Head of the newly established district of Khujand a colonel of the Russian Army A.A. Kushakevich, said about Khujand: "This is the city of the Central Asian silk. There is a huge number of cocoons, exhausting much silk, woven silk significant number (schai - kanaus), semi-silk fabrics: adras, bikasab etc. In Khujand - the best embroiderers on silk cloth and leather, the best painters, industrial city of Tajiks of the Aryan tribe that once populated the whole of Central Asia and the Persians, this is akin to Tajiks."

With 90 years of the XIX century, the beginning of a new period in the development of sericulture in Central Asia, particularly Tajikistan. Historical information on the export of silk goods from the region claims that the silk fabrics and high quality silk paper made from waste cocoons were exported from Tajikistan in the countries of Central Asia, Afghanistan, Iran, and India, the Caucasus, Russia and Europe .

The comparative advantages of silk emergence and development of its in Tajikistan stuck on the following:

• the historical background, such as the situation on the Silk Road;
• experience and tradition in the education of the silkworm cocoon production and farmers - Sericulture;
• climatic conditions - a better quality of silkworm can be achieved in regions with hot and at the same time, the moderate climate.

In order to improve the indigenous production and business activities of the silk industry according the decision of the Government of the Republic of Tajikistan from 31 January 2001, № 54, and the subsequent decision of the Government of the Republic from April 30, 2004 № 183 "The measures of the further management improvement of the silk industry of the country, the ministry, previously occurring in representations of Agriculture republican production Enterprise «Pilla» was included to the Ministry of Energy and industry of the Republic. Main goals of the republican production of company «Pilla» are:

• coordination of the integrated production process quality of dry cocoons, raw silk and silk threads that are competitive on the world market of fabrics;
• strengthening of the economic and technological relations between enterprises and organizations that are in the ministry to improve the contractual relationship;
• intensification of the process of developing a new agricultural integration and organizational forms of cooperation in the field of sericulture, implementation of common technical and investment policy in the field of modern quality of silkworm eggs and cocoons production technology, silk and silk weaving;
• Attracting foreign investment and the creation of enterprises with foreign investment;
• Market research domestic and foreign markets for the expansion of exports of silk products, competitive increase in the ability of our products to the world market.

The association includes 59 enterprises engaged in the preparation and initial processing of cocoons 3 regional associations, including 42 companies in the primary processing of cocoons, two plant preparation of silkworm eggs, 1 breeding station, two joint ventures for processing cocoons, two auto companies, silk - weaving Mill, as well as Tajik Academy of Agricultural Sciences, Institute of Agriculture Experiment Station operates sericulture.

The main objectives of the experimental station of sericulture are to develop effective methods of breeding, creation of highly productive breeds and hybrids of silkworm breeding of the variety of mulberry tree with high yields and leaf nutrient, development of effective pest and disease mulberry, development of efficient technologies for growing mulberry silkworm cocoons and processing.

Currently, the experimental station of sericulture are 25 scientific and technical staff, including 4 candidates of Agricultural Sciences.

Chapter 2. State sericulture now

As the largest domestic base Central Asia - silk penetrated IV millennium of Eastern Turkestan, initiated this fishery in the Fergana Valley. In the first half of the last millennium, it reached its greatest prosperity in the oases of Bukhara, Khujand and Gisarskoy Valley.

The eminent historian, scholar and hadith collector Abu Sad Samani (1113-1167gg.) In "Kitab al-ansab" said an authoritative collection of scientists, who for several generations in Merv XI-XII century. engaged in the production of silk. So they got the nickname "devakashho" - reeling cocoons.

Our country is one of the leading countries in Central Asia in the production of cocoons, which is more than 3 thousand tons per year. This industry also includes the growing of mulberry silkworm egg production, cocoon production and primary processing.

At the same time, unfortunately, in recent years, production of silkworm eggs in the plants and cocoon production decreased. In recent years, for various reasons, food supply sericulture was significantly reduced, leading to a decline in the quality of cocoons and the volume of their production. Domestic industry for processing of cocoons is in crisis. A demand for the products of silk and silk fabrics from year to year. But now silk processing enterprise of republic in 2008 produced 95 thousand meters of silk fabric, and in 2012 105 thousand meters of fabric.

The main reason for the decline is the lack of production of cocoons of silkworm eggs, adapted to the conditions of the republic, money in processing plants and a lack of interest of the peasants.

The biggest harvest of fresh cocoons in the country had been received in 1991, which amounted to 4528 tons. In 2005, production of cocoons was 3244 tons, and in 2012, 1341.5 tons.

In addition, the production of silkworm eggs in plants decreased.

The main reason for the decline is the lack of production of cocoons of silkworm eggs, adapted to the conditions of the republic, money in processing plants and a lack of interest of the peasants. To exit from this state and increase efficiency of the industry at this stage should be implemented evidence-based decision of the Government of the Republic of Tajikistan on August 30, 2011, № 409 program development and processing of silk cocoons in the Republic of Tajikistan for 2012-2020.

Necessary to develop projects such as the reconstruction of food, the mulberry silkworm, selection of modern technology of cocoon production. This is especially necessary to make reconstruction technology of cultivation of silkworms, which requires solid public support.

The production base of silk in the period from 2008 to 2012 characterized by the following figures:

Table 1
Number of boxes of silkworm reared
in the period 2008-2012 (one box = 29 g)

Regions	Year/unit				
	2008	2009	2010	2011	2012
Sughd region	24547	20486	20800	19500	20000
Khatlon region	23870	20068	19200	14582	14382
Regions of Republican Subordination	5263	4148	4030	3309	3620
Total	53680	44702	43580	37391	38002 38002

Table 2

Production of raw (living) of cocoons for period

2008 - 2012 (in tons).

Regions	Years				
	2008	2009	2010	2011	2012
Sogd	1303.1	917.3	396.4	569.2	636.2
Khatlon	1212.7	756.4	518.8	571.8	560.2
Regions of Republican Subordination	243.2	182.4	162.7	120.3	145.1
Total	2759	1856.1	1077.9	1261.3	1341.5

First of all, there should be a qualitative improvement in forage silk (mulberry trees), based in the introduction of a high-yielding varieties of mulberry and prospects of expansion of plantations on them. Scientists - breeders must keep working hard to create and implement industry-leading high-yield and have a high percentage of silkworm silk shell species and hybrids.

Chapter 3. Strengthening the food supply

Production of quality cocoons depends on the number and quality of mulberry leaves. Efficiency and calorie content of leaves, above all, depends on high-yielding mulberry seeds, agricultural work, and leaves moisture and other elements.

In recent years, for various reasons, food supply sericulture was significantly reduced, leading to a decline in the quality of cocoons and the volume of their production. In the republic to replace the existing trees on the new high-yielding varieties and hybrids of the mulberry tree to 5-10 years.

For further development of sericulture must significantly increase the productivity of mulberry trees by replacing the current low grades and introduction of highly promising varieties and hybrids of mulberry, suitable for feeding the larvae at different times of the year. For this purpose, provided planting mulberry increase from 2,500 to 3,100 units in 2015, and the mother of mulberry plantation area of 80ha to 100 hectares in 2015.

On the basis of the experimental station of sericulture, the programs of the Tajik Academy of Agricultural Sciences conducted research work on selection and acquisition of new varieties of mulberry tree. At the station, there is a 1 hectare plantation mother for seeds and 2 ha collection of 28 promising varieties of mulberry.

Over the last five years as a result of the experiments was obtained as new varieties of mulberry "Sughd-1" and "Sughd-2", high forage and nutritional benefits, which is characterized by the following table:

Table 3

Indicator of yield of mulberry trees

Varieties	Quantity of leaves from 1 tree, kg M±m	percentage	Yield of leaves from 1ha, t/ha
Sughdiyon-1	2.55±0.51	142	12.75
Sughdiyon-2	2.52±0.61	140	12.60
Seedless	2.20±0.25	122	11.00
East	2.40±0.25	133	12.00
Yubileyniy	2.10±0.35	117	10.5
Khasak-tut	1.80±0.06	100	9.0

Table 4

Expense of mulberry leaves to produce 1 kg cocoon

Varieties	Yield cocoon from 1 kg of caterpillar, M±m	%	Yield cocoon from 1 box of caterpillar, M±m	Expense of leaves to produce 1 kg of cocoon, kg	%
Sughdiyon-1	4.2±0.20	110,5	79.8	10.60	81.22
Sughdiyon-2	4.1±0.30	108,	77.9	10.20	78.11
Seedless	4.6±0.44	121,0	87.4	11.05	85.57
East	4.8±0.28	126.6	91.2	11.30	84.60
Yubileyniy	4.4±0.37	116.6	83.6	11.20	83.86
Khasak-tut	3.8±0.81	100	72.2	13.05	100

From Table 3 and 4 obvious that the mulberry variety "Sughdiyon-1" and "Sughdiyon-2" in terms of yield and consumption of leaves to produce 1 kg of cocoon exceed other varieties. In the coming years will be recommended sowing the seeds of these varieties of mulberry. Maternal plantation of mulberry cuttings for plants produced high-yielding varieties. In order to expand the sowing area in 2013 the Experimental Station silk allocated 10 hectares of land.

It is necessary to organize to organize 10 ha of seed orchards of mulberry mother under the leadership of Sericulture Experiment Station, of which 5 hectares in the southern and 5 hectares in the northern areas of Tajikistan. There should be seedlings of high-yielding varieties of mother plantations mulberry, which are present in the collection of silk station ..

According to the program development and processing of silk cocoons of silkworms in the Republic of Tajikistan for 2012 – 2020 are given in the table 5.6.

Table 5

SCOPE

Establishment of mulberry plantations in regions, cities and districts of republican subordination for the 2012-2020 years *

Region	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
On the republic	210	250	290	310	320	330	350	370	382	2812
Sughd region	90	100	110	150	190	200	210	220	230	1500
Khatlon region	70	80	90	100	ПО	420	130	147	158	307
Regions of Republican Subordination (RRS)	20	23	28	30	32	35	41	45,5	52,5	307

(hectare)

Table 6
NUMBER

planting mulberry saplings in regions, cities and RRS for 2012 - 2020 years

(thousands of saplings)

Regions	2012	2913	2014	2015	2016	2017	2018	2019	2020	Total number
On the republic	1204	1236	1239	1252	1282	1291	1311	1323	1352	11490
Sughd region	342	352	352	358	360	365	380	385	405	3299
Khatlon region	758	772	772	775	802	805	810	815	820	7129
RRS	104	112	115	119	120	121	121	123	127	1062

Chapter 4. The development of eggs of the silkworm

With 90 years of the XIX century, begins a new period in the development of sericulture in Central Asia, particular in Khujand. Silkworm eggs were first imported to Central Asia (Tajikistan) in 1889, of 2,000 spools (333 boxes) by French grener (silkworm egg breeder) Aloisi.

In 1892, the first time in Central Asia, in Khujand Aloisi started raising a new breed silkworms. He opened a silkworm egg station to provide the population of high-quality Grenier. And from the end of XIX century in Khujand were breeding work on breeding of local breeds of silkworm. In this case, fruitfully worked Khujand silkworm breeders Mir Salih Zaitbaev and Mirzo Khoja Urunhodzhaev, who were awarded with silver and bronze medals for the development of new high-yield hybrid silkworm eggs of the silkworm and demonstrated at the exhibition of silk in 1900. In 1919 he was put in the public silkworm eggs plant in Khujand. For the first time in the history of the republic, silk processing, created by the Soviet National Farm of Khujand silkworm eggs plant played an important role in the reconstruction and development of the local silk.

In the long term development of sericulture is mainly aimed at the production of high quality cocoons, satisfying the needs and requirements of the international market. First of all, it depends on whether the production of highly productive varieties and hybrids of the silkworm, high-technology production of silkworm eggs, that is, the quantity and quality of produced hybrid silkworm eggs.

In recent years the breed silkworm has changed. At the local level, cultivars and hybrids with low productivity parameters raised. Accordingly, the production of silkworm eggs in the country compared to the 1990-1991 decreased 3.5-4.0 times, and today it is only 10,000-12,000 boxes, ie silkworm egg production of the republic is almost entirely dependent on foreign eggs. Sericulture Experiment Station scientists with Uzbek Research Institute of Sericulture works to improve the selection process, the introduction of new varieties and hybrids, and for a short time, developed more than 20 lines and 2 commercial silkworm hybrids. New hybrids were transferred to the state tests and recreational use.

In light of the resolution, the Government, the Ministry of Energy and Industry of the Republic of Tajikistan has taken measures for the production of new national silkworm hybrids (1 Tajikistan, Tajikistan 2 Khujand 1 and Khujand 2).

Table 7

Биологические показатели, изучаемые линии тутового шелкопряда (2012г.)

Biological indicators of the researching line of the silkworm (2012)

	Line of breed	Liveliness of silkworm eggs in %, M±m	Viability of silkworm in %, M±m
1	Tetrohybride – 3, (control)	91,1+1,62	78,6+1,36
2	Tajikistan-1	96,83+1,06	93,6+2,06
3	Tajikistan-2	96,87+1,08	93,0+1,05
4	Khujand-1	97,49+1,97	93,8+1,95
5	Khujand-2	98,86+1,85	91,4+2,22
6	Khatlon-1	97,79+1,65	91,5+2,06
7	Khatlon-5	97,6+1,66	92,8+2,63
8	Khatlon-7	97,96+2,42	89,8+2,16
9	Khatlon-10	97,97+2,34	88,5+2,08
10	Khatlon-11	98,6+1,08	88,6+1,88
11	Khatlon-12	97,2+1,12	89,3+1,58
12	Khatlon-13	99,16+2,56	85,5+2,05
13	Khatlon-14	97,96+1,89	88,5+1,26
14	Khatlon-15	96,98+1,66	86,5+2,08
15	Khatlon-16	97,86+1,90	90,6+1,86

Economically valuable traits of the new national silkworm hybrids are: liveliness of silkworm eggs, viability, average weight of fresh cocoons shell weight and silk.

Table 8

The indicator of yield of the studied breeds and lines of silkworm (2012)

	Breeds and Line	Weight		
		Cocoon weight, g.M±m	Shell mg of cocoon, M±m	silk в %
1	Tetrohybride – 3, (control)	1,42+0,041	328+8,86	23,09
2	Tajikistan-1	1,74+0,051	415+6,15	24,08
3	Tajikistan-2	1,76+0,061	414+6,25	23,52
4	Khujand-1	1,79+0,032	389,+5,60	21,74
5	Khujand-2	1,74+0,066	391+7,62	22,47
6	Khatlon-1	1,71+0,056	341,+6,62	19,94
7	Khatlon-5	1,78+0,052	377+5,48	19,49
8	Khatlon-7	1,79+0,066	385+6,30	23,60
9	Khatlon-10	1,79+0,078	388+5,65	21,67
10	Khatlon-11	1,75+0,049	422+7,56	24,11
11	Khatlon-12	1,74+0,080	437+5,52	29,11
12	Khatlon-13	1,49+0,062	333+6,20	23,68
13	Khatlon-14	1,35+0,070	300+5,55	23,29
14	Khatlon-15	1,43+0,060	333+6,28	23,29
15	Khatlon-16	1,35+0,068	322+6,92	23,85

Comparative indicators of national hybrid silkworm, Tajikistan 1 -Tajikistan 2 and Khujand 1 - Khujand 2 are given in Table 9.

Table 9

Biological and technological indicators of the line of the silkworm (to control)

	Hybrid	Liveliness of silkworm eggs in %	Viability in %	Cocoon weight in g	Weight of shell in mg
1	Tajikistan 1	+5.7	+15.0	+0.32	+87
2	tajikistan 2	+5.8	+14.4	+0.34	+86
3	Khujand 1	+6.4	+15.2	+0.37	+61
4	Khujand 2	+7.7	+12.8	+0.32	+63

New hybrids transferred to the State test and regional use. In 2011, prepared more than 2,000 boxes (1 box - 29 g) hybrids of Tajikistan 1, Tajikistan 2 varieties for sale.
The introduction of new national hybrids significantly increases the yield of the cocoon, the specific consumption of cocoons, productivity and reduced labor costs for 1 kg. of raw silk.

Table 10

Need for silkworm eggs, according to a forecast in the areas and regions of the Republic of Tajikistan for the years 2012-2020

Regions	2012	2013	2014	2015	2016	2017	2018	2019	2020
On Republic	37200	39060	41000	43040	45180	47990	51220	55300	60000
Sughd region	20000	21000	22040	21220	24300	25520	27560	29760	32290

Khatlon region	14000	14700	15440	16100	17000	17840	19260	20800	22568
Region of Republican Subordination (RRS)	3200	3360	3520	3700	3880	4080	4400	4740	5142

Chapter 5. Increased production of cocoons and introduction of new varieties and breeds

Since silk is still the home as a branch of the economy of the village, where the silkworm raising mainly deals in silkworm farmers in the backyard, which does not fully comply with the requirements for the cultivation of silkworms, hence rules of technology for growing silkworms unwittingly violated and subsequently leads to diseases of caterpillars, larvae mortality during growth, and in the overall reduction of the crop of cocoons and the deterioration of their quality. As can be seen from the facts, the average yield of cocoons is not more than 51.6 kg, with each box of silkworm eggs, respectively, the weight of one of the cocoon is not more than 1.10-1.30 g.

Silkworm breeding should take place in optimum conditions. To maintain the necessary humidity and temperature conditions at the present time to the construction of small premises silk capital type of local materials. We know that in the world market prices and demand for natural silk is constantly increasing. Tajikistan, the second largest in Central Asia after Uzbekistan for the production of cocoons and first per capita (8000000 people) in this area has great potential, as silk is one of the ways to improve the living standards of the population. Environmental conditions are favorable in Tajikistan, with appropriate care for plants can be fodder leaves from spring to late autumn. Repeated cultivation of silkworms are able to give good results for the entire growing season mulberry.

Yield and quality characteristics of cocoon silk fibers, however, depends on many components: species and hybrids adapted to the conditions of the republic, the level of agricultural technology incubation, rearing silkworm cocoons and primary processing.

Currently, the technology of growing silkworms does not ensure the viability of the larvae in the process of growing a large percentage of the death of the silkworm, the lag in their development is observed, which is reflected in the performance and quality of cocoons and silk produced from them.

For processing of cocoons in the country there are 67 drying equipment, including SK-150K -38 pieces, CSC-4, 5 - 25 pieces, 4 mechanical desk and 4 Japanese cocoon dryer. Recently, they occupied only by 45.0-50.0%. Cocoon quality of raw material depends on compliance with the technology of primary processing of cocoons, the conditions of transportation, storage, etc.

Naturally, with long-term operation of existing equipment, while energy-intensive, often fail from a lack of spare parts.

Regulations and guidance documents on silk, cocoon production has greatly improved the quality of produced raw materials. In the absence of national standards body sericulture, Republic uses regulations and standards developed by the former Soviet Union, in 1957, which also prevents the production meeting the requirements of the foreign market.

Work to improve the economic potential of the industry will be implemented at all stages of production from increasing food supply, preparation of cocoons, the industrial processing of cocoons, up to the production of finished textiles and their advertising and promotion in the international market.

One of the main activities of the Ministry of Industry is to attract foreign investment in the industry in general, direct, to increase the processing quality of raw silk, silk weaving enterprise modernization and production of competitive finished products and increased exports.
A package of measures to establish a new joint ventures and modernization of the silk industry by attracting foreign investment will significantly increase the export potential.

Conclusions and recommendations

Thus, a review of the current conditions of sericulture and silk industry of the country shows the presence of large capacity and the necessary conditions for the revival of these sectors in Tajikistan. However, the revival of sericulture in the country opened in the following main reasons:
• lack of local production of highly pure hybrid silkworm eggs
• No pricing policies sericulture and effective economic mechanisms of mutual settlements between producers of eggs of silkworm cocoons and raw silk;
• weakness food supply in the country, due to the non-observance of agricultural activities during the growth and operation of the mulberry trees, the implementation of measures to protect them from pests.
Based on our analysis, we believe that the revival of sericulture in Tajikistan in the near future to implement the following:
• restore the pure breeds and hybrids of silkworm egg production in the station and adjust the industrial production of silkworm eggs in the plants and the first 4-5 years funding should be by the government;
• organize a public company for the preparation and processing of cocoons, which will act as the organizer of the industrial processing of silkworm cocoons and mediating between producers. The first 4-5 years of a majority of the company should be the government, and then fully privatize the restoration and establishment of new nurseries for production of mulberry saplings;
• Create favorable conditions for producers (seedlings, cocoons and raw silk), attracting foreign investors to short-term and medium-term loans.
• compliance with technical measures for cultivation and exploitation of mulberry trees, the implementation of measures to protect them from pests;
• creation of seeds and the mother of the graft plantations implement various changes: the replacement of low productive varieties to more productive varieties, replacing less productive stands of tall trees line the high productive plantation of mulberry;
• restoration and implementation of technical modernization of the base cocoon-processing enterprises;
• creation and development of specialized farms on production cocoon and conditions for the development of handicraft production of silk (cocoon production, their winding and production of traditional domestic products of silk);
• full implementation of scientifically based program development for the next few years.

The sericulture in Turkey

By

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(ORAL PRESENTATION)

In 1970 whole cocoon production has changed to hybrid rearing. Now all hybrid silkworm eggs are supplied by Kozabirlik. Beside the egg production Kozabirlik is working in training, extension, cocoon purchasing, and silk reeling fields.

Cocoon production figures in Turkey:

Year	Number of Of Sericulturist Families	Reared Silk Eggs (Box)	Fresh Cocoon Production (Kgs)
1984	46.341	81.432,00	2.147.137
1990	4.541	80.544,00	2.171.292
1994	12.189	17.953,00	455.594
1998	3.115	4.540,00	127.492
2002	2.356	3.834,50	100.013
2006	2.597	5.698,50	128.944
2009	2.358	5.683,00	139.599
2010	2.183	5.476,50	128.960
2011	2.623	5.808,00	150.646
2012	2.572	5.576,00	133.707

STATUS OF SERICULTURE INDUSTRY, PROBLEMS, ISSUES AND DEVELOPMENT STRATEGIES IN THE CENTRAL ASIAN COUNTRIES: KAZAKHSTAN, KIRGHIZSTAN TAJIKISTAN, TURKMENISTAN AND UZBEKISTAN

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(ORAL PRESENTATION)

ABSTRACT: The great Silk Road has made huge impact on formation of the political, economic, cultural device of the countries through which it passed. Along all its routes, there were large and small trading cities and settlements, and especially spotted caravans ways was Central Asia. History of sericulture in all modern countries of the Central Asia: Kazakhstan, Kirghizstan Tajikistan, Turkmenistan and Uzbekistan originate with V-VI centuries A.D. Basically, development of sericulture in the region has been received in the period of Soviet board. After independence of these countries, it was established a free economic mutual relations which resulted in broken of the consistent economic relations that has led to infringement of activity of many branches and including sericulture industry. Consequently volume production of cocoons in Tajikistan and Uzbekistan has decreased twice, in Turkmenistan the third part of the former total production has been kept only, while in Kazakhstan and Kirghizstan sericulture activity has stopped totally since 2001. The countries made decision to restore and develop agrarian sector and

including silk industry in different times. For example, in 1998 under the government of Uzbekistan, the association named "Uzbek Silk" has been created. In this new structure, all sericulture industry sectors have been united in: production of silkworm eggs, cocoon production, post harvest processing, silk production, finished goods manufacture, marketing and science development. In 2004, Tajikistan under of the Ministry of Industry has been created in association "Tajik Silk", and in Turkmenistan in July 2005 at the Ministry of the textile Industry has been created the Joint-stock company «Turkmen Silk».

In Kazakhstan with support of the government, after restoration of mulberry plantations in the South Kazakhstan province, rearing of silkworm carried out and produce 21.17-23.43 kg/box of cocoons. Though production of cocoon was not enough (hardly 2.50 tons/year) but the fact, that the volume of cocoons production step by step increases.

In Tajikistan almost all population are engaged in sericulture, and 52-55 % of cocoons are produced in the northern part of the country in Sagdian region, while the rest of 35-38 % come from southern part of the country, mainly in Khatlon region. Annually, above 60000 families are engaged in cocoon manufacture. For the season silkworm rearing, farmers are producing 24-28 kg/box fresh cocoons, with of payment 2.7 USD/kg, their income generate 140-160 USD/season.

In Turkmenistan the production plan of fresh cocoons is annually carried out; more than 80 000 farmers are annually occupied in cocoon's production. Each farmer, produces per season rearing around 2.2 boxes of silkworm. Average productivity of cocoons has 23-25,5 kg/box fresh cocoons, (at cost 2.9 USD/kg), therefore farmers can earn income of 153,4-170,0 USD/season.

Uzbekistan enters into the five of the world's largest producers of cocoons. The country produces over 85 % of silk from total volume production among Central Asia the countries. 18 silk processing enterprises, 7 cocoon reeling factories, 5 silk-weaving enterprises operate from different pattern ship and ownership. For satisfaction requirement of enterprise in raw materials, is annually necessary to produce more than 25 000 tons fresh cocoons. Cocoons produce practically in all 14 provinces of the country. During season of silkworm rearing, more than 400 000 farmers were engaged. The yield of cocoons is ranging between 25-28 kg/box. The price of sorted fresh cocoons is 2.5-2.6 USD/kg.

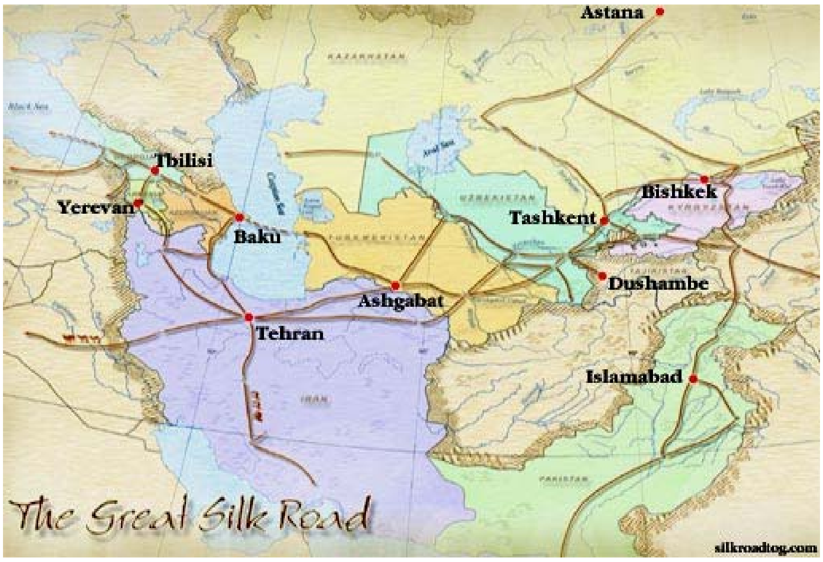
Today the silk industry in the majority of the countries of the Central Asia takes a special place in development of economy, tourism and provides rural population with an additional workplace. Taking into account this priority in the countries for development of sericulture prevented the important role in a context of a state policy of support and stimulation of business in the villages. Usually, the sericulture is the main agrarian activity done in most of Central Asian region. Even though production from this activity was gradually decreased through time, various strategies have been pursued to address on this challenge, and among the major ones consist to revitalizing and boost silk industry. For example: Kirghizstan doesn't put effort on restoring as well as developing the silk branch, although textile industry has huge quantity necessity in raw silk. Thereby, the internal market of silk products is mainly supplied by importation from neighboring countries, especially from China. Concerning Uzbekistan, Tajikistan and Turkmenistan, the ancient sericulture tradition was well kept and continues to develop in better manner. Since cocoon is a cash crop, most Research studies were focused on the introduction of new highly productive mulberry varieties and silkworm hybrids, and promising results were obtained. In turn, there was increase in volume production of silkworm hybrid eggs and cocoons, at the same time cocoon reeling and silk processing factories were modernized, which created new goods assortment from silk.

CHAPTER 1. INTRODUCTION

The Great Silk Road: One of the remarkable achievements of ancient civilizations is considered to be the Great Silk Road. For the first time in human history, it joined countries and peoples from the Mediterranean to the Pacific, has bound their material, artistic and spiritual culture. For many centuries ideas, technology, crafts, beliefs were exchanged on this route.

The onset of the Great Silk Road took place in the second half of the 2nd century BC, when a diplomat Chang Jiang first discovered the countries of Central Asia for Chinese.

The Silk Road had a great influence on the formation of political, economic and cultural order of the countries through which it passed. Along all its routes large and small trading towns were appearing. Especially many caravan routes went through Central Asia. This region was crossed by dozens of trade routes. Important ethnic processes, active interaction of cultures, large-scale commercial operations, diplomatic agreements and military alliances took place here.The people of this region possess an outstanding role in spreading of alphabetic writing and world religions, many cultural and technological developments to the country of Inner Asia and the Far East.



Trends in world silk industry: Silk as a fabric was invented in ancient China and later spread throughout the world through the Great Silk Road, becoming popular among the rich, upper class. Today silk is a luxury, quite affordable to the middle class in Europe and the U.S., and in Asia it continues to play a role of traditional ceremonial dress. Despite this, is the share of silk in the global textile market rather small - less than 0.2%. It is produced in 60 countries of the world. Asian countries are still the main producers (90% mulberry silk and almost 100% of the other types of silk). But recently sericulture started to gather space in Brazil, Bulgaria, Egypt and Madagascar. In China, the silk industry employs about one million workers. Sericulture provides income to seven hundred thousand families in India and twenty thousand in Thailand. China is the biggest producer and supplier of silk to the world markets. India is on the second place. One tenth of the world's silk is produced by Brazil, North Korea, Thailand, Uzbekistan and Vietnam.

Supply of and demand for Raw silk: The five largest producers of raw silk are: China (500 000 for the last 4 years), India (126 000 tons), Uzbekistan (20 200), Brazil (14 000) and Vietnam (13 000).The countries, producing less than 300 tons are: Thailand, North and South Korea, Japan, Iran, Tajikistan, Turkmenistan, Pakistan and Indonesia. Total of 35 to 40 countries are engaged in sericulture. World raw silk production makes an average of 80 000 tons per year, about 70 % from which is being produced in China. In Central Asia, Uzbekistan is the major producer with its share of about 80%.

Recently Food and Agriculture Organization of the United Nations (FAO) has made great efforts on development of Sericulture in Africa and Latin America. Especially successful they were in Brazil and Colombia.

The European Union produces very little raw silk, while the demand for it is very high. Therefore, the European market needs to import raw materials from outside Europe. China is the biggest exporter of textile products. European and American suppliers are experiencing difficulties trying to compete with the low prices and large supplies that China offers. Price of silk on the global market is constantly growing, and in the UK, Italy, France and other European countries sewing companies are switching to synthetic substitutes for silk.

Silk industry in Europe: The European Union and the United States are the largest consumer of silk. Europe plays an important role as a processor and a consumer of silk. Leading countries: France, Germany, Italy, Switzerland and the UK.

Challenges of the silk industry: The problems faced by the silk industry today are:

a) New synthetic fabrics that compete with natural silk: Viscose and Polyester, which are very alike with silk, but are much easier in care, took some market share away from silk.
b) Loss of image silk as a luxury. Non of international commercial campaigns addresses to this issue, which is reflecting the lack of solidarity among suppliers, buyers and sellers in the silk industry.
c) Regional decline - rapidly developing Asian economies were showing an increasing demand for products made of silk, as living conditions were improving.
d) Minimizing of silk production in some countries like Japan and South Korea. As a result, millions of families in rural areas of Asian countries are now faced with a choice - continue to produce silk or not. If farmers decide to switch to a more profitable production, the silk industry is unlikely to be easily restored.
e) Increasing prices for raw silk, especially in China, will strongly affect the price of fabric and processed silk and finished products. As a result, a shift of the demand to replacement products of silk may happen.

For development of the silk industry, next is being offered:

i. Improving the image of silk, positioning it as a product of the highest category, friendly to environment and harmless to health.
ii. The use of silk in medicine, armament, space and interior decoration.
iii. Support of Central Asian countries, as a part of the Asian silk market, as producers, in the light of the problems they are facing today.
iv. Involve European investment for production of cocoons (raw material for silk industry) and modernization of silk processing factories.

CHAPTER 2. REVIEW OF SERICULTURAL STATISTICS 2008 ~ 2012

Previous condition of sericulture in the region

The Silk Road had a great influence on the formation of political, economic and cultural order of the countries through which it passed. Along all its routes large and small trading towns were appearing. Especially many caravan routes went through Central Asia. History of Sericulture on the territories of modern Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan dates back to the V-VI century. Special development of sericulture in the region took place during the period of the Soviet government.

Table 1. Previous condition of sericulture in Central Asia

Countries	Favorable years for sericulture	Number of mulberry and plantations		Production of silkworm eggs, boxes	Production of fresh cocoons, Tons	Productio n of silk yarn, Tons
		Thousand tree	ha			
Kazakhstan	1985	3388	1863	0,000*	248,5	0,00
Kyrgyzstan	1991	7362	2269	43574	854,4	122,0
Tajikistan	1991	54797	47579	156260**	4528,0	550,0

Turkmenistan	1991	56620	41870	178603	3896,8	472,0
Uzbekistan	1991	109964	38116	1500100	33500,0	2564,0

*Kazakhstan imported from Uzbekistan 11632 boxes/year of silkworm eggs.
** Tajikistan imported from Uzbekistan annually about 20% of the total amount of required silkworm eggs.

Depending on the role of sericulture in the national economy, taking into account the climatic conditions and the development of the industry, some countries produced raw material (cocoons), and while the others of were processing it. An example would be Kazakhstan, which did not have any factories for silkworm eggs production, processing of cocoons and production of silk yarn. For production of cocoons silkworm hybrid eggs were imported from Uzbekistan, cocoons reeling silk from Tajikistan, and the further production of finished goods took place in factories in Russia. After independence in these countries, each country has established its own economic relations, which resulted in the destruction of a single economic space. This led to the disruption of many industries, including sericulture. As a result, production of cocoons in Tajikistan and Uzbekistan declined by half, in Turkmenistan retained only one-third of the production, and in Kyrgyzstan and Kazakhstan sericulture, as industry, has ceased to exist since 2001. Countries at different times made decisions to restore and develop the agricultural sector, including the sericulture. For example, in Uzbekistan, the association "Uzbek Silk" was established by the decision of the Cabinet of Ministers in 1998. All sectors of the silk industry were brought in this new structure together: production of silkworm eggs, cocoon production, post harvest processing, silk yarn production, the production of finished goods, marketing, and development of science. In 2004 in Tajikistan by the Ministry of Industry was established the "Tajik Silk" association. And in Turkmenistan in July of 2005 under the Ministry of Textile Industry was created a joint-stock company «Turkmen Silk».

Current condition of sericulture in the region

Today the silk industry in the majority of the countries of the Central Asia plays a special role in economic development, tourism and provides rural population with additional workplaces. Taking into account this priority in the countries, the development of sericulture has an important role in the context of public policy, support and encourage of entrepreneurship in rural areas. Further rise of industry is carried out through increasing of fodder reserves for silkworms. Every year hundreds of thousands of mulberry saplings are grown in special nurseries to create new plantations and planting mulberry on the borders of cotton and other fields, at the same time creating environmental wellbeing. Production of highly productive silkworm hybrid eggs is getting better. Cocoon reeling and silk processing factories are being reconstructed. This will help creating new economic relations on a commercial basis between producers and processors of cocoons. Thus, targeted support to the silk industry from the states will allow to significantly increase harvesting of cocoons and raw silk, opening great opportunities for the development of this ancient industry, which now is being revived. State of sericulture in the region of Central Asia for the period of 2008 – 2012 is estimated as following:

Forage reserves

The quantity and quality of cocoons depends mainly on the quality of silkworms and mulberry leaves. Quality of mulberry leaves depends on mulberry varieties, plantation density, regular maintenance and management of mulberry plantations. Many countries in the region except for Kyrgyzstan continue, or have the intention to develop the ancient tradition of sericulture. To do this, previously deteriorated mulberry plantations are being restored, or new are being layed (table 2).

Table 2. Condition of sericulture forage reserves in the countries of the region 2008-2012

Countries	Number of mulberry trees and plantations (years)									
	2008		2009		2010		2011		2012	
	Number of trees (thousands)	Plantations (thousands ha)	Number of trees (thousands)	Plantations (thousands ha)	Number of trees (thousands)	Plantations (thousands ha)	Number of trees (thousands)	Plantations (thousands ha)	Number of trees (thousands)	Plantations (thousands ha)
Kazakhstan	1752	0,33	1783	0,34	1961	0,36	1971	0,37	2109	0,47
Kyrgyzstan	2454	1,74	1636	1,45	1363	1,21	1239	1,10	-	-
Tajikistan	18776	1,48	18463	1,54	18715	1,60	17200	1,62	16834	1,85
Turkmenistan	22244	2,31	22130	2,50	22089	2,60	19920	2,62	20860	2,73
Uzbekistan	69964	41,1	72163	44,8	72560	48,5	73000	52,0	76000	55,0

After the decision of the Government in 2006 (№ 895) in South ***Kazakhstan*** and Zhambyl region began restoration of mulberry plantations, more than 350,000 linear trees were planted and 140 new mulberry plantations were created.

Tajikistan and ***Turkmenistan*** continue to work on replacement of old, less productive varieties of mulberry by more productive and protect mulberry plantations from diseases and pests. For example, Turkmenistan has imported more mulberry nursery from China and within all provinces were created mulberry nursery plantations for multiplication of new productive mulberry varieties. In Turkmenistan, according to the Presidential Decree from 19th of March 2006, it was commissioned to create 5000 hectares in each region (total 25 000 ha) and plant 20 million mulberry bushes.

In Uzbekistan during 2008-2012 the number of planted mulberry trees was increased by more than 6 million, and mulberry plantation was expanded by 4000 ha. But, unfortunately, in ***Kyrgyzstan*** the collapse of sericulture is continuing: mulberry trees and plantations are ownerless, communities uproot them for firewood.

Production of hybrid silkworm eggs

Another important row material for production of cocoons are silkworm eggs. The hybrid silkworm eggs are usually used for production of industrial cocoons, as their usage in silkworm rearing is considered to be most profitable, in terms of input of forage, labor and at the same time production of high-quality standard cocoons. The majority of Central Asian countries, with exception of Kazakhstan, have modern and well equipped silkworm eggs production factories (table 3):

Table 3. Amount of local production and import of hybrid silkworm eggs

Countries	Year	Used number of silkworm hybrid eggs					
		Local production (Camacho)		Imported		**Total:**	
		Boxes*	Price (Thousand USD)	Boxes	Price (Thousand USD	Boxes	Price (Thousand USD
Kazakhstan	**2008**	0,00	0,00	70	0,364	**70**	**0,364**
	2009	0,00	0,00	90	0,468	**90**	**0,468**
	2010	0,00	0,00	110	0,572	**110**	**0,572**
	2011	0,00	0,00	120	0,624	**120**	**0,624**

	2012	0,00	0,00	120	0,624	**120**	**0,624**
Average price per box:					**5,25 USD**		
Kyrgyzstan	**2008**	0,00	0,00	0,00	0,00	**0,00**	**0,00**
	2009	0,00	0,00	0,00	0,00	**0,00**	**0,00**
	2010	0,00	0,00	0,00	0,00	**0,00**	**0,00**
	2011	0,00	0,00	0,00	0,00	**0,00**	**0,00**
	2012	0,00	0,00	0,00	0,00	**0,00**	**0,00**
Tajikistan	**2008**	33013	100,67	99038	891,34	**132051**	**992,01**
	2009	37512	114,39	96460	868,14	**133972**	**982,53**
	2010	44158	134,65	93835	844,52	**137992**	**979,17**
	2011	30141	91,91	100906	908,15	**131046**	**1000,06**
	2012	31053	94,69	103960	935,64	**135012**	**1030,33**
Average price per box:			**3,05 USD**		**8,95 USD**		
Turkmenistan	**2008**	32436	104,12	147766	1257,49	**180202**	**1361,6**
	2009	41260	132,44	138131	1175,50	**179391**	**1307,9**
	2010	46674	149,82	132841	1130,48	**179515**	**1280,3**
	2011	54965	176,44	116801	993,98	**171766**	**1170,4**
	2012	96976	311,29	82609	703,00	**179585**	**1014,3**
Average price per box:			**3,21 USD**		**8,51 USD**		
Uzbekistan	**2008**	641114	2179,8	345215	2975,8	**986329**	**5155,5**
	2009	662335	2251,9	326224	2812,1	**988559**	**5064,0**
	2010	639651	2174,8	375668	3238,3	**1015319**	**5413,1**
	2011	673761	2290,8	302704	2609,3	**976466**	**4900,1**
	2012	721974	2454,7	267031	2301,8	**989005**	**4756,5**
Average price per box:			**3,47 USD**		**8,64 USD**		

*Usually in these countries, standard box contains 44000 *eggs/box or 29 g, eggs/box, but here calculations are made for 20 000 eggs/box.*

Kazakhstan buys silkworm eggs for the price of 5, 25 USD/box from Uzbekistan. In accordance with the decision of the Government of the Republic from 2006 (№ 895), creation of silkworm eggs production factory is pland for the long term.

In **Kirghizstan,** in Osh province, exists a factory with production capacity of 57050 boxes/year silkworm eggs, but unfortunately it stopped its activity in 2001.

There are two main silkworm production factories in **Tajikistan** to be named: Dushanbe silkworm production factory with capacity of more than 55 000 boxes/year, and Khojent silkworm eggs production factory with capacity 52 000 boxes/year. The existing Experimental Station, in cooperation with the Uzbek Research Institute of Sericulture, created new breeds of silkworm: Tajikistan – 1 and Tajikistan – 2. After their multiplication in Sericulture breeding station, PP materials are transferred to silkworm egg production factories for hybrid eggs production. But there is information that produced cocoons from hybrids with participation of these breeds are not of satisfactory quality according to the requirements of silk industry. Production of camacho silkworm hybrid eggs in Tajikistan has reached around 26,0 % a year, while more than 70 % of the necessary amount of silkworm eggs have been imported from China at the price of 8,95 USD/box.

Turkmenistan has two silkworm production factories: grainage factory Mary with a capacity of more than 65 000 boxes/year and Lebap silkworm hybrid eggs production factory with a capacity of about 60 000 boxes/year. Recently Mary silkworm egg production factory was completely reconstructed. For production of silkworm hybrid eggs the factories are using old and low productive Soviet breeds «Belococoonnay-1» and «Belococoonnay-2», “Turkmenckay-13”, Turkmenckay-16”. With the support of experts from China, PPs are commonly used for producing hybrid eggs. As a result, in 2008 only 18 % of hybrid eggs were produced, an in 2012 silkworm production factories of the country provided 54 % of the required from producers amount of cocoons and the rest (46 %) was imported from China at the price of 8,51 USD/box.

Uzbekistan has the leading silkworm eggs production industry in region, with the following infrastructure: 3 sericulture breeding stations, 14 silkworm hybrid eggs production factories and Sericulture Research Institute. As a whole, grainage capacity of industry in country is more than 13 000 000 boxes of silkworm eggs yearly. Uzbekistan has the richest genetic resources of silkworm maintained and multiplied in Sericulture breeding stations for more than 20 highly productive silkworm breeds. Due to the high yield of the new local silkworm hybrids, each year import of silkworm eggs is reducing. During recent years, purchases of silkworm eggs from China amounted to about 30% of the total amount.

Production of fresh cocoons

Satisfaction of the needs of silk industry in high-quality cocoons, at the same time provide additional working places and income for farmers, expansion of the export potential, are historically the priority problems in the countries of Central Asia. The majority of countries in the Region, along with other arisen difficulties after crash of the Soviet empire, step by step solved also problems of the silk industry by finding new partners for reconstruction of factories, attraction of new technologies and a market for finished goods. Presently, the number of cocoons producers has increased and the production volume of fresh cocoons successfully reached the former one (Tables 4 and 5).

Table 4 Number of farmer/cooperative engaging in production of cocoons

Countries	**Number of producer**				
	2008	**2009**	**2010**	**2011**	**2012**
Kazakhstan	58	75	92	100	102
Kyrgyzstan	0,00	0,00	0,00	0,00	0,00
Tajikistan	59216	60077	61880	58765	60543
Turkmenistan	81835	84374	85778	80331	84120
Uzbekistan	404233	405147	416114	400191	405330

Table 5. Production of fresh cocoons

Countries	**Quantity of produced fresh cocoons (tons)**				
	2008	**2009**	**2010**	**2011**	**2012**
Kazakhstan	1,64	2,07	2,33	2,54	2,67
Kyrgyzstan	0,00	0,00	0,00	0,00	0,00
Tajikistan	3020,0	3124,0	2784,6	1351,6	3118,0
Turkmenistan	4000,0	4038,3	4025,0	4005,3	3865,5
Uzbekistan	23442,7	23972,0	25159	25171,1	25000,0

In Kazakhstan, with the support of the Government, after the restoration of mulberry plantation in South Kazakhstan Province, silkworm rearing was carried out and 21,17-23,43 kg/box cocoons were produced. These results create a possibility of development for sericulture in these provinces. At the same time, creation of an enterprise for cocoon post harvest processing remains unresolved.

Almost the whole population of **Tajikistan** is engaged in sericulture. 52-55 % of cocoons are produced in the northern part of the country, in the Sagdian region, while the rest of 35-38 % come from the southern part of the country, mainly the Khatlon region. Every year more then 60 000 families are engaged in cocoon manufacturing. For one season of silkworm rearing, farmers are producing 24-28 kg/box fresh cocoons, with the payment of 2,7 USD/kg, their income makes 140-160 USD/season. In 2011, yield of fresh cocoons decreased down to 10,3 kg/box, resulting in fulfilling only 43,0 % of the production plan, which means 1351,6 tons of fresh cocoons were produced. This can be explained with unfavorable season of the year for silkworm rearing and bad quality of the imported from China silkworm eggs.

Turkmenistan in 2005, after the establishment of joint-stock company «Turkmen Silk» by the Ministry of Textile Industry, set a goal to reach 4000 tons of production of fresh cocoons, according to which a production plan for the year 2008 was made for regions as follows:

- Akhal region - 210 tons;
- Balkan region - 40 tons;
- Dashoguz region - 1 040 tons;
- Labap region - 1 670 tons;
- Mary region - 1 040 tons.

The production plan of fresh cocoons is fulfilled annually. More than 80 000 farmers are occupied in cocoons production every year. Each farmer produces per rearing season around 2,2 boxes of silkworms. Average productivity of cocoons amounted to 23-25,5 kg/box. At the price of 2,9 USD/kg, every farmer earned in average 153,4-170,0 USD/season.

Uzbekistan is among the five biggest manufacturers of silkworm cocoons. Share of the Republic in the total production of silk in Central Asia is more than 85%. There are 18 silk processing enterprises, 7 cocoon reeling factories, 5 silk-weaving enterprises of different ownership forms. To meet the needs of these enterprises with raw materials, producing more than 25,000 tons of fresh cocoons annually is required. Almost all the 14 provinces of the country are involved in production of cocoons. During each silkworm rearing season more than 400 000 farmers are engaged. The yield of cocoons is ranging between 25-28 kg/box. The Purchase price of sorted fresh cocoons is 2,5-2,6 USD/kg.

Facilities for cocoon post harvest processing and production of finished goods for internal and external markets

The following step after production of fresh cocoons is cocoon post harvest processing, production/processing of silk, production of finished goods and its sale, which demands high quality of processing machinery and the equipment, skilled technical staff, marketing and management. The countries of the region have a strategy of parallel revival of sericulture, necessary increase of volume of fresh cocoons production, and simultaneously development of silk industry, production of goods, competitive on internal and foreign markets, and at the same time increasing export potential of the country (Table 6).

Table 6. Production of silk products in Central Asian countries in 2011

Countries	Dry cocoons		Raw Silk		Production of fabrics		Production of hand graft	
	Tons	Price USD/kg	Tons	Price USD/kg	M^2	Price USD/m^2	Q.ty of assor.t	Total: USD
Kazakhstan	0,902	-	-	-	-	-	-	-
Kyrgyzstan	-	-	-	-	-	-	-	-
Tajikistan	483,00	7,56	153,0	38,23	15 000	7,0	60	2200000
Turkmenistan	1433,40	6,86	453,4	38,88	70375	6,5	65	2627000
Uzbekistan	9012,68	7,10	2123,3	39,52	563 000	5,8	60	4734600

Kazakhstan: in this country sericulture was not developed in the past. Only in two provinces, South Kazakhstan and Jambul, cocoons were produced and at the same time their post harvest processing was carried out. for this purpose were available: 2 units of mechanical device (SK-150K), 5 units of cocoon killing chamber and racks for shadow drying and storage of cocoons. Currently there is no information about the state of facilities for cocoon post harvest processing.

Kirghizstan: Until 2001 it had all industrial bases allowing post harvest processing and reeling of cocoons and even production of finished fabrics. Osh silk factory was processing 1

500 tons of cocoons a year and produce more then 10 million meters of silk fabrics, which were exported to many countries of Europe. The enterprise had the equipment which did not have analogues in Central Asia. Later it has been privatized, and new owners allowed it to derailed. Now, according to the Japanese experts for its restoration and reconstruction more than 5 million USD is necessary.

Tajikistan possesses sufficient infrastructure for cocoon's post harvest processing, cocoon reeling and manufacturing of silk products. In all provinces devices and installations for killing and drying cocoons are available: 12 units of СК-150К, 13 units of КСК-4,5, 7 units of Mechanical Chamber "Simplex". JV "Tajik & Kobool" and "Vietnam Silk" are engaged in the production of raw silk and process 50-60% of produced cocoons and manufacture raw silk for more than 3.5 million USD/year. The rest of cocoons are partly exported to Afghanistan, Pakistan, South Korea, and waste raw silk after reeling of cocoons - to China and India. In 2011 dried cocoons costed 7,56 USD/kg, and income earned was estimated to 3 650 000 USD/year. In manufacturing of finished goods are engaged the next silk processing factories: "Dushanbe Silk", "Tajik atlas" and "Khojand atlas", which annually produce 12000-15000 $м^2$ of silk fabrics. Their products are mainly sold on local market. On "Khojand atlas" manufacturing of silk handcrafts product is well developed. It produces more then 60 000 of different silk fabrics, carpets and traditional products for the sum of more than 2200000 USD/year. Its products are mostly being exported or bought by tourists.

In Turkmenistan cocoons are being processed by the Joint-stock company «Turkmen Silk», which includes five is regional silk associations, Ashkhabad silk reeling factory, Turkmenabat silk production association and new Ruhabat textile complex in Ahal province. Regional silk associations are engaged in the organization production of cocoons and their post harvest processing. For this purposes they possess corresponding devices and installations for killing and drying cocoons: 18 units of СК-150К, 17 units of КСК-4,5, 12 units of Mechanical Chamber "Simplex". Dry cocoons are produced for around 10 millions USD/year. Cocoons are reeled at silk factories, which were recently (2003) completely reconstructed. Automated lines of Chinese production and other imported equipment with computer monitoring systems, which provide production of threads of world quality, are used in workshops for production of silk yarn. Production capacity of Turkmenabat (formerly Chardzhou) Silk production association is more than 300 tons of raw silk and 160 tons of silk yarn a year. Turkmenabat association is one of the largest manufacturers of silk yarn in the region. 2,4 million USD were spent for reconstruction of the Ashkhabad silk reeling factory. Its capacity reached processing of 500 tons of dry cocoons, and production of 160 tons of high-quality silk. Starting from October 2008 started working an ultramodern, supplied with latest equipment and advanced technology, company, producing new kinds of silk fabrics like panne, built in the Ruhabat district of Akhal province. It has to be mentioned that all the equipment of the new factories of the complex - more than 200 units of the hi-tech textile equipment from the best European manufacturers - meets the highest requirements for manufacturing of certificated and competitive in the world market products. Through introduction of newest technologies and advanced achievements in weaving, dyeing and finishing of textiles, the Ruhabat textile complex is for today one of the first enterprises of such this sort on the territory of the NIS countries. Today the products of the factory, more than 40 types of panne fabric, and also products from it, can be purchased in the Shopping centre "Altin asir" in the capital of the country. Mostly (90 %) of made raw silk (for approximately 2 000 000 USD/year) is processed by factories of the silk industry of the Republic to more then 65 various silk goods and handcrafted product (carpets, materials, a product and others) for a total amount of 2 627 000 USD/year. The rest about 10 % (around 1800 000 USD/year) of the produced raw silk is being exported to China.

Uzbekistan: As a result of the taken measures today in Uzbekistan a quality resource base is established. Annually are 23-25 thousands of fresh cocoons are being produced. For their post harvest processing there are more than 550 different equipments and machines: 415 units of СК-150К, 51 units of КСК-4,5, 8 units of mechanical chamber, 8 units of imported equipment, 55 units of cocoon killing chamber "Simplex" and 9 units of steam cocoon killing chamber. For further processing there are 36 large silk interprises in the Republic, 18 of which are silk processing enterprises, 7 cocoon reeling factories and 5 weaving factories. Except these, there are also joint ventures, which deal with processing of silk waste, with participation of the companies from Japan, South Korea, China, such as: “Tonmen”, “Khadan”, “Nurbajahu”. In cooperation with the Japanese company “Marubaky” and “Kanebo” in Namangan is existing a joint silk-spinning enterprise “Silk Road”, with volume of production of 150 tons of high quality and competitive products a year. 18 million USD were spent for its technological re-equipment. The joint Uzbek-American enterprises “Silver Silk” with the newest technologies have been created in the cities of Tashkent and Fergana. Their production volume can reach 80 tons of silk yarn and 200 tons of raw silk a year. In January 2012, Uzbek-Chinese joint venture “InterSilkPro”, which is equipped with modern technologies, started its activity in Termez. These enterprises have together a production capacity of more than 2 000 tons of raw silk a year. Capacity of the four weaving factories, equipped with Russian and Indian equipment makes 500 000 m^2 of silk fabrics a year. Four factories are producing acryl and silk carpets. The enterprises of silk industry are completely modernized. Now silk is being produced using equipment and technology of the leading Japanese, Italian and German companies. Due to this competitive silk products are being exported to Italy, Switzerland, Japan, China, India, Singapore and other countries of the world. In last years, the volume of export achieved more than 8 million USD annually. It means that the most of made products are exported with high added value, because of great demand for the products on the world market.

CHAPTER 3. MAJOR PROBLEMS FOR REVIVAL AND DEVELOPMENT OF SERICULTURE IN THE COUNTRIES OF CENTRAL ASIA. RECOMMENDATIONS.

After gaining independence, each country of the region has chosen individual approach for its economic development, and thereby adjusted partnership with the different countries of the world. On this basis, problems have arisen, which hold the development of sericulture back. They can be divided to internal, regional and external.

Internal problems

- Absence of governmental policy and investments for revival and development of traditional sericulture in the countries. For example, the present government of Kirghizstan does not undertake any actions for revival of sericulture, while in Kazakhstan, in 2005, a decision about revival of sericulture has been accepted by the government. On this basis mulberry plantations have been partially restored, about 200 hectares of plantations were created. Some of the problems remain unsolved, such as increase of cocoons production, cocoon post harvest processing, production of raw silk and marketing.
- Providing independence of each country in highly productive hybrid silkworm eggs. Silkworm eggs production in Tajikistan, Turkmenistan and Uzbekistan provides only 55-70 % of the needed fort he silk industry amount of hybrid silkworm eggs, the rest has to be imported from China. Research studies on nurture of new silkworm breeds, selection and breeding of silkworms in these countries are being very passive.
- It is necessary to regulate price of fresh and dry cocoons for stimulation of farmers. Sericulture farmers are not satisfied with the prices for fresh cocoons (2,5-2,9 USD/kg). Suppliers, in turn, are not satisfied with low prices for dry cocoons (6,8-7,5 USD/kg), which is offered to them by processing factories.
- The high price of energy resources (gas, electricity and fuel), taxes and the low sale price of finished goods on home market.

Regional problems

The major constraint consists in the fact that commercial relations and cooperation in science, technology and training are being absent. An example of this might be:

a) Spreading of especially dangerous pest, namely: *Glyphodis pylailis Walker* on mulberry plantations of Tajikistan and Uzbekistan. Its damage for each country can be counted in hundred thousands dollars a year, but, unfortunately, no common prevention measures are being undertaken. As a consequence, pest can freely spread on mulberry plantations from one neighboring country to the other.
b) Loss of traditional technology of silk handcrafted products: different materials, carpets and other traditional products of the region.

Problems with external partners

Partners of Central Asian countries are: China, India, South Korea and Japan, but China is the main one. Partners are mostly using them as a source of raw materials: dry cocoons, raw silk, waste after cocoon reeling, which are being purchased at low prices. In exchange, they sell them at higher price silkworm hybrid eggs of bad quality, machineries and equipment.

Recommendations:

Based on the higher stated problems, the following is recommended for revival and development of sericulture in each country of the region and for establishment of partnerships between them:

- In countries where sericulture has declined (Kirghizstan) or is not developing on the appropriate level (Kazakhstan), it is necessary that government of these countries take decisions and control the revival and development process of the sericulture industry, using internal potential, strengthening technical opportunities of research institutes, improving professional skills of experts, modernizations of silk enterprises, etc.;
- Creation of regional sericulture association for exchange of scientific knowledge, organization of trainings for improvement of professional skills, introduction of advanced technology, directed to restore and develop silk industry in the region;
- Creation of a regional scientific program for exchange of genetic resources; nurturing new highly productive mulberry varieties and silkworm breeds, which are resistant of diseases; produce highly yielding silkworm hybrid eggs and protection of mulberry plantations against diseases and pests;
- Development of relations between the countries of the region on export, import and exchange of planting materials, silkworm PP, silkworm hybrid eggs, technology, etc.
- Establishment of inter-governmental partnership and attraction of possibilities of financial support, directed on restoration and development of silk industry in the region.

CHAPTER 4. NATIONAL STRATEGIES FOR REVIVAL AND DEVELOPMENT OF SERICULTURE IN THE COUNTRIES OF CENTRAL ASIA

Sericulture has always been one of the main branches of agriculture in the region of Central Asia. Even though production in this branch was gradually decreasing through time, various strategies have been pursued to address this problem. One of the main ones consists in revitalizing and boosting the silk industry. But some of the countries, like, for example, Kirghizstan do not put enough effort on restoration and development of the silk branch, although its textile industry has a great demand for raw silk. The internal market is mainly supplied by import from neighboring countries, mostly from China. Concerning Uzbekistan, Tajikistan and Turkmenistan, the ancient sericulture tradition was well kept and continues to develop there. Since cocoon is a cash crop, the most research studies were focused on development of new highly productive mulberry varieties and silkworm hybrids, which led to promising results. In turn, there was increase in production volume of hybrid silkworm eggs and cocoons, at the same time cocoon reeling and silk processing factories were modernized, which created new assortment of goods made of silk.

Table 7. Long-term plan on preservation and increase of forage reserves in the region

Countries	Number of new plantings of mulberry trees and plantations (years)									
	2013		2014		2015		2016		2017	
	Number of trees (thousands)	Plantations (ha)	Number of trees (thousands)	Plantations (ha)	Number of trees (thousands)	Plantations (ha)	Number of trees (thousands)	Plantations (ha)	Number of trees (thousands)	Plantations (ha)
Kazakhstan	70,0	27	214	30	157	35	180	30	190	30
Kyrgyzstan	-	-		-		-		-		-
Tajikistan	1126	180	1290	200	2059	250	2060	300	1010	300
Turkmenistan	1112	350	1990	380	1980	400	2390	500	1870	500
Uzbekistan	4890	420	9380	450	9430	450	10220	520	8360	550

Table 8. Purchase and internal production plan for hybrid silkworm eggs in the region for 2013 - 2017

Countries	Production volume of silkworm hybrid eggs (thousand boxes/years)									
	2013		2014		2015		2016		2017	
	Commercial	Imported	Commercial	Imported	Commercial	Imported	Commercial	Imported	Commercial	Imported
Kazakhstan	-	0,15	-	0,25	-	0,30	-	0,40	-	0,80
Total:	**0,150**		**0,250**		**0,300**		**0,400**		**0,800**	
Kyrgyzstan	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Total:	**0,00**		**0,00**		**0,00**		**0,00**		**0,00**	
Tajikistan	40	95	50	90	60	85	67	82	95	60
Total:	**135,0**		**140,0**		**145,0**		**149,0**		**155,0**	
Turkmenistan	55	100	70	100	80	90	100	70	135	35
Total:	**155,0**		**170,0**		**170,0**		**170,0**		**170,0**	
Uzbekistan	695	295	795	225	920	160	980	110	1154	0,00
Total:	**990,0**		**1020,0**		**1080,0**		**1090,0**		**1155,0**	

Table 9. Production plan for fresh cocoons in countries of the region for 2013 - 2017

Countries	Quantity of produced fresh cocoons (tons/years)				
	2013	2014	2015	2016	2017
Kazakhstan	3,40	5,75	6,90	9,20	18,50
Kyrgyzstan	0,00	0,00	0,00	0,00	0,00
Tajikistan	3250,0	3400,0	3550,0	3650,0	3800,0
Turkmenistan	3900,0	4000,0	4010,0	4010,0	4010,0
Uzbekistan	26200,0	27000,0	27900,0	28900,0	30000,0

Table 10. Production plan for Raw Silk in Central Asian countries

Countries	Quantity of produced Raw silk and Silk waste (tons/years)									
	2013		2014		2015		2016		2017	
	Raw Silk	Silk Waste	Raw Silk	Silk Waste	Raw Silk	Silk Waste	Raw Silk	Silk Waste	Raw Silk	Silk Waste
Kazakhstan	0,3	0,1	0,5	0,2	0,6	0,2	0,8	0,3	1,5	0,6
Kyrgyzstan	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Tajikistan	268	107	280	112	291	116	300	120	312	125
Turkmenistan	320	128	328	131	330	132	330	132	329	132
Uzbekistan	2150	860	2217	887	2290	916	2375	950	2465	985

All countries, except for Kirghizstan, plan to increase production volume of sericulture industry.

Kazakhstan: Textile and clothing industry cover only 10 % of total needs of internal market, while the internal production should satisfy not less then 30% of the demand in order to ensure economic safety of the country. Kazakh production of natural silk and synthetic fiber is presently inexistent. Textile enterprises manufacture fabrics mostly for industrial use, nonwoven fabrics, carpets, and other textile products, using synthetic and artificial yarns and fibers.

In Kazakhstan, the potential capacity of the market of fabrics can be estimated to 841.8 million sq. m. The capacities of the market by type of fabric are following:

- Cotton fabrics - 590,6 million m^2;
- Woolen fabrics – 47,8 million m^2;
- Silk fabrics - 145,0 million m^2;
- Linen fabrics - 58,3 million m^2;

In order to solve these problems, the government of the Republic of Kazakhstan accepted a decision №895, on 21.09.2006 (with changes according to the conditions № 2305, on 30.12.2009), about establishment of new programs for development of textile industry and increasing its competitiveness, thereby allowing to create conditions for Kazakhstan to become one of the fifty most competitive countries on the world market.

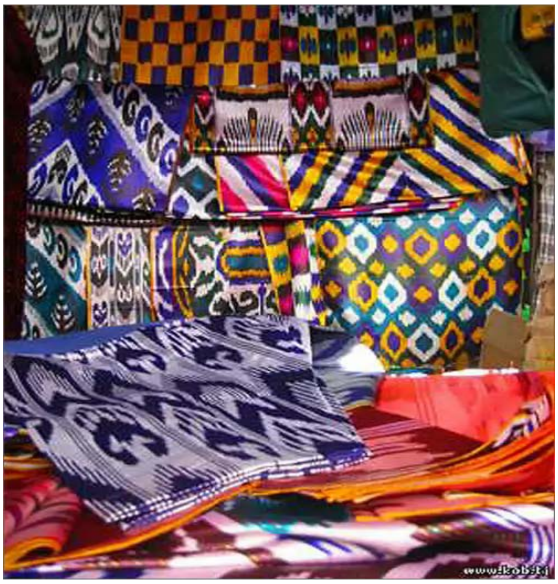
The main objectives of the program are:

- Construction of supply utilities to promote an efficient use of resources (electricity, gas, water) by textile companies;
- Construction and reconstruction of communications infrastructure (roads, railways, telephone networks);
- Presentations and other marketing activities to introduce potential investors to the opportunities and benefits of the Free Economic Zone (FEZ);
- Determining the criteria for selecting investment projects, meeting the objectives of the creation of FEZ;
- Providing construction of vertically integrated, high-tech and export-oriented production in the FEZ;
- Promote the advancement of domestic textile goods produced in the FEZ, to the world market;
- Implementation of measures to support the textile enterprises in the FEZ;
- Organize capacity building system and improve skills of administration and technical staff.

The governors of South Kazakhstan and Zhambyl provinces were instructed for implementing this program, to prepare a proposal of research program for the revival and development of sericulture to the Ministry of Agriculture For the program, and the Ministry of Finance is providing the necessary budget.

In the southern Kazakhstan, where climatic and soil conditions are favorable, new productive mulberry plantation was established on an area of about 500 ha. For the purposes of increasing mulberry trees, it is planned for the period of 2013-2017, to renew 70 000 to 190 000 old mulberry trees, located along roads and around fields. In addition, more than 120 ha mulberry plantation will be created in order to produce 20 tons of fresh cocoons. Scientists will carry out research studies through selective breeding for creating more adapted mulberry varieties and silkworm breeds to the local environmental conditions. Additionally, various publications shall be prepared for increasing awareness about role of sericulture in generating new employments and improvement of economic conditions of rural farmers. Training of farmers and cooperatives will by organized on the basis of LTD “A.L.M.” and “YUZNPTSSKH”.

For Tajikistan, where mountains cover more than 90% of the country, agriculture and industry are an integral part of the economy and on their rational development and progress depends solution of social problems and ensuring the standard of living of the people. The industry of Tajikistan is represented in more than 80 types. The main priority industries are: mining, light industry, production of construction materials. In the agricultural sector, high-quality sorts of cotton and cocoons are grown, which provides further development of processing, cotton, silk and textile industry, traditional national-art crafts. The Ministry of Industry coordinates the industrial policy in the country, irrespective of forms of ownership, and performs and unites the whole industrial complex. More than 20 companies are engaged in foreign trade activities in the light industry: JV “Tajik&Kobool”, JV “Javony”, the JV “VT Silk”, “Dushanbe Silk”, “Khojand atlas”, etc. They export: cotton yarn and fabrics, garments, cocoons, raw silk and so on. The volume of export of these enterprises is only 13,7 % from the total production of the country. Besides, it is necessary to notice that enterprises export up to 50-60 % raw materials, and the rest as finished goods. As adopted by the Government of the Republic of Tajikistan, the Programme for development of light industry (2005), the Programme for complete processing of cotton fiber (2007), the Program for complete processing of animal raw materials (leather and wool) (2008) and the Program for production of goods for children (2009), put the task of progressive development of light industry until 2015.For providing reliability of the programs, measures have to be undertaken on improvement of investment conditions, in particular, for attraction of capital investments for building new enterprises, through establishment of some tax and customs preferences. On cocoon reeling factories are mainly installed machines of old Soviet and Japanese models, which have already used up their resources. It is known that the modern market demands goods of high quality. According to the information, provided by the Manager of the Silk Industry Department at the Ministry of Industry, these days the government plans to address the problem of modernization of cocoon reeling factories for full processing of cocoons and raw silk waste (up to 90%) and production of finished products to meet the needs of the domestic market and increase export potential. The beginning of modernization of factories is planned for 2014-2015. For this purposes, a modernization project and investment plans are being prepared. In order to further increase production of cocoons for, full satisfaction of the needs of silk industry for qualitative raw materials of own production, and for fulfilling the national economy



Program for 2006-2015 and further, the Ministry of Agriculture together with the Ministry of Industry prepared a long-term development plan for silk industry:

- Establish new mulberry plantations from highly productive varieties of mulberry tree, supply farmers with organic and mineral fertilizers and regularly protect mulberry plantations against diseases and pests.
- The Tajik Academy of Agriculture with its experimental station will work on development of new highly productive and disease resistant varieties of mulberry and silkworm, which meet the needs of the silk industry.
- Association "Tajik Silk" together with the regional management undertake all efforts in order to achieve production level of 4000 tons of fresh cocoons a year till 2015.
- The Ministry of Industry, cocoon and silk processing enterprises have to develop a modernization plan for processing of cocoons and production of high quality silk, and step by step achieve the complete processing of the wastes of the silk industry, manufacture finished goods, as well as increase national export potential.
- Forage reserves for the rearing of silkworms must be constantly renewed, otherwise the harvest of leaves reduces. In Tajikistan, due to the fact that about 17 million mulberry trees are located on the sides of roads and fields, they are not regularly fertilized, and hence become vulnerable against diseases and pests (especially *Glyphodis pylailis Walker*). An annual updating old linear mulberry plantings is planned with a goal of renewal of more than 8 million trees. Therefore, about 1500 hectares of mulberry plantations will be established, using new highly productive sorts and hybrids mulberry tree.

Academy of Agriculture possesses an experimental station for carrying out research activities in the field of Sericulture. There are 2 hectares with more than 25 various mulberry tree sorts and genetic resources, consisting of 17 silkworm breeds. Selection and breeding are carried out with a goal of development of new mulberry varieties and silkworm breeds, adapted to local environmental conditions and at the same time improvement of silkworm rearing technology. Farmers and agriculturists are taught the technologies of mulberry cultivation, maintenance and management. Scientists of this station, in collaboration with Uzbek researchers, have developed some adapted mulberry varieties and silkworm breeds, which are presently being tested. The Silkworm breeding station, situated in village Vahda, near the capital, is manufacturing P_1 - P_3 silkworm eggs for production of commercial hybrid eggs. It is planned to reduce step-by-step the import of silkworm eggs from China down to 30-35 % by 2015. According to the long-term plan on increasing production fresh cocoons, it is planned to reach 4000,0 tons by 2017 (table 5). At the same time, employment potential will be raised, which could help farmers financially. More than 60 000 families will be occupied in silkworm rearing and thus will earn 200 USD per season. After post harvest proceeding of cocoons, the volume of dry cocoons makes about 1450 tons. Their weaving processing on factories will result in about 300 tons of raw silk and about 130 tons of silk waste (table 6). With adjustment of silk waste processing and manufacturing of finished goods, the profit of silk industry will make more than 7-8 million USD a year. This will result in creation of more than 20000 – 25000 constant workplaces, which are being needed at the present unemployment rate in the country.

Turkmenistan: Sericulture is one of the most ancient national crafts of Turkmenistan. Throughout centuries, national tradition was passing from generation to generation, and had kept up to date secrets of manufacturing magnificent carpets from silk.

Presently, the silk industry of Turkmenistan is experiencing transformations in all manufacturing steps – from mulberry cultivation and silk worm rearing up to production of raw silk and finished goods. Developments of trade and textile industry, and also production of carpets and individual business, are the main concerns of the government. The country has assigned to the heads of competent departments to increase the export volume of produced goods, considerably expand economic relations with foreign partners, carry out modernization and reconstruction of the out-of-date capacities of textile industry. In conformity with it, for the last 10 years the following a cocoon reeling and silk processing factories have been modernized and reconstructed:

- Industrial silk association Turkmenabat (the former Chardzhou) with capacity of 300 tons of raw silk and 160 tons of silk yarn a year;
- Ashkhabad cocoon reeling factory with a capacity of processing 500 tons cocoons, and producing 160 tons of high-quality silk;
- Textile complex "Ruhobat" possess all the machines of the new complex of factories (more than 200 units of hi-tech textile equipment from the best European manufacturers), which meet the highest standard for production of certificated and competitive products for the world market.

The textile complex "Ruhobat" is designed to produce 20.3 million square meters of gray fabric products and 40 million square meters of high-quality dyed fabrics. Greater economy of raw materials is provided by own spinning factory for production of blended yarn from cotton and polyester fibers, the annual demand for which amounts to 3642 tons.

During the years of independence in the reconstruction and modernization of existing textile enterprises were invested over one billion 650 million USD, of which the share of foreign investment was 300 million USD, or 18 percent. Behind these figures are thousands of jobs, dozens of buildings of new factories, their innovative equipment and advanced technology to produce high-quality, competitive on the world market goods. In favor of the competitive advantages of Turkmen textiles played not only the enterprises, but also the closure process chain "raw materials - finished goods" within a few large industrial structures of the emerging textile cluster.

Achievement of complex development of Turkmenistan economy is directed by diversification of textile industry and production of new sorts of products. In general, it is planned to introduce into industrial structure of the country about 200 new small, medium and large enterprises to the existing production, which will not only reduce imports but also to expand the range of exported goods. It has to be mentioned, that at the meeting, held on the 20th of December by the Cabinet of Ministers of Turkmenistan, the President paid special attention to the further development of the sericulture industry and and its basis – silk production industry, strengthening its raw-materials base by approving production plans for cocoons in 2013 in all provinces.The President of the Republic said, that sericulture is one of the most ancient national crafts of the Turkmens, in which the people have reached great skill and perfection. And our purpose, having continued national traditions of domestic sericulture, to bring it on a modern level, using advanced achievements of science. We have all the needed resources for this. To date does not decrease the popularity of the country's national silk "keteni", from which in the old days was sewn traditional Turkmen clothing, and today silk is widely in demand of the fashion industry. The demand and price for it is growing on the world market. Thus, the textile sector of economy of Turkmenistan, having provided requirements of home market for necessary production, and successfully realizing a problem of replacement of import textile products with products of own manufacturing, continues to increase the export possibilities. Overall, in the branch of light industry and the trade sector, there has been a shift away from mass production to expansion of assortment through flexible manufacturing technologies.

Based on the above, the Government, together with the governors of the regions, for the execution of the program for the sector of textile industry and trade of Turkmenistan for 2012-2016, developed a long-term plan for production of cocoons during this period, according to which at least 4,000 tons of live cocoons must be produced each year. For example, in 2013 the Ministry of Textile Industry and the governors of the regions are instructed to ensure production of live cocoons in the amount of 3900 tons (table 9):

Akhal region - 210 tons;
Balkan region - 40 tons;
Dashogus region- 1 035 tons;
Labap region - 1 650 tons;
Mary region - 1 010 tons.

Along with this it is planned to expand forage reserves, using high-yielding varieties and hybrids of mulberry, create annually 350-500 ha of new mulberry plantations and increase the production of hybrid silkworm eggs to the required volume (170 000 boxes / year).

In Turkmenistan, there is no special research institute dedicated to solving problems of sericulture and silk industry. As reported by the association "Turkmen Silk", scientific issues are solved by agricultural institutes and other educational institutions and research institutes. There is no information concerning the existence of genetic resources of mulberry tree and silkworms.

Future strategy of Turkmenistan's textile industry, along with the rapid development of textile production, includes the formation of its own fashion industry, with participation of famous foreign designers, evolve a national school of modeling and design with an emphasis on creative interpretation of national art and decorative traditions. Turkmenistan is historically a leader in production of carpets in the region. In the last years the need for production of giant carpets has increased dramatically. Turkmen masters succeeded in this monumental work, as evidenced by the fact that the Turkmen carpets entered the Guinness World Records as the largest handmade canvas. The government is taking all necessary measures for preservation and development of national hand craft carpets production through increasing the status and prestige of the handcraft masters, creating the best conditions for their work, building nationwide new carpet factories and widely promoting national carpet makers abroad. In nearest future, it is planned to produce more than 50,000 square meters of carpet products a year.

Uzbekistan: For years, Uzbekistan's economy and textile industry, including silk, was characterized by orientation on production of raw materials. The national economy was based exclusively on cotton cultivation. After gaining independence economic and structural reforms led to development of the silk industry of Uzbekistan in two directions: modernization of the entire production cycle in with a goal of deep processing of raw materials and manufacturing of ready products with high added value and expansion of export for competitive silk products. According to the governmental joint-stock company "Uzbek textile Industry", in recent years Uzbekistan produces 8500-9000 tons of dry cocoons a year, of which 2.1-2.2 thousand tons of raw silk. Usually in the process of raw material processing remain up to 2 thousand tons of silk waste a year. Earlier only 4% of the total waste was processed and the rest was exported. According to calculations, under the condition that the total volume of silk waste is being processed, a profit of 64 million USD a year can be made. At the present time Uzbekistan takes the third place in the world in production of cocoons, after China and India, it is the fifth largest producer of raw silk and the eighth in silk production per capita. On the world market, especially in South-East Asia, the demand for the products from silk is growing, contributing to an increasing development of silk industry. In this regard, the most important problem in the silk industry is the full utilization of silk waste. To do this, Uzbekistan jointly with China, created a JV "Khualu", which has a production capacity of 120 tons of silk waste per year. In the future, to make full use of raw silk, will be developed new projects for the processing of silk waste. In Namangan and Ferghana regions factories are already being built together with the Japanese Co LTD “Murabeky” for processing silk waste using the latest technologies. As a result of implementation of the recycling program overall production capacity of raw silk will be increased by 50-60% and will reach about 2500 tons. Accelerated development of the silk industry is planned not only through attraction of foreign investments, but also increase of the share of finished products in the industry and their export to the world market. The development of silk industry is not possible without production of cocoons. Within the framework of the program “On the priorities of industrial development in the Republic of Uzbekistan in 2011-2015” was underlined the need to increase production of cocoons to meets the needs of silk industry. In conformity with this program the Ministry of Agriculture planned to increase the volume of production of fresh cocoons. In 2015 there will be 28 000 tons of fresh cocoons produced, and in 2017 the production of will be increased up to 30 000 tons. For this purpose, by the initiative of agrarian sector, silk industry, public and political organizations the association of cocoon and silk fabric producers “Uzbekistan Ipagi” has been recaptured. According to the strategies of the Association, the given structure will serve to further development of the sphere, forage reserve strengthening and development of new mulberry varieties and silkworm breeds, which shall provide production of silk yarn which meets the international standards. This will provide opportunities to sell silk threads on the basis of modern market principles, raise volumes of processing and export, prepare qualified experts, protect interests of workers in the sphere on the new qualitative level. Regional and local authorities are entrusted to carry out management and maintenance of mulberry plantings and to enlarge plantation area, with the use of highly productive varieties and hybrids of mulberry. Silkworm eggs factories will increase production volume of hybrid silkworm eggs, whereby the required amount for satisfaction of the needs of cocoon producers will be reached by 2017. The principal goals of development of silk industry in long terms consist in increasing of export potential, promotion of domestic silk production to foreign markets, as well as carrying out marketing researches. Prospects of development of the silk industry in Uzbekistan depend on the following factors:

- High density of population in the regions and labor intensity of silk industry, which allows to solve the problem of unemployment;
- The consumer factor, which has a great influence on development and placement of enterprises practically in all regions providing satisfaction of needs of the population in silk products;
- Presence of demand for silk threads and fabrics for other purposes, such as medicine (surgery), military and great demand for silk products on the world market;
- Favorable climatic conditions for production of high-quality and cheap cocoons for the industry.

Export is a powerful stimulating factor of economic growth for development of production silk goods, new technologies, markets for goods of the silk branch. The enterprises of the silk industry of Uzbekistan have a possibility to deliver on foreign markets cocoons, silk threads, yarn, fabrics, etc.

Uzbekistan is the only country in region with a developed technical and scientific base for sericulture and silk industry:

- Uzbek Sericulture Research Institute deals with scientific solutions to problems of sericulture. It, while having more than 350 kinds of genetic varieties and 220 breeds and genetic lines of silkworm, is engaged in selection with a purpose of producing new high-yielding varieties of mulberry and silkworm breeds, develops technologies against pests, diseases and post harvest processing of cocoons, silk product certification, educates and improves professional skills.

- The Tashkent State Agrarian University offers 18 bachelor programs and 38 master programs in all areas of agricultural Studies, including Sericulture.
- In Tashkent Institute of Textile and Light Industry, 3500 students are studying on 6 faculties. It offers 11 bachelor programs and 25 master programs in the field of processing of cotton, silk etc. in the textile, light and printing industry, including silk industry.

CHAPTER 5. DEVELOPMENT STRATEGIES

Development strategies and active cooperation are necessary for revival of sericulture and development of the silk industry in the region of Central Asia. For this purpose, based on the information above, the following is offered:

Short-term proposals:

- The International Association BACSA should prepare an appeal to the governments of its member states to establish a regional intergovernmental committee for reconstruction and development of sericulture and silk industry in the countries of Central Asia.
- Establishment of a regional work shop to discuss the problems of sericulture and silk industry, creation of a regional association of scientists and experts to address emerging regional issues.
- Creation of a regional fund for revival and development of sericulture, silk industry and handcrafting in Central Asia.

Medium-term proposals:

- Create an information centre, which will be responsible for analyzing, exchange of arisen problems and decision-making in the countries of the region, carrying out common research, and exchange of results, realization of mutual services.
- Creation of a regional centre, which would reunite scientists and experts for exchange of experience, advanced technology, promoting an exchange of genetic resources, development of a common program on breeding of new highly productive silkworm and mulberry breeds and hybrids, protection of mulberry tree plantations from pests and diseases.
- Creation of breeding centers for producing industrial silkworm hybrids, carrying out of tests with the purpose of revealing the most adapted hybrids, which would be economically profitable to breed in different regions.
- Creation of training centers for improvement of professional skills of experts silk and common standardization system for silk industry products originated from the Central Asian countries.
- Exchange experience of experts in revival and development of silk handicraft products.
- Attract european and international investors and donors for rehabilitation and development of sericulture and silk industry in the countries of Central Asia with the mediation of BACSA.
- Establishment and expansion of trade and economic relations between the Central Asian and the European members of BACSA.

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STATE OF THE ART AND PROSPECTS OF DEVELOPMENT SERICULTURE IN UZBEKISTAN

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(ORAL PRESENTATION)

ABSTRACT: Uzbekistan sericulture has its more than 3500 years history, original ways of its development, revival and progress. The Republic of Uzbekistan is a dry country in Central Asia with continental climate. Less than 10% of its territory is intensively cultivated, irrigated land in river valleys and oases. Total area - 447,400 km^2. Population - 2012 estimate 29,559,100.

Sericulture of the Republic of Uzbekistan due to rainless and hot summer is based on year single spring cycle of cocoon production.

Uzbekistan historically was formed as favorable region for productive manufacture of cocoons, raw silk and silky goods taking into account climatic conditions, hard-working and educated population, well developed scientific and technical potential.

Uzbekistan after collapse of the USSR integrated in international community became fast develop. Certainly there are temporary growing difficulties during reorganization period and due to economic crisis. Initially observed fall (till 18-20 thousands Mt in 2000-2005) gave way to partial recovery of cocoons production (till 25 thousands Mt in 2010-2012) because of correct investment policy (more than 10 Orders and Decrees of the President and government of Uzbekistan). Last Order of the Cabinet of Ministries (December 2012) is particularly significant. It was given a directive to build in agricultural regions specialized factories for centralized silkworm rearing of 50-100 boxes of eggs with present day facilities and service comlexes for operating personnel.

In Uzbekistan R&D works directed on development of improved sorts of mulberry trees, breed and hybrid of silkworm for spring season, on a strains and hybrids and methods of their breeding oriented for silkworm rearing in summer and autumn seasons, on improvement of pedigree work, on reconstruction of egg production and centralization of rearing technology, on biocontrol methods of mulberry pest management, on utilization of unused today resources of moriculture and sericulture, on rational use of silk material for manufacturing of new goods, especially with application of biotechnology approaches are continued.

Now Uzbekistan ranks N8 on silk fabric production per capita after France, Italy, England, Japan, China, USA and Germany, N5 on raw-silk production after China, Japan, South Korea and India, N3 in the world on volumes of cocoons production after China and India. Its share on silk production in the CIS states makes up over 85%.

Chapter 1. Introduction.

Uzbekistan sericulture has its long-standing history, distinctive development, rather fast period of development particularly during last 100 years and supports scientific search for ways of its intensification and progress. Being located at the middle of the Great Silk Road between East and West Central Asia's inhabitants not only manufactured and sold its original silk and other goods but also absorbed last achievements of silky craft and culture generally. Because of these such cities as Shash (Tashkent), Samarkand, Bukhara, Khiva, Karshi, Shakhrisabs, Termez, Kokand, Margilan, Fergana, Andijan and others started to develop on the Silk Road very fast as well as outstanding encyclopedists and historical persons such as Al-Khorezmi, Al-Farobi, Abu Ali ibn Sino (Avicenna), Al-Beruni, Al-Fargoni, Timurlang, Ulugbek, Navoi, Bobur and others appeared and glorified on this land.

Being a monophagous insect mulberry silkworm *Bombyx mori* L. as opposed to other agricultural animals burst into the history of agriculture together with its fodder plant – mulberry tree *Morus alba* L. As a result of human activity these both biological species presenting bases of sericulture were significantly changed in comparison with their wild species. So sericulture can be refer to traditional biotechnological manufactures along with crop growing, livestock farming, bread baking, cheese and vine making and other similar ancient manufactures.

It will be noted that importance of these species for mankind are connected not only with sericulture. They are considered as efficient producers of renewable plant and animal organic raw material for food and pharmaceutical industries, as highly sensitive biosensors in life-science and environment screening as well as outstanding candidates capable to provide human life in the space and at alien settlements of astronauts.

In spite of achievements in mulberry growing, sericulture and mechanization of the branch, silk production traditionally remains a season cottage industry depending on skill of individual farmers, on climatic conditions, on diseases and pests of mulberry trees and mulberry silkworm.

To correct understand present-day situation and not simple development of this branch in our country it is necessary to look back to history of beginning, survival and development of sericulture by the example on present-day territory of Central Asia and in particular of Uzbekistan.

Sericulture in Central Asian region was spread by Chinese quite early (about 2000 b.c.). But endless wars had as after-effect almost total liquidation of this craft which was preserved only in Merv oasis. In 1785 Bukharian khan Shamuratbeck captured almost all population of Merv and settled them near Bukhara and Khatyrchi. They were engaged in sericulture and silk processing and taught sericulture to other habitant of Bukhara from where sericulture was spread in Turkestan again.

Development of whole sericulture branch got serious impulse when in 1865 Turkestan joined to Russian empire. A new branch of industry arisen with creation of silkworm eggs breeding stations. This branch lead out Russia on the third place in the world by production of high-quality and healthy silkworm eggs. Generally in Turkestan by 1917 a silk industry was on the third place among other branches of industries. Later a sericulture got intensive development already at Soviet period. From these examples it can be seen how wisdom of some historical persons and correct the state politics could lead both to preservation and acceleration of industrial production. This is important for revival of sericulture in states which recently lost this branch having favor ecological and socio-economical condition.

So Uzbekistan historically was formed as favorable region for productive manufacture of cocoons, raw silk and silky goods taking into account climatic conditions, hard-working and educated population, well developed scientific and technical potential. Scientific Council on coordination of all R & D in the former USSR was at SANIISH – Middle Asian Scientific Research Institute of Sericulture formed in 1927 in Tashkent. Academicians Astaurov B.L. and Strunnikov V.A., professors Slonim M.I., Efraimson V.A., Belyaev N.K., Poyarkov E.F., Mikhailov E.N., Nasirillaev U.N. and many other scientists worked and made their discoveries here. Their followers continue these and develop modern directions in Uzbekistan. Contribution of these scientists to Uzbek and World sericulture is well known. They promoted to development, preservation and revival of genetics and selection work and to training of highly qualified professionals. Sericulture in Uzbekistan in those years had a great importance both civil and defense branch.

Uzbekistan after collapse of the USSR integrated in international community became fast develop. Certainly there are temporary growing difficulties during reorganization period and due to economic crisis. Initially observed fall (till 18-20 thousands Mt in 2000-2005) gave way to partial recovery of cocoons production (till 25 thousands Mt in 2010-2012) because of correct investment policy (more then 10 Orders and Decrees of the President and government of Uzbekistan). Last Order of the Cabinet of Ministries (December 2012) is particularly significant. It was given a directive to build in agricultural regions 196 specialized factories for centralized silkworm rearing of 50-100 boxes of eggs with present day facilities for operating personnel.

In Uzbekistan scientific R&D works directed on improvement of sorts of mulberry trees, breeds and hybrids of silkworm for spring season, on development of strains and hybrids and methods of their breeding oriented for silkworm rearing in summer and autumn seasons, on improvement of pedigree work, on reconstruction of egg production and centralization of rearing technology, on biocontrol methods of mulberry pest management, on utilization of unused today resources of mori- and sericulture for manufacturing of new goods, especially with application of biotechnologies are continued.

Thereby at present the Republic succeeds to get a yield in 25 thousands tons in spite of temporary difficulties. Forward-looking and reasonable state and international politics of investments to the silk industry will allow get and increase before reorganization level of cocoons and raw silk production, to expand silk products assortment including high-tech products relatively soon.

Chapter 2. Present Situation in Sericulture of Uzbekistan (Summary Review).

Uzbekistan is a dry, doubly landlocked country in Central Asia. Less than 10% of its territory is intensively cultivated irrigated land in river valleys and oases. The rest is vast desert (Kyzyl Kum) and mountains. It shares borders with Kazakhstan to the west and to the north, Kyrgyzstan and Tajikistan to the east, and Afghanistan and Turkmenistan to the south. Before 1991, it was part of the Soviet Union.

Area - Total 447,400 km^2. 172,742 sq mi - Water (%) - 4.9.

Population - 2012 estimate 29,559,100 - Density 61.4/km^2.

The climate in the Republic of Uzbekistan is continental, with little precipitation expected annually (100–200 millimeters, or 3.9–7.9 inches). The average summer high temperature tends to be 40°C (104°F), while the average winter low temperature is around −23°C (−9°F).

Sericulture of the Republic of Uzbekistan due to rainless and hot summer is based on year single spring cycle of cocoon production.

Situation in Sericulture 1984 - 2005 of Uzbekistan in country report of Ist BACSA conference more fully described. Here we give a last cited data.

Uzbekistan ranks N8 on silk fabric production per capita after France, Italy, England, Japan, China, USA and Germany, N5 on raw-silk production after China, Japan, South Korea and India, N3 in the world on volumes of production cocoons after China and India. Its share on silk production in the CIS states makes up over 85%. At present there are 36 large silk enterprises in Uzbekistan. Among them are 18 silk processing enterprises, 7 filatures, 5 silk weaving manufactures. In 2010 Uzbekistan exported silk production for more than $8million (according to data of State Statistic Committee).

Joint ventures with Japan, South Korea and China companies on processing of silk wastes are working in silk industry (“Tonmen”, “Hadan”, “Nurbajahu”). Silk enterprise “Silk Road” (Joint venture with “Marubeni” and “Canebo” – Japan) works in Namangan region. Production volume is 150 Mt of high quality and competitive production per year. Joint Uzbek-American enterprise «Silver-Silk» with high-tech was created in Tashkent and in Fergana valley. Their production volume is 80 Mt of silk yarn and 200 Mt of raw silk per year.

In the future it is necessary to develop new projects for processing of silk wastes with view of total utilization of raw silk. In Namangan and Fergana regions factories for processing of silk wastes by new technologies are under construction together with Japan Company “Marubeni”. This experience need to spread and in other regions of the Republic which are specialized on manufacture of silk production. Overall productive capacities on raw silk will be increased on 50% and will rich 1,515 Mt per year including 1,000 Mt of top grade silk yarn as a result of fulfillment of wastes processing program.

According to data of State Stock Company (Uzbek Light Industry) at present Uzbekistan produces annually 22-25 thousand Mt of cocoons, of which 2.1-2.2 thousand Mt raw silk. Up to 2 thousand Mt of silk wastes annually remain after processing of raw material. Only 7-8 Mt are reprocessed by silk reeling factories. Remaining wastes are for sale to other countries. Price of 1kg of silk yarn at world market is $32. Calculations show that upon condition of reprocessing of all volume of silk wastes could be obtained profit in $64 million. In this connection total utilization of silk wastes is the most important problem in silk industry.

It is expected that Uzbekistan will increase capacities on production of raw silk by 50% by 2011, which is envisaged in the investment programme for 2005-2011. It is planned to implement 16 projects for US$20 million. Total capacities on production of raw silk will reach 1,515 Mt, including 1,000 Mt of 2A and 3A grades.

Decree of the President of the Republic of Uzbekistan № ПП-512 dated November 15, 2006. - “On measures for further reforming of silk industry of the Republic” is the main document of management for Uzbekistan sericulturists. The Decree is directed to further deepening of economical reforms in field of sericulture, to creation of favourable conditions for attraction of foreign investments to silk industry of the Republic, for modernization and creation new manufactures, to increase volume and expand assortment of final products competitive at world market.

According to data of Ministry of Agriculture and Water Resources of the Republic of Uzbekistan in 2010 there were reared 455,328 boxes of mulberry silkworm larvae in the Republic, obtained 25,159.5 Mt of alive cocoons. Yield of cocoons from each box of mulberry silkworm larvae in average was 55.3kg. It is on 1.7kg more than previous year.

In 2011 there were reared 437,877 boxes of mulberry silkworm larvae in the Republic, obtained 25,171.1 Mt of alive cocoons. Yield of cocoons from each box of mulberry silkworm larvae in average was 57.5kg. It is on 2.2kg more than previous year.

Attention which the President and the Government of the Republic of Uzbekistan pay to development of sericulture is the base for positive changing in Uzbekistan sericulture.

Thus in 2012 sericulturists of Uzbekistan prepared more than 25 thousands Mt of cocoons. In 2012 average price for cocoons was increased on 20% for the purpose of financial stimulation, and 30% of foreseen yield cost were paid in advance. This season, 44 thousand farmers in Uzbekistan produced 443,500 boxes of silkworm eggs and obtained from each in average 57 kg of yield. The bulk of the harvest was of top-grade. In 2012 as a result of the implementation of activities aimed at the full saturation of the internal market with high-quality domestic products it is observed an increase in the volume of production January-July of the previous year silk industry by 19,9%.

The Government of Uzbekistan places a great emphasis on attraction of foreign investments. At present there are a number of Joint Ventures on mulberry silkworm growing and silk processing in the Republic.

As a result of assumed measures in the Republic a number of farmers who create own mulberry tree plantations and develop this branch grows from year to year. For example in Jizakh region private company “Jizakh-Kukhinur” arranged enterprise with annual silk yarn production and processing capacity about 350-400 tones per year.

For example a new vertically integrated silk complex is due in Namangan. The new facility will be created on the base of Vodiy Ipagi LLC. In 2012-2016, a Singaporean company Verigrow Pte. Ltd. is investing not less than $10 million in the project, including $5 million in the first three years. By the end of 2012 the complex is planned to produce 240 tons of raw silk and 2 million square meters of silk fabrics a year. Over 80% of output will be exported. After reaching its full capacity the company will create 700 new jobs. Verigrow Rte. Ltd. also plans to create specialized mulberry plantations on 200 hectares of land allocated by Namangan regional administration. In 2012-2014, the Ministry of Agriculture and Water Resources of Uzbekistan will supply the new company with not less than 400 tons of dry cocoons annually for the production of raw silk. In turn, silk reeling enterprises of the Republic will sell its silk threads for hard currency at a price not lower than the world ones at a zero VAT rate, provided that not less than 80% of products will be exported.

Vodiy Ipagi Industrial Park specializing in the silk production will be created in Uzbekistan. According to Uzdaily.com, this is the first project of this scale in this industry. The industrial park will carry out the full silk production cycle: from cultivation of mulberry trees to the finished tissue. Approximately $10 million will be invested in the complete modernization of the industrial park till 2015. As a result, Vodiy Ipagi will be able to process up to 240 tons of silk yarn and produce 2 million meters of silk a year. At full production capacity, exports of finished products will be about $9 million.

In end of 2012 a new Association of Sericulturists and Silk Fabrics Manufacturers” named “Uzbekiston Ipaqi” (“Uzbekistan Silk”) was founded. The Ministry of Agriculture and Water Resources, state joint-stock company “Uzbekengilsanoat”, Uzbek Research Institute of Sericulture, Tashkent Institute of Textile and Light Industry, “Forum of social responsible sitizens of Uzbekistan”, sericultural enterprises, non-state organization organizations and business structures are founders of the Association.

Foundation of the Association of Sericulturists and Silk Fabrics Manufacturers “Uzbekiston Ipaqi” will serve to further development of branch of cocoons growing and processing, to strengthening of fodder base, to creation of new silk sort, to provision of matching of silk thread quality to requirements of international standards. This will give opportunity to sell silk thread on base of present-day market principles, to increase volumes of its processing and export, to prepare qualified specialists, to rise work on protection of interests of workers of the branch to brand-new level**.**

“O’zpaxtasanoat” Association started realization of unique project on development of sericulture cluster in zone of ecological catastrophe of Subaral – in Karakalpakstan. Total cost of the project exceeds 7.7 bln soums, 800 mln soums are already spent. Five processing enterprises will build with necessary infrastructure and will arrange process of mulberry silkworm cocoons growing. Specialized rearing centers will be built in 12 settlements together with trading-social and service complexes. 60 ha of land were allocated for mulberry plantations. Special working group will visit China and Vietnam with aim to increase efficiency of the project.

Last 5 years in April-May Innovation exhibitions are held in Tashkent. Achievements in different fields of science, technology, agriculture and local industry including sericulture are demonstrated on these exhibitions.

Uzbekistan widely promotes own silk fabrics at different international exhibitions and presentations. For example on October 31, 2012 London hosted an exhibition of Uzbek silk. Visitors could learn the history, techniques and modern trends in the production and use of silk, particularly ikat, that enjoys a growing popularity in Europe.

Every October Art Week Style.uz is held at Tashkent. It is the most high-profile cultural event in Central Asia which is aimed to develop modern and traditional Uzbek fashion and art. National Dress Festival is among these events. Gests can see different kinds of Uzbek silk here. Among those who have attended previous Art Weeks were representatives of fashion houses from Italy: Valentino, Brioni, MaxMara, Salvatore Ferragamo, Domenico Vacca. National dress festivals are regular held in Uzbekistan were local designers show their original models.

Every year there are international exhibitions where Uzbek silk and sericulture products are represented. For example this year we have two exhibitions:

1. AgroExpo Uzbekistan 2013, Date: 14-16-MAY-13. City: Tashkent. 2nd international specialized exhibition "Agricultural machinery. Agricultural products" - "AgroExpo Uzbekistan 2013", Venue: Uzexpocentre, Site of the organizer: www.zarexpo.com
2. Textile Expo Uzbekistan 2013. Date: 11-SEP-13 to 13-SEP-13. City: Tashkent. 10th Central Asian International Specialized Exhibition - "Textile Expo Uzbekistan 2013". Venue: Uzexpocentre. Site of the organizer: www.ite-uzbekistan.uz.

Chapter 3. Major Problems, Issues and Recommendations

As it was pointed out in Chapters 1 and 2 - definite successes in creation of fodder base along with production of eggs of zoned industrial silkworm breeds and hybrids have been achieved. However local sorts of mulberry trees as well as developed silkworm germ-plasm products fall behind the best foreign analogues due to differences in strategy of gene-selection works, their purposeful direction during Soviet period. To correct this Uzbekistan scientists genetic - selectioners after collapse of the USSR charted a course toward approaching of local sorts of mulberry trees, silkworm breeds and hybrids to the best world samples by parameters of productivity and quality using scientific experience and potential of scientists.

Recently in the URIS Ph.D. and Dr. Sc. dissertations on top questions of moriculture, sericulture, its mechanization, on protection of mulberry trees against pests and diseases, on physiology, biochemistry and biotechnology of silkworm feeding and development, resource-energy saving and rational use of silk in prospecting directions including biomedical, bio- and nanotechnological, in creation of NEMS и MEMS products were defended. Developed artificial diet provides full cycle of development of monophage – mulberry silkworm regardless of year season and geography, including in the space. Mulberry pyralid biocontrol methods will make a contribution to ecological science and practice of the Republic. The artificial diet was tested at the Institute of Biology of Development (Moscow), in International space experiment on pilotless Earth satellite “Bion-10”. Realization of new technology demands to create silkworm industrial rearing Centers under regional silk stations of the Republic. The artificial diet for tropical sericulture of Malaysia has been developed on the basis of local raw material. The advanced technology for obtaining of acidic and enzymatic fibroin hydrolyzates and matrix forms of bioactive substances on the base of fibroin has been created. Biotechnological utilization of silk wastes will expand products assortment. So we are open in these fields for cooperation in frames of international scientific-technical foundations. We hope that BACSA will promote such cooperation.

Moreover it is necessary integrated and rational utilization of all products, semiproducts and wastes of sericulture and silk processing using present-day scientific and technical achievements for the branch to be commercially viable. It is especially important when we have rather high percent of grade-out and defective cocoons due to technology imperfection. From the other hand mulberry stems, pupae, waste waters (sericin is up to 25%) and also wastes to which we do not pay attention: larvae and pupae cuticles and excrements have not proper application. Also it is necessary to pay attention to functional sericulture which became developed in leading countries last 15-20 years (Japan, Korea).

Recent jubilee conference “Top problems of sericulture and their scientific-technological solutions” devoted to 85-th anniversary of URIS was directed to definition of problems in moriculture and silk technology, to possible ways of their solution in order to increase commercial viability of the branch. For example geneticists and plant breeders introduced prospective sorts and hybrids of mulberry (see Tables 1 and 2 in Appendix). A new hybrid rising generation (Topcross - 2, Topcross -3 and Uzbekistan) was 100-% whole-leave at all stages of plants development. The generation was characterized by powerful growth and phenotypic uniformity of features. It is close to recognized varieties by commercially valuable characteristics.

It is seen from table 1 data that productivity of Topcross - 2, Topcross - 3 and Uzbekistan higher than productivity of control hybrid. Cocoons output from 1 ha of Topcross-2 hybrid is 103.1%, Topcross-3 hybrid is 85.1%, Uzbekistan hybrid is 84.8% - higher than at control hybrid. The recognized varieties provide average till 8-9 centner of alive cocoons per hectare of plantation with planting scheme 4.0 x 0.5 m due to high integrifolious ability and better nutritive properties of leaves. Less consumption of leaves for obtaining of 1 kg of alive cocoons is one of advantage of graded mulberry tree.

The recommendations for creation of bush mulberry plantations were developed. Also it is pointed out to importance of mulberry selection in development of sericulture in Uzbekistan under new conditions.

URIS Departments of silkworm genetics & selection and silkworm pedigree developed specified mulberry silkworm breeds, lines and hybrids with important biological and technological characteristics of cocoons which are better than control ones (Table 3). Hybrids Ipakchi 1 x Ipakchi 2, Ipakchi 2 x Ipakchi 1 are fed in industrial sericulture of Uzbekistan in huge scale (volume). Part of these hybrids in country’s cocoons gross yield is 60%. Original breeds Ipakchi 1 and Ipakchi 2 are designed by methods of synthetic selection with participation of parthenogenetic clones. Cocoons of Ipakchi 1 breed have round shape, Ipakchi 2 breed – lengthened shape with soft interception, cocoons of hybrids have lenghthened shape. Eggs both breeds and hybrids are dark gray with green cast. Larvae of Ipakchi 1 x Ipakchi 2 and Ipakchi 2 x Ipakchi 1 hybrids develop uniformly and simultaneously go for reeling. Vitality of larvae is 93.0-94.2%. Shell ratio achieves 25.7-26.2% at cocoon mass 1.91-1.99g. Hybrid’s cocoon thread has special fineness 3120-335 m/g, hybrid’s cocoons have good unreeling ability – 88.2-90.44%. These characteristics of the hybrids are important for textile industry.

Researches on development of new sufficiently simple effective methods for selection of pedigree material by silkworm cocoons technological characteristics are carried out by Laboratory of pedigree of the Uzbek Research Institute of Sericulture.

Method of cocoons reeling with alive pupae in enzymes solutions is developed. These solutions do not show negative effect on vitality of pupae and fertility of appeared moths while process of threads reeling performs easy and fast. Use of such method at first stages of selection would allow to carry out correct analysis of pedigree cocoons by technological characteristics and in huge volumes and to speed up selection process in such a way.

A great phenotypic variability (C_v=12.5-18.3%) and sufficiently high degree of heritability (h^2 =0.313) of cocoon shells granularity (amount of buttons per 1cm^2) were found out at study of genetic bases for selection of pedigree material in populations of prospecting breeds and lines. This proves possibility of efficient selection by easily determined morphological characteristics - cocoons granularity.

Technological characteristics testing method by cocoon shells granularity was developed on the base of determined close positive correlation interrelationships between granularity and leading technological characteristics of cocoons (r=0.63 - 0.944).

Practical application of simple and efficient method of selection of pedigree material by granularity of silk shell would provide increasing of qualitative cocoons characteristics both in selection process and at final stages of pedigree works with breeds.

Breeders perform selection of cocoons with average mass in the process of pedigree work to preserve cocoons mass native to propagated breed. In such a case selected cocoons caliber has special interest.

Study of nine breeds and selection lines showed: 1) a bigger variability of cocoons caliber with close mass; 2) a negative interrelation of caliber with basic technological characteristics: with raw silk output (r = - 0.992), reeling ability (r = - 0.978), length and fineness of cocoon thread (r = - 0.990; r = - 0.999).

Method of selection of compact cocoons (cocoons with average mass and light caliber) was developed on the base of negative correlation. This method promotes increasing of cocoons technological characteristics.

At present the abovementioned methods are used for breeding of new high-yielding controllable by sex breeds and breeds with improved technological properties of cocoons. New industrial hybrids are created on their base.

Exceptionally male new hybrids have definite value. They have cocoon mass on general level due to increased heterosis ability. But they differ by high rates of silk-bearing ability, technological characteristics: raw silk output 48.7%, reeling ability 85.9%, length of silk thread 1,433m, metric number 3,521 m/g.

Pure male form new hybrids would provide sufficient high yield of cocoons and silk and correspondingly incomes of farmers sericulturists in industrial conditions.

A problem of control of serious mulberry tree pest – *Glyphodes pyloalis* Wlk. is particularly topical. Intensified control of the pest by chemical insecticides affects entomophages rather than target insect, causing greater propagation of mulberry pyralid and other pests and, as a whole, damages not only mulberry plantations, but also cotton growing due to territorial closeness of the cultures.

Last years we developed methods of biological control of this pest which are save for environment, animal and human beings. Practical measures in the control of mulberry pyralid must become the following: reduction of use of chemical insecticides affecting useful entomofauna, use of biocontrol agents produced on biofactory (bracon and golden-eyed lacewings), as well as make the conditions for attraction and propagation of other active entomophages of mulberry pyralid: ladybirds, spiders, ants, hornets, wasps, others hymenopterans and some dipterans.

Weighty alternative to chemical insecticides can become baculovirul preparations – wild and recombinant with group specificity, for example *Autographa californica* affecting mulberry pyralid and do not affect mulberry silkworm. Besides, some bacterial, fungal and nematode preparations can be used after cocoons seasonal harvest (end of a may in Uzbekistan). But virulence of used strain in any form completely have to disappear under the affect of biotic and abiotic factors before the following season of silkworm feeding in sericulture. Their use is possible together with "botanical" insecticides, as well as with some chemicals whose mode of their action is safe for animal and man.

For full liquidation of the pest it is necessary to use total, destructive actions after cold winters significantly reducing its population.

Thereby problems appeared with broad spreading of the serious pest of the mulberry - mulberry pyralid *Glyphodes pyloalis* Walker can be solved by extensive integrated control with preferential use of natural agents in combination with eco-friendly preparations, with land treatment and favorable meteorological conditions.

It will be noted the works on new direction – creation breeds and hybrids and also breeding technology in summer and autumn periods that significantly increases of cocoons production in future, on development effective technologies of grains preparation for repeated worm rearing, on search a way of cultivation of cocoons with high metric number of the thread.

Questions of resource saving in silk industry with use of biotechnological approaches were discussed at the Conference. Such developments are directed to rational utilization and wastelessness of silk production in total and other branches of local industry with simultaneous widening an assortment of silk goods including for pharmaceutical and food industry as well as for biotechnology and high-tech (see also presentations of Madyarov Sh.R. and Madyarov Sh.R. and Khamraev A.Sh. in these proceedings).

A series of papers are dedicated to improving of methods and devices for cocoon processing, to mechanization of processes cocoons separation by sex, to creation register of silkworm breeds, lines and hybrids by resistance to polyhedrosis and pebrine diseases. New shuttleless weaving machines for manufacturing of fabrics from natural silk and series of other decisions in creation and improvement of equipment for raw silk processing and devices for evaluating quality of threads, yarn and silk products are very interesting. We are ready for a fruitful cooperation in solving top and everyday problems of moriculture, sericulture and silk technology.

Chapter 4. National strategy for sericulture revival and development in Uzbekistan.

What are the ways for solution of problems appeared in sericulture and silk processing in Uzbekistan after collapse of the Soviet Union and in conditions of World crisis?

As was shown in the Introduction as reasonable decisions of several historical personalities lead to revival of lost craft as well as calculated and real investments of tsar's Russia in silk industry of Turkestan quickly lead this branch of our region to progress of industry. During Soviet period goal-oriented investments were continued and real profit due to these investments was obvious. That time silk industry of former USSR was so developed that made this country independent in this strategic product. Before collapse of the USSR a level of cocoon production was ~ 43 thousands MT. Part of Uzbekistan was 64% i.e. ~ 2/3 of cocoons production belonged to Uzbekistan. Soviet machinery industry provided production of cocoon dryers, different equipment of filature and textile processes. It was great income into silk industry

Uzbekistan after collapse of the USSR some time produced sufficiently big volumes of green cocoons – up to 34 thousands tons in 1992. In the course of time this level felt till 18 thousands tons in 2000. But in 2010 the yield - 25 thousands tons was harvested. This fact confirms that Uzbekistan remains an important potential cocoons producer and at own and foreign investments quickly replies on investments in spite of economic crisis. As a result of abovementioned there are he following short-, medium- and long-term tasks for recovery of former level of production of cocoons, raw-silk and silk goods:

- To continue the course of state and foreign investing in silk branch.

- To continue tendency to material interest of farmers. To stimulate transition of manufacture to centralization on the scientifically based biotechnics of industrial sericulture.
- It is necessary to arrange courses of unified sericulture with application of present-day R&D achievements of silk manufacturing for farmers-beginners.
- To arrange cooperation and sharing of experience with progressive sericulture countries with similar climate.
- To develop new mulberry sorts and hybrids with high productivity and nutritional value and new local silkworm breeds and hybrids with high technologic parameters of cocoons similar to international standards.
- To conttinue reorganization silkworm seed plants to produce high quality silkworm eggs.
- To develop breeds and hybrids for summer and autumn seasons and rearing technology in submontane regions with fresh climate to use them for additional increase of cocoons production. To develop artificial diet and adopted breeds and hybrids as well as biotechnology for mass silkworm rearing.
- For increasing efficiency of mulberry pyralid and other pests control to develop recommendations including integrated methods of control with predominant use of biocontrol agents, especially after cold winters which significantly decrease mulberry pyralid population.
- To develop further the tendency of total processing of cocoon raw-material, byproducts and wastes to raw-silk, means of traditional medicines, original fabrics, consumer goods, handicraft ets.
- To widening assortment of natural silk goods it is necessary to intensify R&D and their implementation in bi- and multilateral cooperation in high-tech field (biotechnology and nanotechnology, bioreactors, drug and gene delivery system, microprosthesis, microsensors, MEMS and NEMS products etc.).

Coming after such strategy and tactics it could be both achieve and increase level and volume of production of before reforming period and widen assortment of silk goods, to increase quality of silk products, to provide wastelessness and cost efficiency of silk branch in total.

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APPENDIX

Table 1. Productivity of adopted to the field mulberry tree hybrids

Name of hybrid	Yield capacity of leaves		Fresh cocoon output		Raw silk output	
	t/hectare	% to the control	Kg/hectare	% to the control	Kg/hectare	% to the control
Topcross-2	11.305	176.6	995	203.1	172.2	202.6
Topcross-3	9.142	142.8	907.1	185.1	170.5	200.6
Uzbekistan	9.125	142.6	905.7	184.8	170.2	200.2
Kokuso-70 free pollination	6.400	100.0	490.0	100.0	85.0	100.0

Table 2. Productivity of adopted to the field mulberry varieties

Mulberry varieties	Yield capacity of leaves		Fresh cocoons output from 1 hectare of plantings	
	t/hectare	% to the control	kg/hectare	% to the control
Tajic non-seed	11.900	140.0	1.070	150.7
Khasak-control	8.500	100.0	710	100.0
Pioneer	10.480	162.7	870	161.1
Khasak-control	6.440	100.0	540	100.0
October	9.450	156.2	930	150.0
Khasak-control	6.050	100.0	620	100.0
Surkh-tut	8.940	127.3	820	132.3
Hybrid control	7.020	100.0	620	100.0
Uzbek	11.060	130.0	990	133.8
Tajic non-seed -control	8.500	100.0	740	100.0
Winter-stable	11.500	163.2	970	161.7
Tajic non-seed -control	7.100	100.0	600	100.0
Mankent	9.310	138.1	870	142.6
Pioneer-control	6.740	100.0	610	100.0
Gulodnostepskiy-6	11.210	113.9	1.070	124.4
Tajic non-seed -control	9.840	100.0	860	100.0
SANIISh-33	18.750	108.2	1570	142.8
Tajic non-seed-control	17.330	100.0	1180	100.0

Djararik-7	14.850	151.53	1102	154.45
Tajic non-seed-control	9.800	100.0	708	100.0
Djararik-8	18.950	193.36	1662	223.63
Tajic non-seed-control	9.800	100.0	778	100

Table 3. Factors of leading commercially valuable characteristics of new selection breeds, lines and prospecting industrial hybrids of mulberry silkworm

Names of hybrids	Viability, %	Average fresh cocoon weight, g.	Cocoon shell weight. mg	Shell ratio, %	Average dry cocoon weight, g	Raw silk output, %	Silk products output, %	Cocoon reelability %	Filament size, denier	Unbreakable filament length, m	Total filament length, m
Guzal	90.7	2.52	593	23.5	1.054	44.8	53.9	83.0	2949	1333	1458
Marvarid	90.6	2.57	583	22.7	1.077	45.2	53.1	85.2	3268	1242	1342
Line 1m	86.5	2.35	539	22.9	1.009	43.7	53.6	81.6	3117	1108	1404
Line 2m	88.0	2.19	490	22.4	0.909	43.8	52.2	84.0	3066	988	1308
Line 61	81.6	2.21	554	25.1	0.938	47.0	56.2	83.6	3546	692	1625
Line 65	85.2	1.67	390	23.4	0.710	44.8	53.9	83.1	3597	1208	1208
Marvarid x Line 61	91.8	2.59	610	23.6	1.053	46.6	54.6	85.3	3413	1267	1717
Line 2m x Line 3m	89.1	2.25	520	23.1	0.949	47.9	54.5	87.8	3236	1283	1550
Line 1m x Line 3m	91.9	2.29	545	23.8	0.959	46.8	54.3	86.2	3086	900	1375
Line 2m x Line 61	89.4	2.45	576	23.5	1.042	43.9	53.8	81.6	3521	1325	1733
Line 36 x Line 61	90.3	2.28	539	23.6	0.921	48.1	55.1	87.3	3322	1025	1500

New possibilities of sericulture development in Poland

By

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(ORAL PRESENTATION)

INF&MP had got an information that Poland will have no UE subsidy for farmers which breed the mulberry silkworm until 2020. This fact complicates sericulture development in large scale. That is why INF&MP must find new sources of funding. The presentation will show original but also very risky activities and possibilities to develop sericulture net and produce cocoons in Poland.

The present status and future of sericulture industry in Korea

By

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(ORAL PRESENTATION)

The silkworm industry in Korea, which had been focusing on silk production previously, shifted its market for supplying food supplement and raw medicinal materials from 1995. Traditional silk production industry had reached at the highest values in the mid 1970s, 488 thousands farmers produced total 308 million US $. Recently sericulture industry has been reduced into small scale, 7 thousand people produce 45 million $; however, it produce various high value-added materials. New promising sericulture market are constituted of silkworm powder for reducing blood glucose levels, silkworm 'Dongchunghacho(Cordyceps)' effective to cure cancer and strengthen the immune system, functional silk cosmetics including soap and toothpaste and food materials made by mulberry leaf and fruits. The sericulture industries are focused on not only silk fabric as traditional sense, but also the functional medicinal materials, as a new paradigm, to improve health of people as well as increase the farmers' income. The functional sericulture would be expanded to wide range of health-related market and developed into modern biotechnology-based agriculture in the future.

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New Progress in the Research on Sericulture Resource Utility

By

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(ORAL PRESENTATION)

ABSTRACT: China has a long history for sericulture and is still the world largest sericulture production country in the world. Here is briefly to introduce the sericulture resource utilizing in China recently. It is of great significance to think over how to develop the sericulture industry chain and realize the multiple development of silkworm in the angle of developing and utilizing sericulture resources furthermore.
Key words: Sericulture, silkworm, mulberry, China, Resource Utility

China has a long history for sericulture and it is still the largest sericulture production country in the world, so far with the sericulture areas covering over 1,000 counties in 26 provinces (cities, districts) nationwide, and about 20 million households of farmers engaging in sericulture production activities. Nevertheless, though planting mulberry, feeding silkworm and harvesting cocoon are taken as the major economic income sources, the sericulture in our country has also a lot of side-products available for utility. To have all-around utility of sericulture resources, it can not only "convert waste into treasure" for a lot of idle sericulture resources, but it is also beneficial to increase the sericulture production efficiency and the raisers' income. It is furthermore beneficial for the upgrade and development of sericulture and the increase of the competition power in market for the whole industry. Presently, a wide consensus on efficient development and utility of sericulture resources have been reached in the industry and some breakthrough in technology R & D (research and development) and application has also been achieved. Therefore, it is of great significance to think over how to develop the sericulture industry chain and create a multiple development of the silkworm in the angle of further developing and utilizing sericulture resources.

1 The present status of sericulture development in China

As an advantageous and featured industry with thousands of years of traditions in China, silk industry has been playing by far a significant role in the national economy especially in developing the regional economy of countryside. At present, China has been in the monopoly position in terms of the world silk export market, and it is still the center of world silk industry. After experiencing the great adjustment in the two years from 2007 to 2008, the sericulture production in our country started to increase again in 2009, and showed the restorative increase trend in 2010 with the all-around increase in such indexes as the mulberry field areas, eggs release quantity, cocoon output and cocoon income, etc. According to the statistics made by the competent authorities of sericulture production from 15 provinces (districts, cities), the mulberry field areas nationwide were 792,000 hectares in 2010, the eggs release quantity were 15.96 million boxes in 2010 up to 10.98% in comparison to the year of 2009 (14.38 million boxes)□ the total cocoon output were 655,100 tons, up to 16.36% in 2010 in comparison to the year of 2009 (5629,900 tons). Due to the output increase and the great rise of cocoon price, the income of silkworm raisers has been universally increased. In terms of the economic efficiency, the total cocoon revenue of the whole country was 19.11 billion Yuan in 2010, with an increase by 7.09

billion Yuan that represents 59% increase in comparison to the year of 2009, and that has created the best level in history. According to the statistics made by the State Statistics Bureau, the total output value of silk industry created in 2010 was 195.9 billion Yuan, and the industrial sale amount was 192.2 billion Yuan, up to 64.62% and 65.26% respectively more than in 2005 and the annual growth reached 10.48% and 10.53% respectively. Compared with that at the end of “the tenth five-year plan” period, a greater growth has been performed in terms of the output value size and the sales size of silk industry (China Silk Association, 2011). Based on the analysis on the sericulture production cycle of China, it has entered the slow growth period of the third long cycle since 2009. With the precondition of the co-existence for the gradual rise of China’s economy and the pressure from inflation in 2011, the sericulture production will continue to show such a layout as the increase in both output and income, but the growth range of cocoon output, price and income will be slower than that in 2010.

In addition, with the economy development in the coastal areas and regulations made on the overall layout of sericulture industry in our country, the sericulture production regions will get gathered to the western regions which mainly cover Guangxi, Yunnan, and whose status as the largest sericulture production areas in our country will be furthermore consolidated. With the forceful drive from the state sericulture industry technology system, the national sericulture production technology level has been lifted, the science research and promotion teams have been consolidated and expanded, and the advantage in sericulture resource development and utility has become more distinct. With the diversified demand from consumers in the market as the guideline, a new direction for the sustainable development of sericulture for China and the world has been provided by fully utilizing the materials and cultural resources along all the chain of sericulture, and developing new functions including the medicine and food purposes, animal’s feedstuff purpose, new material purpose and cultural and ecological purposes etc.

2 The development and utility of mulberry resources

2.1 Mulberry leaves

The mulberry leaf is the major product of mulberry trees□and covers about 64% of the overground yield. In our country, the resource of mulberry tree species are very rich, and over 3,000 accession varieties (or strains) are preserved in the national mulberry germplasm garden, Zhenjiang and Guangdong, respectively. The different mulberry tree species resources have been collected including 15 mulberry species and 4 varieties, i.e. *Morus multicaulis*, *M□alba*, *M□atropurpurea*, *M□bombycis*, *M□mizuho*, *M□wittiorum*, *M□laevigata*, *M□nigra*, *M□cathayana*, *M□serrata*, *M□mongolica*, *M□notabilis*, *M□nigrifor mis*, *M□yunnanensis*, *M□australis*. The variety are involved *M□mongolica* var. *duabolica*, *M□alba* var. *macrophylla*, *M□alba* var. *venose*, *M□alba* var. *pendula*, respectively. The mulberry planting covers over 1,300 counties in 28 provinces (districts, cities) nationwide and the mulberry field area in 2010 reached around 801,000 km^2 (Zhang *et al.* ,2011).

As a kind of traditional Chinese medicine, mulberry leaf was called as “immortal herb” in China’s ancient medical book name of *Compendium of Materia Medica* and National Ministry of Health has also listed it as the plant of dual purposes as medicine and food. Nowadays, in-depth research has been made in the development and utility of mulberry leaves in terms of food, medicine, cosmetics, chemicals etc. Besides containing abundant carbohydrate and plant protein, mulberry leaves contain more cellulose, several vitamins, fatty acids, minerals and trace elements as well as special functional compounds such as polyphe[nols and flavonoids, etc(Lu *et al.*,2007; Xu *et al.*,2010).

A series of mulberry leaf products has been developed in the food field including mulberry leaf dishes, mulberry leaf tea and mulberry leaf drinking etc.(Smart Pig, 2009; Zhou *et al.*,2008); in terms of medicines, drugs of reducing blood press dominated by the active ingredients of mulberry leaves have been developed by utilizing polysaccharides, flavones and alkaloids etc., and have been promoted for usage as the product of health care (Tang *et al.*, 2009); meanwhile, by optimizing the research on the extraction of 1-deoxynojirimycin (DNJ) from mulberry leaves, drugs of anti-cancer, anti-virus types, etc. have been developed efficiently (Zhao *et al.*, 2006) and have been furthermore developed as the oral antibacterial anti-inflammatory drugs (Kuźma *et al.*, 2007). In terms of the development and utility of daily chemical articles, such products including mulberry leaf cigarettes, shampoo, preservatives and cosmetics, etc. have been promoted in the market(He *et al.*,2007; Yang *et al.*, 2010; Jin *et al.*,2007).

2.2 Mulberry branches

The mulberry branch covers about 64% of the annual dried product output in the mulberry field, and it is the vegetable organ that covers the highest ratio of biomass in mulberry plants. As a traditional Chinese herb, mulberry branches contain multiple active ingredients used in the modern medical research, such as flavones: for example, mulberry branch skin ethanol extract can reduce blood fat, has an antioxidation effect and reduces blood sugar etc. (Zhang *et al.*, 2011; Ma *et al.*, 2010; Xing *et al.*, 2010). Mulberry branches are rich in pectin so that it is possible to prepare medical and biological composite membranes by extracting pectin from mulberry branches, and to prepare nano-crystalline cellulose (Liu *et al.*, 2010).It is also reported that the water soluble anionic surfactant -- sodium carboxy methyl cellulose (CMC) prepared by using mulberry branches can reach the production application standard to be used in the composition of such daily chemical articles as detergents, toothpastes, as well as textile products (Cao *et al.*, 2011). Mulberry branches are rich in several nutrients such as cellulose and crude protein , which can be used as the basic material to cultivate edible mushrooms such as Hericium erinaceus, Plelmtus eqngiu, edible fungus and Ganoderma lucidum, etc.(Lu *et al.*, 2011; Zhang *et al.*, 2010; Wang *et al.*, 2010; He,2010), and presently, the edible mushroom cultivation with mulberry branches has become a newly emerging industry in those sericulture areas of the countryside including Guangxi, Jiangsu, Zhejiang, Chongqing and Sichuan etc.

Not only the bast fiber or xylem fiber of mulberry branches are nice materials for papermaking and boards, but also the mulberry wood can be used to make utensils. The fast food box production line made from mulberry branch fibers through sulfite hydrolysis method, discovered by the South China University of Technology can reduce contamination very efficiently, but it failed to enter into production because it is quite expensive. Mulberry branches can be used to braid such craftworks as large wicker baskets while the bast can be used to make artificial silk floss and mulberry bark fiber, which are applied in the textile field or the health care food (Chen *et al.*, 2010; Yu *et al.*, 2009). Furthermore, mulberry branches can be used to make soluble dietary fiber and the feedstuff additive: oligosaccharides. With mulberry branches (corn cob, sugar cane trash) as the raw material, the oligosaccharides that are soluble in water can be made by using the xylan hydrolysis enzyme of microorganism, it can accelerate the wriggle of digestive tract upon the ingestion of human and animals, increase the nutrient absorption and promote the elimination of toxicants, and it is therefore a new highlight for international biomass production.

2.3 Mulberry fruit

Mulberry fruit (also named as mulberry syncarp) was consumed in China with a long history of some thousand years as edible fruit, and was said to be a kind of imperial supplement for Chinese emperors. The National Ministry of Health listed mulberry fruit as the agricultural product which is “both food and medicine” in 1993. Mulberry fruit is rich in nutrition and contains 16 kinds of amino acids, 7 kinds of vitamins, minerals and trace elements together with carotenes, pectin and cellulose etc. In the present food field, mulberry fruit has been developed into many products for the market, such as mulberry fruit cans, juice, preserves, wine, jelly, jam, paste, pigments, ice-cream sticks, vinegar and seed oil, etc. Production of some of these products including mulberry fruit juice and mulberry fruit wine have been industrialized and gradually formed the mulberry fruit industry (Qiu *et al.*, 2009). It is showed from modern pharmacology that: mulberry fruit has the function of regulating immunity, it promotes the growth of hematopoietic cells efficiently, increases resistance to radiation, reduces blood sugar, reduces blood fat, impedes aging and protects liver. Clinically, it can be used as the adjuvant medicine to treat chronic hepatitis, high blood pressure, high blood fat, diabetes, aplastic anemia, gastrointestinal diseases, gerontic constipation and sleeping disorders (Wang *et al.*, 2011). According to some incomplete statistics, there are over 100 secret recipes, folk prescriptions and proved recipes with mulberry fruit as the traditional Chinese medicine for 52 kinds of indications.

Additionally, the mulberry tree roots, the root bark of white mulberry, and some insects parasitized in mulberry can also be used as medicine. The machines are adapted to the disease entities of 88. The doctors' recipe quantities are involved 171 (Su Kuncheng, private communications). Presently, in China importance has also been attributed to the greening and ecological protection function of mulberry trees. On this basis, mulberry trees have been planted as the landscape forest in northern China; the project combined with sand and forest protection and the production of animal feedstuff is in progress, while the exploration on planting mulberry trees to prevent stony desertification and protect dams. is also in progress in the Three Gorges dam side of the Yangtze River, in the areas along the Yellow River and in some places in Southern China.

3 The comprehensive utility of silkworm resources

3.1 Young silkworms

Young silkworm larvae have very high protein content, so that they are a very good food resource. After cold drying and grinding silkworm larvae, the whole silkworm powder made with a particular process has been used in traditional Chinese medicine to reduce blood glycemia in China, Japan and South Korea. South Korea are the earliest ones to study and report that the whole silkworm powder can treat diabetes: 20% blood sugar value will drop off after taking this kind of natural remedy four weeks（Ryu *et al.*, 1997). A substantial part of the sericulture in South Korea is for the purpose of producing whole silkworm powder. It is reported that by using the whole silkworm powder it is possible to separate and extract 1-deoxynojirimycin (DNJ) whose isolate can play a remarkable role in restricting the growth of HeLa cancer cells (Lou *et al.*, 2010). Besides, relevant Chinese research has also confirmed that the whole silkworm powder has remarkable function to reduce blood sugar, as stated by Korean scientists (Cao *et al.*, 2011; Shi *et al.*, 2009; Kang *et al.*, 2008). According to our understanding, people in Guangdong in the ancient time used to eat "chicken excrement cocoon" (also called as spoiled cocoon) as folk prescription to treat diabetes, but we have found upon testing that the active ingredient (flavonoids) in spoiled cocoon is slightly less than that in normal cocoon, so its effectiveness mechanism remains to be explored (the results have not been released yet).

After being infected with *Beauveria bassiana* Vuillemin, the silkworm larva becomes stiff ; it is believed that it has the function to increase resistance to faint from fear, to reduce cholesterol, to prevent coagulation and thrombus formation .It is a kind of very frequently used traditional Chinese medicine (Mi and Liu, 2010). Yan *et al.* (2006) have proved that stiff silkworm chloroform extract has a major anti-eclampsia action. Clinically, stiff silkworms can be used to treat asthma (Zhang *et al.*, 2009), bronchial asthma (Yan, 2009), pseudobulbar palsy after cerebral apoplexy etc.

Additionally, silkworm exuviae, which are namely esoskeleton remainings after moulting of young silkworm, are used to treat metrorrhagia and metrostaxis, gynaecological diseases, dysentery and hematemesis in traditional Chinese medicine. Since it is easy to feed silkworms and furthermore, the physical and chemical properties of silkworms and even the genome information have become very clear as the representative species of olometabolous insects, times have gradually become mature to produce various top end biopharmaceuticals by using the expression system of silkworm virus and with silkworm as the biological reactor, and some products have already approached clinical experiments or even some applications.

3.2 Silkworm pupa

Silkworm pupa is very rich in protein, fatty acids, chitin, multiple protein hormones, vitamins and trace elements. The present status of utilizing silkworm pupa is mainly to have it as flavored food or nutrition addictive or to extract silkworm pupa protein, which is furthermore processed into albumen peptide or is to separate into amino acids (Chen *et al*.,2009; Lv *et al*.,,2009). The silkworm pupa oil can be separated into fatty acids and refined as edible oil; additionally, it can also treat hyperlipemia (Hu *et al*., 2011) and presently relevant silkworm pupa oil soft capsule as health care product has been promoted to the market. Besides, due to the alkaline polysaccharide compositions such as chitin and chitosan contained in the silkworm pupa, they have the effect to restrict gastrohelicosis, protect liver, increase the body immunity, prevent blood coagulation, reduce blood pressure and blood sugar, increase resistance and treat cancer (Wu *et al*., 2011; Chen *et al*.,2011),while silkworm pupa shell chitosan and glycine derivatives can be furthermore developed as tanti-coagulation material for medical purposes (Shi and Wu, 2010). Chitin can also be applied in the food industry as the juice flocculation clarifying agent, tackifier, antiseptic and emulsifier etc.

The fungus *Cordyceps militaris* growing on silkworm pupa, after on-purpose infection, can be deeply processed into various top end health care products such as pupa *Cordyceps* tea and pupa *Cordyceps* wine and it is reported that the silkworm pupa *Cordyceps* polysaccharides give a distinct protection on liver damage from hydrocortisone in the mice (Zhen *et al*., 2011). It is indicated from some researches that the oxaminic acid content in stiff silkworm pupa infected with *Cordyceps* is similar to that in stiff silkworm larvae and can replace the effect of stiff silkworms (Song and Mu, 2004). Silkworm pupa can also be used as a new type of adsorbing material to separate heavy metals from waste water (Paulino *et al*., 2008).In addition, with the development of modern science and technology, silkworm pupa has been deeply researched and applied in terms of industrial material development, textile and paper making development, animal feedstuff, bio-engineering vaccine etc (Chen *et al*., 2006; Lv *et al*., 2010; Deng *et al*., 2010). Our unit has got a serial of achievements in terms of research and application of silkworm pupa antibacterial peptides and the relevant products are under industrialized production.

3.3 Silkworm moth

Silkworm moth does not have high content of protein, but contains rich bioactive ingredients including sex hormone□ molting hormone, juvenile hormone and brain hormone etc., so it has a rather higher edible and medical value (He *et al*., 2005). It is possible to use the enzymatic hydrolysis of male silkworm moth to prepare bioactive material with particular physiological function (Zhang *et al*., 2008). In the present markets, there are more focus on using the male silkworm moths, such as male silkworm moth wine, senior nutrient solution and capsule of natural compounded amino acids . Records in the Chinese "*Compendium of Materia Medica*" reports that the major functions of male silkworm moths are as follows: “to benefit vital essence, enhance vagina, tireless intercourse and also stop semen leakage, strengthen male sexuality and stop gonacratia and hematuria etc.” In the market of South Korea, the male aphrodisiac health care product “NUEGRA” with male silkworm moths as the major composition has been promoted and there is a hot sale in the market each year. Zhang *et al*.(2008) have prepared an active peptide from protein by using silkworm moths, and they demonstrated a remarkable anti-fatigue effect upon testing it on mice Medical research indicated that male silkworm moth is the ideal food to supplement exogenous male hormone (Wang *et al*.,2008). Additionally, health care wines including “male silkworm moth wine”, “male silkworm moth tonic wine” and the featured food “soft can of silkworm moth” etc. made with male silkworm as the raw material have the function to invigorate the kidney, enhance sexual function and intensify immune function etc(Gu *et al*., 2007).

3.4 Silkworm excrement

As a large side product resource of sericulture production, silkworm excrements cover 22% of the dried production of the mulberry field and contain multiple nutrients including abundant protein, chlorophyll and carotene (Huang *et al*.,2011). Silkworm excrements are active in reducing blood glycemia and are frequently used in the recipes for diabetes in Chinese Traditional Medicine (TCM). The chlorophyll extracted from silkworm excrement as raw material and its derivatives, xanthophylls, flavonoids, carotenoids etc. have been widely applied in some industrial fields including food, drinking, cosmetics and medicine etc. In 1957, Yang started the research on chlorophyll extracted from silkworm excrements and prepared sodium copper chlorophyll and carotenoid in 1960. In 1972, the chlorophyll paste extracted from silkworm excrements was exported to Japan, and during this period, factories were built one by one in Zhejiang, Jiangsu and

Guangdong for production, which were pioneers in the road of Chinese industrilization. In 1980, sodium copper chlorophyll was approved as medicine due to its good effect on treating hepatitis and was put into production at Guangzhou No. 4 Pharmaceutical Factory. In 1981, South China Agriculture Institute assisted Yidu County, Shandong to complete the first sodium copper chlorophyll factory with the annual output of 1,000 kg supplied in our country as medicine raw material, food addictive and for export. Later, sodium copper chlorophyll factories were built in Hangzhou, Yuhang of Zhejiang, Kunshan of Jiangsu, Langzhong of Sichuan, and Huanggang of Hubei etc. In 1965, the Hangzhou Chlorophyll Factory also started some researches and made sodium iron chlorophyll and chlorophyll together with its derivatives, which have the effects to promote liver protection, antitumous effect, to promote wound healing, and anti-anemia (Liu *et al.*, 2007). The drugs produced with chlorophyll as the raw material include such new ones as Bilsan, Liver Blood Treasure, Blood Generation Tablet, Stomach Green Tablet and Stomach Health U. In recent years, some health care products with chlorophyll as the raw material have also been produced. Chlorophyll and sodium copper chlorophyll, sodium iron chlorophyll are mostly used abroad as the raw materials for drugs, food addictive and daily chemical articles.

Moreover, the silkworm excrements after extracting chlorophyll are utilized as the raw material to produce pectin, triacontanol□rapeseed sterol and carotenoid are furthermore compounded as Vitamin E and K1 etc. The β-carotene extracted from silkworm excrements has the function of restricting cancer cells while the pectin extracted from silkworm excrements can be used as the carrier for release preparation and controlled release preparation (Wu *et al.*, 2001). After air drying, the silkworm excrements can be made as health care pillows which can treat headache, daze and have the function of clearing away heart-fire and improving acuity of vision (Li and Li, 2009). Agrocybe aegerita (Bai,2008)and Plelmtus eqngiu (Liu *et al.*, 2009) can be planted by using mulberry branches and silkworm excrements, while in Guangxi, abundant silkworm wastes including silkworm excrements are utilized to leaven and produce sewage gas which is used as the bio-fuel and energy, and even as illumination (Luo *et al.*, 2001); in addition to that, such wastes are used as the feedstuff for animals directly as ox, fish etc., so it is able to save costs and to increase earnings (Ma *et al.*,1990; Jiang *et al.*,1991); or used as organic and inorganic compounded fertilizer for vegetable crops, resulting in remarkable increase of the soil biomass and the soil quality improvement (Lv *et al.*, 2003).

3.5 Natural silk

Natural silk is composed by the two proteins: fibroin and sericin. In recent years, the largest application of quantities of silk in China is that for silk quilt and it has played a significant role in stabilizing China's sericulture development. On the other hand, in terms of the research on the deep development and application of silk, from the original purpose of supplying textile raw material it has transited to the aim of supplying top end raw materials in terms of medicine, cosmetics, and food, and biochemical articles. As a result, the function of fibroin and fibroin peptides to reduce blood sugar value and the cholesterol content, to obtain skin whitening, to prevent aging and have the prevention effect for dementia have been studied (Shen *et al.*, 2008). Silk fibroin has been widely used in the filed of cosmetics, because foundation material of makes-up, lipsticks, toning lotions, face creams, hair colorants, hair vaselines and talcum powdesr contains silk proteins and have been widely sold in market. It is also widely used in medical field, since fibroin membranes are applied to prepare materials as suture threads, contact lenses, artificial skin, artificial corneas and artificial blood vessels. Since Meinel *et al.*□2005□prepared fibroin protein for the first time into 3-dimensional porous poly-fibroin protein support, which is used in the bone tissue engineering research. The research on the application of fibroin protein in the medical field has become more and more in-depth. Studies have proved that fibroin proteins can be used for the restoration and regeneration of bone tissues, cartilage tissues, muscle tendons and ligament tissues, intervertebral disc tissues and liver tissues (Jones *et al.*, 2009; Miao *et al.*, 2008; Tian *et al.*, 2010; Chang *et al.*, 2010; Xu *et al.*, 2011) and can be used as the release material for drugs in the research of orthopedics tissue engineering (Cao *et al.*, 2009). Additionally, fibroin protein powder can be used as the catalyst for the biological disintegrating process of plastics (Lu *et al*., 2011). In terms of the application of biotechnology, fibroin membranes can be further used as tcarriers of immobilized enzymes and in the preparation of biological sensors (Huo *et al*., 2008). According to one of the latest reports, the US scientists have made a piece of clothes that can make a person become invisible when putting on; this new type material is produced by utilizing the substance extracted from silk and smearing a layer of gold coating (Zhi,2011).

4 Problems and outlooks.

Very great progress has been achieved in the research on silk resource development and utility, but many problems also exist as the industry production is still under the exploration stage. The countryside labor force is lacking, it is hard to promote or carry out an improvement in the technology level of modern mulberry planting and silkworm feeding, so that the mechanization level of silkworm feeding and mulberry planting remains low and administrative policies on sericulture failed. As a result, the silkworm egg production quality is uneven, diseases in silkworm rearing break out from time to time and the raw material cocoon quality can hardly satisfy the demand of international textile companies. Because of the low unitary production and processing methods, the undersized scale and the backward technology and equipments of enterprises have caused reeling silk companies to have low efficiency, and lacking high qualified labor and decreasing their competitiveness. Agricultural chain or industry chain is short, and the deeply processing enterprise is insufficiency. So it causes the sericultural comprehensive benefit low. Furthermore, all industries are lack of investment in innovation and R & D (research and development) and many identical or copied products have resulted in a serial undesirable competition. Compared with traditional sericulture, the utilization of all the sericulture resources is a new field. The overall industrial exploration on the resource utilitzation is conducted with different extents in all the sericulture areas nationwide, but the relevant technology remains weak, its promotion and application ratios are still very small, the overall development and utility have remained at the preliminary processing stages and the potential huge economic, social and ecological efficiency still can not be developed.

Therefore, in order to achieve an efficient and comprehensive utilization of the whole sericulture resources, all the traditional sericulture departments must make converge their strengths, combine their own advantages in terms of funds and talents, somewhere it might be necessary to unify science and technology research institutes, to have more in-depth research regarding the physical and chemical properties, processing properties, pharmacological activity of the silkworm, mulberry and silk resources, to accumulate scientific bases for innovation, or draw lessons from the common key technology in other fields, to solve difficult problems existing in the product processing of sericulture resources, and to fully dig out the potential value of sericulture resources in all the industrial and agricultural fields. Besides, it is necessary to fully dig out and utilize the rich sericulture germplasm resources in our country, to integrate into the other fields of the sericulture research---the already well-known silkworm genome information, and the mulberry tree genome information still in-progress, by proactively thinking over the multipurpose production of silkworm, mulberry and silk to expand the “genomics” product market in the sericulture resource genome era. Finally, it is necessary to transform traditional ideas. It is suggested to start from the basis in terms of the utilization of sericulture resources, to make trade, industry and agriculture complement each other, nourish agriculture and industry, increase the overall economic efficiency of sericulture and realize the sustainable and multiple developments for sericulture.

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SERICULTURE INITIATIVES IN RWANDA: COUNTRY REPORT

By

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(ORAL PRESENTATION)

The Government of Rwanda has in recent years embarked on policy initiatives geared towards economic transformation addressing poverty reduction, food and nutritional security, diversification of economy and expansion of export base. In this framework sericulture has been considered as one of the promising enterprises suitable for rural development. Sericulture provides employment opportunities and improved household incomes as well as export revenues at national level. Mulberry cultivation improves bio-diversity and reduces soil erosion on slopped landscapes. Silk industry also leads to evolution of cottage industries producing silk handcrafts for both local and export markets. With further investments, sericulture presents a wide range of secondary products such as functional foods, pharmaceuticals and cosmetics. Sericulture activities are currently coordinated by National Sericulture Centre (NSC), a special unit under Ministry of Agriculture and Animal Resources (MINAGRI). The industry is still in its infant stages and involves 40 pilot cooperatives producing less than 10 tons of fresh cocoons per year. Under IFAD Project for Increasing Rural Incomes through Exports (PRICE), the current cooperative-based production model will gradually shift to farmer based model targeting a cumulative total of 1,600 beneficiary farmers over a 5-year period with each cooperative having 40 satellite farmers. The individual farmers will rear young silk worms (3rd instars) provided by cooperatives, allowing 8 rearing cycles per year with a projected annual turnover of 640 – 960 tons of fresh cocoons. The major limiting factors of silk industry include lack of domestic market for farmers' cocoons,

limited technical knowhow and lack of robust and resilient silkworm seed adaptable to Rwandan conditions. This report highlights historical profile of sericulture in Rwanda, the country's comparative advantage in developing silk industry as well as strategic approaches for transforming Rwanda into a vibrant silk producing country.

Keywords: Rwanda, Sericulture, market, strategy

Scientific – technical reports session

Section 1. Moriculture and non-mulberry food plants for sericigenous insects: selection, propagation and cultivation

Screening of mulberry genotypes for alkali tolerance- An integrated approach

By

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ABSTRACT: In view of rapid industrialization and competition from other cash crops, there is a need to utilize salt affected soils for sericulture where normal agricultural crops cannot be raised very profitably. In India, an estimated area of over 10 million ha. of alkali and saline soils exists which are increasing due to various factors. Due to slow or partial adoption of reclamation by famrers and difficulty in achieving the maximum genetic potential of the mulberry genotypes under salt stress, an integrated approach was devised for growing tolerant mulberry genotypes and to increase the sericultural productivity. The study indicates that genotypic variation exists in mulberry genotypes in alkali soils with or without reclamation. As the soil properties viz., pH, ESP, SAR and Ec improved significantly with application of soil amendments particularly pressmud, makes the intercultural operations easy and economical for a marginal farmer. With respect to macronutrient status, Organic carbon and Phosphorous content were found to be highest in soils reclaimed with organic amendments and inorganic amendments, respectively though Potassium content was not affected. Among micronutrients, maximum levels of Copper and Iron were recorded in soils reclaimed with inorganic amendments, where as Zinc and Manganese contents were higher in case of soils reclaimed with organic amendments. Genotype AR-12 has registered an increase of 29.70% and 42.49% in leaf yield during first and second year of the study, respectively. Out of the test genotypes and checks employed in the present study, it was observed that response of the genotype, AR-12 was superior with respect to various physiological and bio-chemical traits including bioassay parameters, except for ERR by number, where improvement was non-significant. This infers suitability of AR-12 in alkali soils before and after reclamation with pressmud.

Keywords: Alkali soils, reclamation, salt tolerance, bio-assay

Introduction:

It is an established fact that slightly acidic (6.2-6.9 pH) soils are most ideal for mulberry cultivation in India. The choice of increasing income from sericulture is achieved through either vertical growth i.e., by increasing silk production per unit area of mulberry plantation or horizontal growth i.e., by exploring and expanding more and more new areas for mulberry cultivation. Research and Development units of various institutes/organizations of sericulture are making constant efforts to increase the silk production per unit area by way of improvement in yield, quality of mulberry leaf and silkworm races, protection against pests and diseases, improvement in rearing and post cocoon technologies etc. In spite of all this, the vertical growth is slow due to several constraints, which warrants need for horizontal expansion. Keeping in view the pressure on the available arable agriculture lands, wastelands like salt affected soils where normal agricultural crops cannot be raised very profitably can be utilized for mulberry cultivation. It has been estimated that an area of over 10 million ha. is salt affected in India, comprising 5.5 million ha. of alkali soil and 4.5 million ha of saline soils, which are increasing further owing to the continuing process of salinization and alkalization.

Soil alkalinity reduces plant growth, survival and economic yield by osmotic stress, ion toxicity, and nutritional disturbance. These alkali soils could be effectively utilized either by reclamation or by growing alkali tolerant genotypes. The projects on reclamation of salt affected soils are time consuming and capital-intensive propositions. Hence, adoption at farmer's level is either slow or partial. Though tolerant mulberry genotypes found to be most suitable for profitable cultivation under alkali soils, however it is difficult to achieve the maximum genetic potential of the genotypes due to the salt stress. In order to extend intensive cultivation to marginal environment, development of an integrated approach for growing tolerant mulberry genotypes and to envisage the technology for the reclamation to increase the sericultural productivity was taken up.

Materials and Methods:

Study covered a series of field experiments conducted at the farm of Central Sericultural Research and Training Institute, Mysore situated at village Kinakahalli in the Southern Indian State of Karnataka. Experimental site was of black cotton soil with pH of 9.5, electrical conductivity in the range of 0.32 - 0.84, Exchangeable Sodium Percentage of 42 and Sodium Adsorption ratio of 30%, clearly indicating its alkali nature.

Based on initial screening for rooting ability and primary evaluation results, five mulberry genotypes viz., AR-12, AR-14, AR-10, AR-08 and AR-29 were considered in the study along with V1, a high yielding genotype under normal soil conditions as an entry, S34 as improved check and Mysore Local, as normal check. 64 plants were maintained per genotype per replication excluding border plants, in a Randomized Block Design (RBD). Three replications considered were unreclaimed alkali soil, alkali soil reclaimed with organic amendments (pressmud @ 50 MT/ha.) and alkali soil reclaimed with inorganic amendments (gypsum @ 8MT/ha. + Sulphur @ 1MT/ha.). The soil treatments were also shortlisted based on the soil reclamation studies on the same site.

Chemical properties, Macro-nutrient status and micro-nutrient status were studied before and after reclamation. Plantation was maintained by following recommended package of practices for the region. Yield data of the mulberry genotypes was collected for two years, after initial establishment of mulberry plants for one year. Comparative rearing performance through bioassay studies with ruling commercial silkworm hybrid considering various commercial rearing parameters was carried out during the second year of the study. Statistical analysis was carried out by appropriate statistical procedures.

Results & Discussion:

The object of the present study was to recommend a functional integrated approach by growing mulberry genotypes tolerant to alkalinity and by reclamation of soil by different amendments for utilizing vast alkaline areas of South India where mulberry is considered to be one of the most profitable cash crops. Among soil characteristics (**Table-1**), maximum soil pH of 9.5 was recorded in case of unreclaimed alkali soils followed by soils reclaimed with organic amendments (8.3) and soils reclaimed with inorganic amendments (7.9).

Likewise, improvement in electrical conductivity (Ec), exchangeable sodium percentage (ESP) and sodium adsorption ratio (SAR) was recorded with reclamation. With respect to macronutrient status, Organic carbon and Phosphorous content were found to be highest in soils reclaimed with organic amendments and inorganic amendments, respectively. Reclamation has not affected Potassium content, positively. Among micronutrients, while maximum levels of Copper and Iron were recorded in soils reclaimed with inorganic amendments, Zinc and Manganese contents were higher in case of soils reclaimed with organic amendments. Micronutrient content was least in unreclaimed alkali soils.

Table-1: Soil properties before and after reclamation with amendments

Parameters	**Un-reclaimed alkali soil**	**After reclamation with**	
		inorganic amendments	**organic amendment**
pH	9.50	7.90	8.30
Electrical Conductivity (mmhos/cm)	0.58	0.63	0.40
Exchangeable Sodium Percentage (%)	42.00	12.00	18.60
Sodium Adsorption Ratio (%)	30.00	8.00	14.00
Macro-nutrient status :			
Organic Carbon (%)	0.33	0.54	0.76
Potassium (kg/ha.)	363.00	360.00	327.00
Phosphorous (kg/ha.)	7.00	9.00	6.70
Micro-nutrient status (ppm) :			
Copper	0.16	0.38	0.31
Zinc	0.96	1.40	1.61
Manganese	27.70	35.40	38.40
Iron	0.97	6.20	4.30

Reclamation of alkali soils involves reversing of the process, which caused deterioration of these soils i.e., replacing excess exchangeable sodium with calcium supplied either through outside source or mobilizing precipitated calcium carbonate present in soil. Improvement of soil properties with decrease in soil pH, Ec, ESP, SAR in soil reclaimed with inorganic and organic amendments was is in accordance to the findings of Subbaswamy *et. al*., (1990), Bose *et. al*., (1992) and Bose *et al*., (1995). Maximum reduction was noticed in soil reclaimed with gypsum+sulphur and pressmud with respect to pH, ESP & SAR and Ec, respectively compared to alkali soil with no reclamation as reported by Subbarayappa *et. al*., (1993), who observed best results by reclamation with Sulphur (1MT/ha.) + Gypsum (8MT/ha.) in reducing soil pH. Press mud was found to be the most economic reclamant in reducing pH, Ec and increasing organic carbon and available phosphorous, which resulted in maximum leaf yield.

Highest Organic carbon, zinc and manganese contents were recorded on soil reclaimed with pressmud, whereas improvement with respect to potassium, phosphorous, copper, manganese and iron content was more on reclamation with gypsum and sulphur. These results are in line with finding of Deo *et. al.,* (1968) who observed decrease in total uptake of N, P, Ca, Fe and Mn with increasing concentration of the sodium salts. Reclamation effect through gypsum may be attributed to the increased solubility of soil calcium carbonate which replaces sodium salts in soil, with a resultant decrease in the soil pH and ESP of the soil and increase in the availability of nutrients (Singh and Abrol, 1988), which brings in the growth and quality of mulberry. Improvement in macro and micronutrients in soils reclaimed with gypsum and sulphur is due to synergistic effect of sulphur in the uptake of nutrients (Ishwari *et. al*., 1987).

Superior reclamation nature of pressmud in the present study is supported by the findings of Somani & Totawat (1993) who also reported the efficacy of pressmud due to relatively more soluble calcium and its organic-acidic (pH 5.62) nature bringing in accumulation and movement of micronutrients, as reported by Kapur and Kanwar (1989). With initial reclamation, improvement in the soil properties and nutrient status were found to sustain during the study period, which is supported by Chand *et. al*., (1980) who observed improvement in soil properties even after four years after reclamation of alkali soil.

Though the breeder has the freedom to choose any environment for breeding alkali tolerant mulberry genotypes, it is obvious that if reclaimed soil conditions are chosen, the genetic potential of the genotype will be expressed because of better managerial practices due to improved soil properties. In addition, plants may exhibit growth reduction, largely on account of energy expenditure for uptake and synthesis of solute, under salt stress conditions, resulting in the inability of the genotype to express its genetic potential.

Year-wise leaf yield of different mulberry genotypes under reclaimed and unreclaimed soil conditions was recorded for two years (5 crops per year). Pooled data of the two years (in MT/ha./year) at **Table-2** revealed that AR-12 was significantly superior over all the test genotypes, followed by AR-14 and AR-29 with significant difference between them. Minimum leaf yield was observed in case of Mysore Local.

Table-2: Average leaf yield (MT/ha./Year) of mulberry genotypes

Sl. No.	Mulberry Genotype	Unreclaimed Alkali Soil	Soil reclaimed with inorganic amendments	Soil reclaimed with organic amendments	Average
1	AR-12	16.87	20.43	23.01	20.10
2	AR-14	14.72	17.73	20.82	17.76
3	AR-10	11.35	13.13	15.11	13.20
4	AR-08	12.65	14.74	16.34	14.58
5	AR-29	14.24	16.95	18.87	16.69
6	V1	12.09	14.73	16.86	14.56
7	S34	11.18	13.30	14.81	13.10
8	Mysore Local	9.12	10.71	11.72	10.52

	Average	12.78	15.22	17.19	15.06

CD at 0.05 for:

Treatment (Reclamation)	*0.28*
Mulberry Genotype	*0.45*
Reclamation x Mulberry Genotype	*0.78*

In most tolerant forage crops, yield of forage is more sensitive to salt stress than other parameters like seed production (Ayers and Hayward, 1948). In plants, where harvestable yield is composed of vegetative parts such as leaves, leaf yields are generally reduced under salt stress conditions in proportion to decrease in plant size (Bernestein, 1964). Various workers reported the varietal variability under salt stress in different crop plants including forage crops. They observed that the economical yield of crop plants (grain yield or forage yield) was less at higher salt concentrations (Lunin *et. al*., 1963).

Similarly, genotypic variation with respect to mulberry leaf yield within the treatments was observed, which is in agreement with the findings of Raja Indira and Raja (1980) and Bose & Majumder (1999). Performance of the different mulberry genotypes in different reclamation treatments indicated that the expression of leaf yield of genotypes is dependent on both reclamation treatment and the mulberry genotypes. Treatment x genotype interaction was also found to be significant. Though leaf yield varied significantly among mulberry genotypes in the same reclamation treatments, yet the effect of different reclamation treatments was evident by average increased gain in the yield in reclamation treatment with organic amendment followed by reclamation treatment with inorganic amendment. Though the leaf yield level increased with the change of reclamation treatments, yet the ranking of genotypes remained the same in each of the treatments, independently.

Six mulberry genotypes were evaluated under different stress conditions like, soil moisture stress, alkalinity and salinity by Urs *et.al.* (2011). It is indicated by Rajat Mohan et al., (2012) evaluated mulberry genotypes and found that AR-12 and AR-14 suitable for Sodic soils of Uttar Pradesh, India and felt that this will not only help sericulture farmers to get income from cocoon crop but will be a great contribution for environment as in a span of time such plantation will convert uncultivable land into cultivable land and reclamation will completely rehabilitate the soil.

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In view of the importance attributed to bioassay (Krishnaswami *et. al.,* 1971; Benchamin, 1989; Benchamin and Anantharaman, 1990; Lou Chengfu, 1994), to test mulberry leaf quality, same was studied taking in to consideration, weight of 10 matured larvae, ERR/10000 larvae (by number and weight), Single cocoon weight, Single shell weight and Shell ratio percentage for five crops during third year of plantation. Bioassay results indicated superiority of the genotype AR-12 under reclaimed conditions over other genotypes and treatments, which supported the findings of Anas and Vivekanandan (1997), who found significant varietal differences in all the parameters of bioassay, reflecting the differences in leaf quality of different mulberry genotypes grown in saline soils. Improvement in cocoon yield and economic characters of cocoons confirms the better quality of mulberry genotypes under reclaimed conditions, is in agreement with the findings of Li and Sano (1984), Tayade and Jawale (1984) and Chaluvachari and Bongale (1995).

Integrated package for raising profitable mulberry culture in alkali soils:

The study indicates that genotypic variation exists in mulberry genotypes in alkali soils with or without reclamation. As the soil properties improve significantly with application of amendments particularly pressmud, makes the intercultural operations easy and economical for a marginal farmer. Genotype AR-12 has registered an increase of 29.70% and 42.49% in leaf yield during first and second year of the study, respectively (**Table-3**). Out of the test genotypes and checks employed in the present study, it was observed that response of the genotype, AR-12 was superior with respect to all traits including morpho-physiological and bioassay parameters, except for ERR by number, where improvement was non-significant (Sathyanarayana K., *et.al.* 2008a & b). This infers suitability of AR-12 in alkali soils before and after reclamation with pressmud, beyo nd dou bt.

Table-3: Percentage of improvement in the most promising mulberry genotype (AR-12) under integrated package with initial soil reclamation with pressmud @ 50 MT/ha.

Characters	Un-reclaimed Alkali soil	Reclaimed with organic amendment	Improvement (%)
Leaf yield (MT/ha./yr.)			
First year	15.96	20.7 *	29.70
Second year	17.77	25.32 *	42.49
Average of two years	16.87	23.01 *	36.40
Weight of larvae (g)	32.509	34.652 *	6.59
ERR by number	8742.8	8961 **NS**	2.50
ERR by weight (kg)	15.183	16.047 *	5.69
Single cocoon weight (g)	1.822	1.881 *	3.24
Single shell weight (g)	0.326	0.349 *	7.06
Shell ratio (%)	17.88	18.59 *	3.97

**** Significant over unreclaimed treatment at 5% level***
NS Not significant over unreclaimed treatment at 5% level

The Genotype AR-12 was provisionally admitted for registration by Central Sericultural Germplasm Resources Centre (CSGRC), Hosur of Central Silk Board on 30.5.2005 and registered in July, 2005 (ISGR 05 066) under Indian Sericultural Germplasm (ISGR) system. Simultaneously, the breeders' stock and multiplication plantations were established in Central Sericultural Research and Training Institute, Mysore. The seed cutting material of AR-12 was supplied to Training Institute, Hindupur, RSRS, Chamarajanagar, RSRS, Salem where cultivable lands found alkaline in nature. Later, it was considered as a new technology and included in Transfer of Technology of CSR & TI, Mysore for utilization of alkali waste lands. The seed material was provided in large quantities to Kollegal area (Suttur) of Chamarajanagara district of Karnataka. Salient characteristics/ Chief botanical and morpho-agronomic description of mulberry variety AR-12 as accepted by ISGR system are mentioned below.

Morphological Characteristics	Characters of AR-12
1. Type of species	*Morus indica*
2. Sexuality	Predominantly male

3. Plant type	Erect
4. Ploidy level	Triploid
5. No. of shoots/plant	8-10
6. Total length of shoots	739 cm
7. Length of inter node	3.75 cm
8. Leaf size and shape	Large, entire, cordate Length : 17-21 cm ; Breadth : 14-17 cm
Morphological Characteristics	**Characters of AR-12**
9. Leaf surface	Smooth, glossy, dark green
10. Leaf thickness	170 um
11. 100 leaf weight (13 to 20^{th})	425 g
12. Resistance to diseases	Tolerant to leaf spot, moderately resistant to leaf rust.
13. Leaf yield	16-17 MT/ha/year under normal alkali soils (pH up to 9.5) & 22-24 MT/ha/ year under organic reclamation of alkali soil before plantation in comparison to 10-11 & 14-15MT/ha/year in S-34 under similar conditions respectively.
14. Regeneration	13-15 days after pruning during Winter season. 9-10 days after pruning during other seasons.
15. Sprouting (at 30^{th} day)	94%
16. Rooting (90 days for tropical and 120 days for sub-tropical and temperate).	90 % (under alkali soils)

Genotype AR-12 was found superior in alkali/ sodic soils of both south as well as north India. It may be exploited for cultivation in waste lands and for tree plantation for greenery and sericulture. Though it is developed for specific purpose i.e., utilization of alkali soils for silk production, it may be included in All India Coordinated Experiments for Mulberry (AICEM) for assessment of its potential in other parts of India. In general triploids performing better in hilly and high altitude areas, it may be evaluated.

Above study infers that the organic amendment, pressmud is the best source to correct the soil alkalinity and improve the soil characteristics for increased production from tolerant genotypes in the alkali soil and AR-12 is the suitable genotype for growing in alkali soil with the best rearing performance. The cocoon characters were further improved with organic amendment.

Proper planning for multiplication of alkali tolerant mulberry genotype AR-12 and the adoption of reclamation package as suggested is expected to result in effective utilization of hitherto untapped alkali soils for mulberry cultivation. Further, efforts should be made to utilize the genetic variability in mulberry to identify species-specific markers for alkalinity stress condition. Also, empirical testing in hot spots for alkali soil is the best way to screen promising mulberry germplasm accessions tolerant to such soils.

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Efficacy of bio-foliar spray on growth and biochemical constituents of different mulberry varieties

By

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Bio-foliar is an eco-friendly formulation combined with biological based organisms viz; Spirulina, Soybean and Vermiwash. The objective of the present study was to enhance the growth, yield and biochemical constituents of mulberry by using bio-foliar in an instant available form. 15, 30 and 45 ppm concentrations of bio-foliar sprayed on five different mulberry varieties namely S-1, S-146, S-1635, BR-2 and AR-14. Results of the investigation revealed that among selected mulberry varieties and treatments, BR-2 and S-1635 mulberry varieties were performed well in respect of productivity and biochemical constituents. Highest leaf area (234.07 cm^2) and total leaf yield per

hectare (51.48 tons) were noticed in BR-2 mulberry variety at 45 ppm followed by S-1635 variety. Further, same trend has been continued with highest protein (0.555 mg/g), carbohydrate (0.668 mg/g), carotenoids (0.550 mg/g), total chlorophyll (2.04 mg/g) and crude protein content (26.67 %) at 45 ppm concentration were recorded in BR-2 variety followed by S-1635 variety as compared to control. The outcome of research implies that, among five mulberry varieties and concentrations, BR-2 and S-1635 varieties with 45 ppm concentration performed well and successfully augments the productivity and biochemical constituents of different mulberry varieties without any side effect.

Keywords: Bio-foliar, mulberry, spirulina, soybean, vermiwash.

EFFECT OF PLANT PRODUCTS ON INCIDENCE OF TUKRA ON MULBERRY

By

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(POSTER)

ABSTRACT: Tukra is one of the major problem in mulberry growing areas and it is caused by pink mealy bug *Maconellicoccus hirsutus* which affect both the quality and yield of mulberry leaf. A preliminary attempt has been made to control tukra in mulberry by using plant extracts of natural pesticidal origin. During the experimentation, the seed kernel and leaf extracts of *Azadirachta indica, Pongamia pinnata, Madhuca longifolia* and only leaf extracts of *Lantana camara, Adathoda vasica* were directly used as a foliar spray to control Tukra. Out of four sprays given with an interval of 7 days, but the data on effect of medicinal plant extracts on tukra incidence revealed, non significant results after first spray. However, there was a considerable leaf area free from tukra infestation after second spray (14 days). The total leaf area free from the incidence was 13.12 and 4.34 per cent which were recorded @ 4% Neem seed kernel extract and 10% *Lantana* leaf extract respectively. The trend was same even after third and fourth spray. Further, plants sprayed with Neem seed kernel extract @ 4% (24.04% and 35.33%), *Pongamia* seed kernel extract @ 2% (20.22% and 30.46%), *Pongamia* seed kernel extract @ 4% (20.00% and 29.10%) revealed decreased incidence of Tukra from seed kernel extracts sprayed plants than leaf extracts. In control plot, the incidence was increased from 31.59 to 36.40 per cent and 31.59 to 41.27 per cent which was found to be higher than treated plots. It is further observed that, the reduction in mealy bug population in M-5 mulberry was due to the IGR effect of Neem which kills the immature stages of insect with repellent and insecticidal property on soft bodied insects.

Key words: Mulberry, *Maconellicoccus hirsuts,*Plant products

INTRODUCTION

Mulberry is the indispensable food for mulberry silkworm and is known for its luxuriant growth. About 300 insect and non-insect species of pests are known to inflict the damage to mulberry in different parts of the world. The pests of mulberry are classified as defoliators (leaf eating pests), sucking pests (sap suckers), stem borers and root feeders. Among these, sucking pests *viz.,* Mealy bugs, Spiralling whiteflies, Jassids, Thrips, Scale insects and mites are causing considerable damage to mulberry depending on the season, region and mulberry varieties (Reddy and Narayanaswamy, 2003). Being a perennial, evergreen and high biomass producing plant, mulberry offers ideal conditions for uninterrupted and rapid multiplication of these pests in space and time, often reaching alarming proportions (Manjunath, 2004). However, the pink mealy bug *Maconellicoccus hirsutus* Green (Pseudococcidae: Homoptera) is considered as an important cosmopolitan sucking pest and regular in occurrence. This pest is highly prevalent in tropical regions and has a wide range of alternate hosts including ornamental, fruit trees, timber and wild plants.

During infestation the mealy bug prefer tender portion of the plant because of succulence. It sucks the sap simultaneously releasing toxins which results in short internodes, curling, wrinkling and crumpling of apical leaves virtually stopping the growth of the plant by suppression of stem elongation affecting the yield of leaves. Further the affected region swells and turns into deep green color. Therefore, the symptoms of mealy bug infestation in mulberry collectively called as tukra (Misra, 1919). Besides, reduction in leaf area, yellowing of leaves, premature leaf fall occurs due to impaired function of the petiole due to mealy bug infestation.

MATERIAL AND METHODS

This experiment was laid out during summer season of 2011-2012 in Randomized Block Design with three replications. Well established M5 variety mulberry garden were selected at University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bangalore . for this study. Total of four sprays were given with an interval of 7 days.

Treatments Details

Tr. No	Treatments
T1: NSKE @ 4%	Neem (*Azadirachta indica*) seed kernel extract @4% + Soap powder @1%
T2: NSKE @ 2%	Neem (*Azadirachta indica*) seed kernel extract @2% + Soap powder @1%
T3: NLE @ 10%	Neem (*Azadirachta indica*) leaf extract @ 10%
T4: NLE @ 8%	Neem (*Azadirachta indica*) leaf extract @8%
T5: PSKE @ 4%	Honge *(Pongamia pinnata)* seed kernel extract @ 4% + Soap powder @1%
T6: PSKE @ 2%	Honge *(Pongamia pinnata)* seed kernel extract @2%+ Soap powder @1%
T7: PLE @ 10%	Honge (*Pongamia pinnata*) leaf extract @ 10%

T8: PLE @ 8%	Honge (*Pongamia pinnata*) leaf extract@ 8%
T9: MSKE @ 4%	Mahua (*Madhuca longifolia*) seed kernal extract @4% + Soap powder @1%
T10: MSKE @ 2%	Mahua (*Madhuca longifolia*) seed kernal extract@2% + Soap powder @1%
T11: MLE @ 10%	Mahua (*Madhuca longifolia*) leaf extract @10%
T12: MLE @ 8%	Mahua (*Madhuca longifolia*) leaf extract@8%
T13: LLE @ 10%	*Lantana (Lantana camara)* leaf extract@ 10%
T14: LLE @ 8%	*Lantana (Lantana camara)* leaf extract @8%
T15: ALE @ 10%	Adusoge (*Adathoda vasica)* leaf extract @10%
T16: ALE @ 8%	Adusoge (*Adathoda vasica)* leaf extract @ 8%
T17	Control

Observations

In each plant (both sprayed and unsprayed) the total number of infested and healthy leaves was recorded to calculate the per cent tukra incidence by the formulae of Mc Kinney (1923) in the following 5 different grades.

I-Grade 1-10 % -leaf area affected by tukra

II-Grade 11-25 % -leaf area affected by tukra

III-Grade 26-50 % -leaf area affected by tukra

IV-Grade 51-75% -leaf area affected by tukra

V-Grade 76-100% -leaf area affected by tukra

Percent tukra incidence

$$\text{Tukra incidence (\%)} = \frac{\text{Sum of numerical values}}{\text{Total no. of leaves} \times \text{Maximum grading}} \times 100$$

RESULTS AND DISCUSSION

- After fourth spray the maximum per cent leaf area free from incidence was recorded from NSKE @ 4% (35.33%) followed by PSKE @ 2% (30.46%) and minimum was recorded from LLE @ 8% (8.38%).
- The per cent protection over pre count of tukra incidence was reported maximum in NSKE @ 4% (92.10%) followed by PSKE @ 2% (86.64%) and minimun was recorded in LLE @ 8% (29.91%) and found significant.
- The reduced tukra incidence recorded in leaf extracts was comparatively lesser than seed kernel extract. However, the least reduction in tukra incidence was recorded in control (9.68%) and found lesser than both the types of botanical extracts.

- Babu *et al.* (1994) also revealed the use of aqueous plant extracts on *Maconellicoccus hirsutus* prepared from *Azadirachta indica, Rhizophora apiculata, Adathoda vasica, Parthenium hysterophorus, Lantana camera* and *Prosophis juliflora* directly used as a foliar spray on six mulberry varieties *viz.,* M_5, S_{13}, MR_2, Kosen, BC2-59 and Tr_4 revealed prevention of spread of *Maconellicoccus hirsutus*. However application of *Azadirhachta indica and Adathoda vasica* sprayed directly on mulberry have controlled the tukra and did not affect nutritional status of mulberry and silkworm rearing parameters. Further, the maximum decrease in incidence was observed with aqueous extracts of *A.indica* (82.37, 24.27, 32.69 and 100%) followed by *Adathoda vasica* (51.45, 51.98, 77.09 and 52.22 %) and *Prosopis juliflora* (42.43, 58.24, 20.45 and 16.21 %) respectively in MR-2,BC-2-59, Tr-4 and Kosen mulberry varieties respectively. The deviation of the tukra incidence obtained from the present study might be due to the difference in concentration, environmental factors and differ in mulberry variety as reported.

Table 1: Effect of plant extracts on tukra incidence due to *M. hirsutus,* 7 and 14 days after spray

Treatments	Pre treatment count	7 DAS	14 DAS	Area free from incidence	% Protection over pre treatment count
NSKE @ 4%	38.30	38.30	25.18	13.12	33.83
NSKE @ 2%	34.24	34.24	24.87	9.36	28.55
NLE @ 10%	37.62	37.62	30.93	6.68	24.01
NLE @ 8%	34.90	34.90	26.96	7.94	25.25
PSKE @ 4%	34.43	34.43	24.30	10.13	32.83
PSKE @ 2%	35.12	35.12	24.45	10.67	31.21
PLE @ 10%	31.60	31.6	22.99	8.60	30.22
PLE @ 8%	28.32	28.32	21.40	6.91	36.85
MSKE @4%	32.02	32.02	24.59	7.43	31.92
MSKE @2%	32.86	32.86	23.45	9.41	32.84
MLE @10%	29.29	29.29	21.37	7.92	37.80
MLE @ 8%	32.83	32.83	26.97	5.85	26.68
LLE @ 10%	26.16	26.16	21.82	4.34	27.39
LLE @ 8%	27.89	27.89	22.98	4.90	22.24
ALE @10%	26.34	26.34	17.49	8.85	35.58
ALE @ 8%	31.94	31.94	23.79	8.14	30.85
Control	31.59	31.59	31.50	0.00	0.00
F –test	NS	NS	NS	NS	NS
S.Em±	2.94	2.94	2.97	1.57	5.66
CD at 5%	-	-	-	-	-

Table 2: Effect of plant extracts on tukra incidence due to *M. hirsutus,* 21 days after spray

Treatments	Pre treatment count	21 DAS	Area free from incidence	% Protection over pre treatment count
NSKE @ 4%	38.30	14.26	24.04	56.22
NSKE @ 2%	34.24	14.82	19.42	45.93

NLE @ 10%	37.62	18.95	18.67	47.64
NLE @ 8%	34.90	15.96	18.94	51.18
PSKE @ 4%	34.43	14.44	20.00	55.72
PSKE @ 2%	35.12	14.90	20.22	54.08
PLE @ 10%	31.60	15.45	16.16	49.84
PLE @ 8%	28.32	15.12	13.20	49.15
MSKE @ 4%	32.02	16.12	15.91	48.74
MSKE @ 2%	32.86	18.02	14.84	53.26
MLE @ 10%	29.29	19.77	9.52	44.33
MLE @ 8%	32.83	24.83	7.99	39.51
LLE @ 10%	26.16	20.26	5.90	40.80
LLE @ 8%	27.89	20.61	7.28	35.59
ALE @ 10%	26.34	11.97	14.38	52.53
ALE @ 8%	31.94	15.07	16.87	48.43
Control	31.59	36.40	-	-
F- test	NS	*	*	NS
S.Em±	2.94	1.89	1.94	8.84
CD at 5%	-	5.44	5.60	-

Table 3: Effect of plant extracts on tukra incidence due to *M. hirsutus* 28 days after spray

Treatments	Pre treatment count	28 DAS	Area free from incidence	% Protection over pre treatment count
NSKE @ 4%	38.30	2.97	35.33	92.10
NSKE @ 2%	34.24	4.73	29.51	86.07

NLE @ 10%	37.62	9.55	28.06	74.59
NLE @ 8%	34.90	10.76	24.14	69.23
PSKE @ 4%	34.43	5.33	29.10	84.46
PSKE @ 2%	35.12	4.65	30.46	86.64
PLE @ 10%	31.60	10.58	21.02	66.50
PLE @ 8%	28.32	12.03	16.29	57.40
MSKE @ 4%	32.02	12.38	19.64	61.30
MSKE @ 2%	32.86	15.67	17.20	52.34
MLE @ 10%	29.29	16.55	12.74	43.36
MLE @ 8%	32.83	20.88	11.95	36.45
LLE @ 10%	26.16	16.65	9.51	36.20
LLE @ 8%	27.89	19.51	8.38	29.91
ALE @ 10%	26.34	7.20	19.14	72.60
ALE @ 8%	31.94	10.89	21.05	65.73
Control	31.59	41.27	9.68	-
F- test	NS	*	*	*
S.Em±	2.94	1.37	1.94	0.51
CD at 5%	-	3.95	5.59	1.47

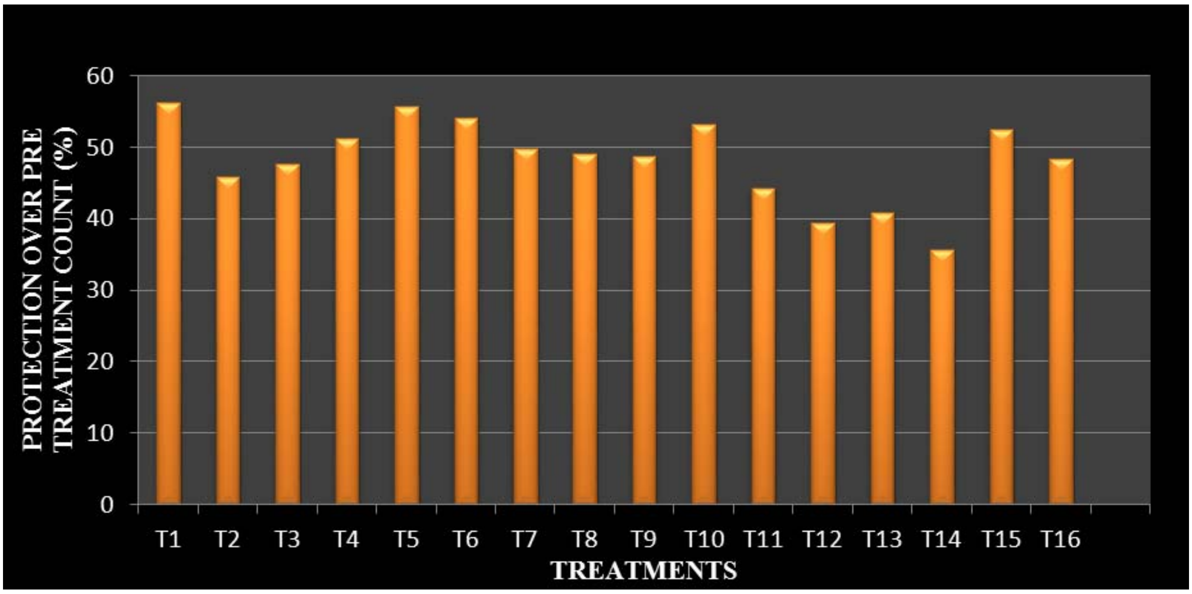

Fig. 1: Tukra incidence as influenced by plant extracts at 21 days after spray

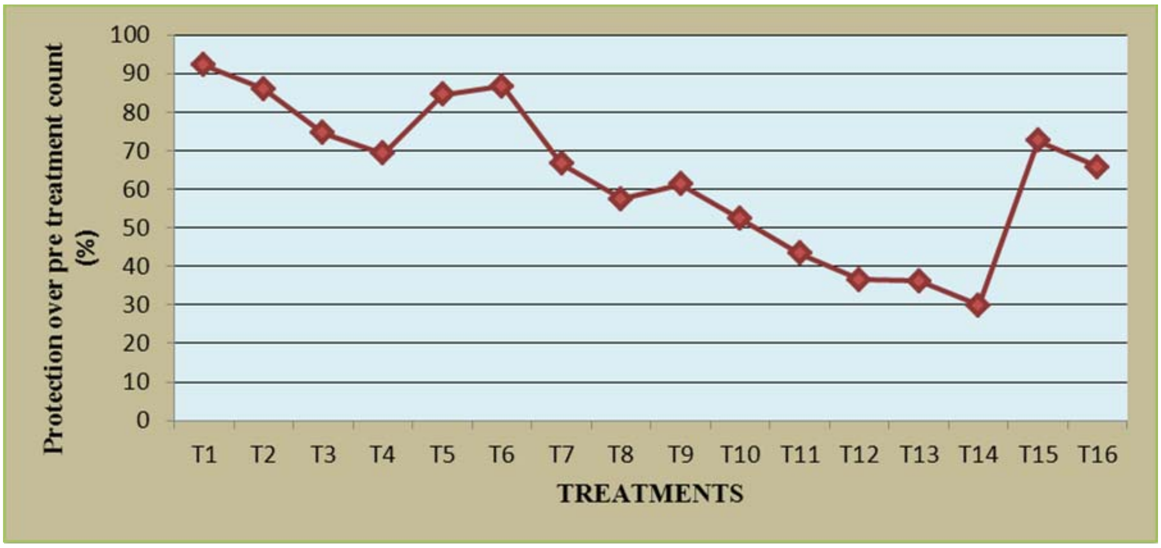

Fig. 2: Effect of plant extract on tukra incidence due to *M. hirsutus* infestation at 28 days after spray

T1-NSKE @ 4%, T2-NSKE @ 2%, T3-NLE @ 10%, T4- NLE @ 8%
T5-PSKE @ 4%, T6-PSKE @ 2%, T7-PLE @ 10%, T8-PLE @ 8%
T9-MSKE @ 4%, T10-MSKE @ 2%, T11-MLE @ 10%, T12-MLE @ 8%
T13-LLE @ 10%, T14-LLE @ 8%, T15-ALE @ 10%, T16- ALE @ 8%
T17- Control

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INFLUENCE OF MINE ORE WASTES AS A SOURCE OF MICRONUTRIENTS IN MULBERRY

By

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Experiments were conducted to know the effect of application of Copper/Gold ore mine wastes of Chitradurga Hutti mines on V-1 Mulberry hybrid raised on red soils as a source of Micronutrients. The study was carriedout at Department of Agril. Entomology,University of Agricultural Sciences, Dharwad from November 2005 to March 2007. The pooled data analysis revealed that application of COT (Cooper Ore Tailing) @ 2 tonnes/ha/year along with NPK (350:140:140) + 50% FYM (10 tonnes/ha/year) could produce on par results with recommended check [N:P:K: 350:140:140+FYM (20 tonnes)] for leaf, shoot and cocoon yield. The pooled data analysis showed non significant difference for shoot yield. However, maximum shoot yield was recorded in T6 (515.24) and was on par with all other treatments including check except for T4. It was interesting to note that application of RDF + 50% FYM (10 tonnes) + COT (2 tonnes)/ha/year (t12) and RDF + 50% FYM (10 tonnes) + GOT (1 ton)/ha/year (T9) was non lethal to silkworms and recorded statistically on par results for leaf, shoot and cocoon yield with RDF + FYM (20 tonnes) (T1). Application of COT was safe to silkworms and could save Rs. 7000/-/ha/year due to reduction in application of 50% FYM (Farm Yard Manure) (10 tonnes). Since mulberry is a perennial crop and remains in the field for a long period (15-20 years), there is need to assess the micronutrient status in the soil as well as mulberry leaf over years to fix the suitable frequency of application of COT. There is also need to develop a micronutrient foliar spray formulation for easy application. The results have been discussed.

Keywords: Mulberry, COT, GOT, Micronutrients, Non toxic, Silkworms, Cocoon yield

ZONATING LEAFSPOT CAUSED BY *GONATOPHRAGMIUM SP.* : A NEW FOLIAR DISEASE OF MULBERRY IN THE PHILIPPINES

By

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Preliminary morphological characterization and fungal identification was done based largely on Ellis' (1976) Dematiaceous Hyphomycetes to determine the new disease of mulberry observed attacking mulberry plants in the Philippines.

Infected leaves were collected from SRDI experimental station, brought to the laboratory for examination. The symptoms were described. The fungal structures from young lesions were picked-up carefully with a dissecting needle, transferred into a drop of plain lactophenol on a clean glass slide and covered with a cover slip. The morphology of the fungal structure was described using a compound microscope under oil immersion magnification. The size of the important parts of the fungus was measured using micrometer.

Gonatophragmium genus was tentatively identified to be the causal organism attacking mulberry leaves causing large zonate brown leaf spot. The fungus is a denticulate hyphomycete.

Preliminary field surveillance showed that , there were 12 mulberry varieties affected by zonating leafspot caused by *Gonatophragmium sp.* S54 and Batac varieties were severely infected while Alfonso, J-Unlobed, M local, Kosen, MR2, Papua, S13 and SRDC2 were observed disease-free. Studies on etiology, characterization of the life cycle of the pathogen and disease management shall be the focused of the institute and should be immediately address.

Keywords: Dematiaceous Hyphomycetes , lesions, *Gonatophragmium, zonating,*

CROP IMPROVEMENT AND ROLE OF PRE-BREEDING IN MULBERRY (*MORUS* SPP.) TO TACKLE THE CLIMATE CHANGE

By

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In the present paper the details of pre-breeding of wild mulberry and its utility have been highlighted. Mulberry, the principal food of silkworm (*Bombyx mori* L.) need to sustain the climate change which is one of the major challenges for future. Climate change is characterized by extreme rainfall variations, unpredictable droughts, floods, high temperatures and fragile natural resource base. Environmental effects such as desertification and rising sea levels triggered by climate change can lead to increased conflict for resources.

Mulberry crop has the potential to adapt and mitigate the impact of climate change. This is possible through adoption of high yielding, climate change resilient crop varieties and substantial crop management practices, such as improved soil, crop, water and nutrient management. Sericulture can also serve as potential sink for carbon and contribute to the resilience that is needed by small holder farmers to adopt and withstand the impact of climate change. To tackle the wider adverse climatic condition, wild mulberry resources can utilize to harness the useful gene and improve the cultivated one through Pre-breeding procedures.

Morus laevigata an indigenous wild mulberry is having large leaf, long inflorescence, long fruit and high timber value and also adapted wider agro-climatic regions from mean sea level to elevation up to 1500m covering humid tropical regions to subtropical regions. Likewise, *Morus serrata* is a wild mulberry endemic to northwest India available at higher altitude (700-2200m) and found tolerant to biotic and abiotic stresses. Pre-breeding interspecific hybridization (*M.indica* x *M.laevigata*) and (*M.indica* x *M.serrata*) was employed to use the useful characters and obtained successful F1 hybrid. The F1 hybrid was sturdy, vigorous growth with succulent leaves suitable for silkworm rearing and withstands the biotic and abiotic stress and maintained in the mulberry Germplasm. The pre-breed material can be further used for specific purpose depending on the need to adopt varied agro-climatic condition.

Key words: Pre-breeding, wild mulberry, indigenous, climate, germplasm

Pest management in mulberry- a new concept for environmental modulation

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Synthetic chemicals have unfortunate consequences like environmental contamination and creation of health hazards. The chemicals disrupt and kill the beneficial organisms that serve as natural pest control systems in plantation environment. Thereby, increased dependence on chemical substances has become uneconomical and impractical. Manipulation of crop production inputs, trap crops, behavioural chemicals and other ecological methods have been adopted to manage pests and beneficial insect species. Biological control is considered to be the corner stone of many integrated pest management programmes that utilize natural enemies such as pests, predators and pathogens. The current revival of interest in biological control is driven by a change from conventional approaches to emphasizing long term sustainability of mulberry plantations. Pest management through ecologically modified environment is vital to the sericulture farming, plantation biologists, sericulture scientists and farmers in promoting the productivity and balancing the eco-systems. The concept involves evaluation of comprehensive knowledge and consolidation of farm-scaping technique of hedge rowing in a unified programme for management of pest populations in mulberry plantations. The designated approach has no adverse effects on target species and the environment because environmental modulation and biological controls are limited by their specificity with respect to the distribution of target pest organisms or their persistence in the environment. The system enhances protective natural enemy habitats as well as augmentation methods in saving mulberry plantations.
Key Words : Mulberry, Environmental modulation, Hedge Rowing, Pest Management

IMPROVEMENT OF PROTECTION TECHNIQUES OF MULBERRY PLANTATION AGAINST DISEASES AND PESTS

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(POSTER)

ABSTRACT

The sericulture forage reserve in Rwanda is at an early stage of development. However, in most mulberry plantations, Mulberry bacterial disease, and pests such as vine weevil Otiorhynchus sulcatus and Tachypodoiulus niger were mostly observed. Research results had showed that the aptitude of mulberry saplings to resist or tolerate pest namely Tachypodoiulus niger and Otiorhynchus sulcatus is coupled to optimal application of organic manure, malathion (2%), lime and complex inorganic fertilizers ($N_{30}P_{24}K_{18}$) with 15g, 2g, 3g and 3.2g, respectively. Additionally, the growth of mulberry saplings in nursery beds was observed to be normal developed. For instance, rooting percentage of saplings in

nursery had reached almost 90 % (on 26,7 %), and thereby for a period of 90 days, mulberry branches have grown 2 times more than in control part. The aim of this research consists develop and improve technology of protection against diseases and pests in mulberry plantation.
Keywords: mulberry plantations, ***bacterial*** diseases and pest's application, silk worm, cocoon yield.

INTRODUCTION

Production of high-quality cocoons is mainly depending on quantity and quality of mulberry leaves. The yield and quality of leaves, in turn, depend on grade of mulberry, type of plantation, level of agricultural technicians, and also moisture content and nutrients elements in leaves. Most of the silk produced in the world is from mulberry silkworm, *Bombyx mori L.,* which is a monophagous insect eating mulberry leaves only. Therefore, sericulture development is not possible without improvement of mulberry cultivation. The success of mulberry leave's production depends on three main factors namely: resistance of mulberry varieties to diseases and pests, maintenance and management of mulberry plantation.

Sericulture forage reserve in Rwanda is at an early stage of development. Several years ago, with the support of the International Center of Insects Physiology and Ecology (ICIPE), some mulberry varieties have been introduced in the country, named: S36, S41, K2, Sangilpong, Gunsalpong, Chungilpong, Local, Susangpong, Thika, Thailand, Embu, and Kanva-2, were planted on about 350 ha across different regions of the country. Multiplication and creation of mulberry plantations was carried out without taking into account resistance or tolerance of mulberry varieties to diseases and pests.

In several mulberry plantations, different diseases were found (leaf dwarf, *Cylindrosporiosis*, bacterial blight *Pseudomonas syringae* pv. *Mori,* Sato M &Takahashi K, (1972), *Mulberry bacteriosis* Pickett *at al.*, (*2004*), Wang Guofen *et al*, (2008)*,* powdery mildew *Erwinia carotovora (*Takahashi & Sato*,1978)*, *Pseudomonas solanacearum* (He *at al.,*1983) , *Ralstoina solanacearum* (Taghavi *et al.,* 1966) and pests (different plant louses (*Aphididae*), mulberry scale *(Psudaulacaspis Pentagona*), *Multilegs* (*Myriapoda*), *Gryllotalpa gryllotalpa*, vine weevil (*Otiorhynchus sulcatus* and *Tachypodoiulus niger*). In aggregate, diseases and pests led to the reduction of plants, as well as worsens leave's quality; alongside with food contaminated by viruses, bacteria, fungus and other pathogens there was increase of silkworm diseases, such as: *Bacterial toxicosis*, viral diseases (*NPV* and *CPV*) and *Infectious flacherie*. Therefore, research on technological improvement of protection mulberry plantation against diseases and pests remains the priority.

MATERIALS AND METHODS

Preservation quality of mulberry leaves from diseases:

Bacterium mori is among the numerous mulberry diseases that are most widespread and dangerous. Once infect the plant, the immune system level decreases, which gradually lead to the reduction and destructions (Gupta *et al*., 1995; Sugimura *et al*., 1999; Ethel and Doidge, 2008). In many страна with tropical and temperate climates, mulberry plantations suffer from *Bacterium Mori* (Achtar M.A and Sarvar M., 1988**)**. Rwanda as is not excluded, though sericulture starts to be developed. Acreages of mulberry plantations are limited, but the increase of disease incidence in most plantations is significantly alarming. In order to improve technologies intended to prevent and control mulberry bacterial diseases, research studies were carried out in the following variants:

- Mulberry plantation density was changed by modify distance between lines and within lines from 1.0m : 0.6m to 2m : 0.6m;

- Pruning and weeding in plantation was carried out and afterward fertilizers were added around roots of each plan, with the following concentration: $N_{30}P_{24}K_{18}$-100 kg/ha and organic fertilizers 30 t/ha.
- As preventive measure, complex solution composed by: $Ca(OH)_2$ (1,0 %): CuSO4 (0,25 %): $N_{30}P_{24}K_{18}$ (0,01 %) was sprayed on leaves.
- Caterpillars of a silkworm were reared on mulberry leaves treated by the above chemical solution, and each 5 days data on survival rate were collected.

Protection of mulberry nursery plantation from pests:

Different classes of insects not only harm of mulberry plantation but also reduce yield of leaves and become carriers of diseases for silkworms. The big damage is brought by insects living in soil, such like *Multilegs* (*Myriapoda*), *Gryllotalpa gryllotalpa* (*Otiorhynchus sulcatus*). Earthworms (*Lumbricina*) especially the Family: Julidae, Genus: *Tachypodoiulus*, Species: *Tachypodoiulus niger*, and Vine Weevil (*Otiorhynchus sulcatus*) is harming root system a plant, especially is damaging a new planted mulberry cuttings and saplings. In order to improve technology of protection planting material and mulberry saplings against soil parasites, the following research was carried out:

- Preliminary treatment of mulberry cuttings with different concentration of solution of Malathion dust (2 %) and Lime;
- Fertilization of a new planted cuttings and mulberry saplings in nursery with organic and inorganic fertilizers.

RESULTS AND DISCUSSION

Mulberry diseases caused by bacterial pathogens were found to be the most extended in most mulberry plantations**.** The causing agent is the bacteria known as *Bacterium mori*. The disease outbreaks during vegetation when there is a suddenly seasonal change: increase humidity combined with low temperature. The disease affects the buds, leaves and young shoots, causing deep wounds. After the primary infection, some washy spots appear on the leaf surface. Their color is light yellow at the beginning and then turns into brown to black. The disease infects also the leaf nervation and the bark of young shoots. Due to the contamination, assimilation is disturbed and consequently leaves are fallen down.

Research results have shown that incidence mulberry diseases caused by bacteria were high when maintenance and management plantation was poorly performed. In due time, upper plant part is not spent, and once pruning process is not carried out, consequently there is lack of illumination and air movement in plantation is limited. It was observed that different mulberry varieties possess resistance or tolerance characteristics against *Mulberry bacterium* infection. In order to improve technology of prevention and control mulberry diseases, the following studies were explored:

Pict. 1. Bacterial disease on mulberry

- The distance of row-spacings, between plants, was expanded by twice as well as decreasing number of branches. After weeding, mineral and organic fertilizers were applied;
- Mulberry plants were sprayed by a liquid named Bardov solution, with 0,01 % of $N_{30}P_{24}K_{18}$, and thereby improve resistibility of plant against mulberry bacterium.

After the application of the solution composed by: Ca $(OH)_2$ (1,0 %): CuSO4 (0,25 %): $N_{30}P_{24}K_{18}$ (0,01 %), treated mulberry leaves were fed on silkworm larvae, by taking into account date of treatment (table 1).

Table 1. Efficiency of disinfector ($CuSO_4$: Ca $(OH)_2$: $N_{30}P_{24}K_{18}$) on biological parameters and yield of silkworm

Variants	Viability of pupal (%)	Weight of a cocoon (g)	Weight of a cocoon shell (mg)	Percentage of silk	Harvest cocoons kg/bo
10 days *	21,5±1,32	1,72±0,78	369,8±1,45	21,5±1,82	7,40±3,02
15 days	65,0±1,67	1,80±0,65	394,2±1,42	21,9±1,76	23,4±3,12
20 days	83,7±1,23	1,97±0,32	449,2±1,56	22,8±1,62	33,0±2,83
25 days	92,5±1,37	1,95±0,25	452,4±1,48	23,2±1,66	36,1±2,94
Control	77,5±1,77	1,80±0,52	396,0±1,69	22,0±1,70	27,9±3,17

* Used after treatment of mulberry leaves for silkworm rearing P=005

Results have shown that conduct silkworm rearing, after 10 days treatment date of the above solution on mulberry leaves, is pernicious on silkworm larvae. Nevertheless, after 20 days from date of treatment, toxicity in leaves is decreased, while on the 25th day put toxic substances were completely disappear so that mulberry leaves could be safely fed as well as prevent against infectivity of Mulberry *bacterium mori*. In this manner, mulberry trees start to grow intensively, and also the use of such leave's quality in rearing may increase viability of larvae, this was resulted in high harvest cocoons (36,1±2,94 kg/box), than on 8,0 kg/box more than control part.

CONCLUSION:

- Incidence of bacterial disease has been optimal decreased, 25 days after the application of the solution Ca $(OH)_2$ (1,0%) : CuSO4 (0,25%) : NPK (0,01%);
- It is recommended to use of treated mulberry leaves, by the above solution, after a minimum of 20 days against *Mulberry bacterium mori*.

Protection of mulberry nursery plantation from pests:

Vine Weevil *Otiorhynchus sulcatus*;

Various types of insects attack mulberry plantation: insects living in soil, such as *Multilegs* (*Myriapoda*), *Gryllotalpa gryllotalpa*. Especially Earthworms Vine Weevil *Otiorhynchus sulcatus* and *Tachypodoiulus niger*, strongly damages mulberry cutting and saplings.

Pict. 2 *Otiorhynchus sulcatus*

Root weevils in the genus *Otiorhynchus sulcatus* F. (Coleoptera: Curculionidae), is a polyphagous insect are cited as one of the most important pests in the major nursery and small fruit production areas throughout the United States, western Canada, and northern Europe (Moorhouse et al., 1992; Van Tol et al.,2012). Currently, effective pesticides against weevil larvae are not available, and the large-scale biocontrol of weevil larvae with parasitic nematodes is costly. The only economically feasible method available in The Netherlands is to control adult weevils by spraying acephate. This pesticide is not compatible with integrated control, as it kills the natural enemies of other pests.

The Vine Weevil is a pest of many garden plants. All vine weevils are female and each can lay up to 1,000 eggs in favorable conditions. Embryonic egg development lasts about 20 days. The larvae are stout, creamy white, legless grubs with brown heads; their bodies are slightly curved and up to 10mm long, they bury themselves deep in the ground, they feed on the roots of many and the tubers of plants, wounding the large ones. Growth lasts from 9 months to two years. The adults emerge in a warm season of year and the females lay eggs during August – September and all the next year. They spend a adverse period in the ground and under various shelters. The larvae hibernate once or twice before pupating.

Pict. 3 *Adult of the Otiorhynchus sulcatus*

Earthworm *Tachypodoiulus niger*;

Another earthworms (*Lumbricina*) especially the Family: Julidae, Genus: *Tachypodoiulus*, Species: *Tachypodoiulus niger*, known variously as the white-legged snake millipede or the black millipede, is an European species of millipede. It is very similar to other species such as *Cilindroiulua londinensis,* from which it can be reliably distinguished only by studying the shape of the Telson. It is especially common on chalky and limestone soils. *T. niger* has a roughly cylindrical shiny black body, with around 100 pairs of contrasting white legs on its 41–56 body segments. It lives in leaf litter, under bark or in moss, and feeds on humus, at its absence roots stalks plants detritus and sometimes fruit such as raspberries. It is predators are most is active at night up to sunrise, although in summer also becomes active in the afternoon. Like many millipedes, *T. niger* coils itself into a spiral, with its legs on the inside and its head in the centre, when it is threatened, but it can also flee with side winding movements.

Pict. 4 *Tachypodoiulus niger* in defensive posture

Research studies were carried out on different chemical substances and sprayed in soil to fight against earthworms, namely: *Tachypodoiulus niger* and *Otiorhynchus sulcatus*. Since vegetative propagation is the most method used to establish mulberry plantation, pests listed above might cause damage of newly sprouted cuttings and consequently loss of yield. For the preliminary processing of mulberry cuttings, mixture of Malathion dust (2 %) and Lime was applied. This has resulted in the significant decreasing of number of pests around planted cuttings. Once young branches were emerged and tender roots on cuttings came out, the first fertilization in nursery bed with combination of organic manure and inorganic fertilizers was performed (Table 2).

Table 2. Effect of different chemical substances composition on *Tachypodoiulus niger* and *Otiorhynchus sulcatus*

Experiment variants		Q-ty of chemical/tree (g)	Effect	Percentage of rooting (%)	Height of branches, (cm)	Number of leaves
1	Organic fertilizer	15,0	Partially	63,7±2,74	25,5±0,42	10,5±0,21
	Malathion dust (2%)	0,5				
	Lime	1,0				
	$N_{30}P_{24}K_{18}$	1,0				
2	Organic fertilizer	15,0	Moderately	68,5±3,11	32,6±0,25	12,5±0,12
	Malathion dust (2%)	1,0				
	Lime	1,6				
	$N_{30}P_{24}K_{18}$	1,3				
4	Organic fertilizer	15,0	Full absence of the pests	80,2±2,33	42,8±0,34	15,8±0,22
	Malathion dust (2%)	1,3				
	Lime	2,6				
	$N_{30}P_{24}K_{18}$	2,8				
5	Organic fertilizer	15,0	Full absence of the pests	89,4±2,55	45,5±0,23	16,2±0,34
	Malathion dust (2%)	2,0				
	Lime	3,0				
	$N_{30}P_{24}K_{18}$	3,2				
6	Control: Organic fertilizer	15,0	Actions was not observed	62,7±3,22	25,8±0,69	10,2±0,52

P=005

Research had showed that the ability of mulberry saplings to resist or tolerate insect pests and disease is tied to optimal application of: Organic fertilizer, N30P24K18, Malathion dust (2 %), Lime, with 15, 2, 3, and 3.2 g respectively. Additionnaly, it provides normal growth development of mulberry saplings in nursery. For instance,
provided full protection from *Tachypodoiulus niger* and *Otiorhynchus sulcatus* and. Percentage of rooting at nursery has reached almost 90 % (on 26,7 %) within 90 days and mulberry branches have grown on 0,5 m, corresponding in 2 times more than the control part.

CONCLUSION: The best method which can be used against mulberry pests: *Tachypodoiulus niger* and *Otiorhynchus sulcatus* consists to apply: Organic fertilizer -15,0 g: Malathion dust (2%) -2,0g: Lime -3,0 g: $N_{30}P_{24}K_{18}$ -3,2g within nursery bed.

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MULBERRY SCALE (WHITE PEACH), PSEUDAULACASPIS PENTAGONA (TARGIONI) (INSECTA: HEMIPTERA: DIASPIDIDAE)

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ABSTRACT

Mulberry scale (white peach), Pseudaulacaspis pentagona (Targioni), is an important economic pests of many woody ornamentals and crops. In 2006, the government of Rwanda has set up policies for develop sericulture as one of the priority in the agriculture branch. Since, it can be very effective in creating new job opportunities, employment in family,

poverty alleviation and rural development. Previously, for establish mulberry plantation for silkworm rearing, planting materials were imported from neighboring and others countries, without any control application of phyto-sanitary standards. Consequently, the delivered planting materials were carried some harmful pests, such as: mulberry scale (white peach) - Pseudaulacaspis pentagona. The purpose of this research study consist to investigate incidence and transmibility of mulberry scale, and develop recommendations about prevention and control measures against these pest in mulberry plantation.

Keywords: mulberry plantations, pests, mulberry scale (white peach), planting material fumigation.

INTRODUCTION

Mulberry scale (white peach), *Pseudaulacaspis pentagona* (Targioni), is believed to have originated in Japan or China, although one report places the point of origin in Italy where it was first described in 1886 by Targioni. This insect is an important economic pests of many woody ornamentals/crops: the (Aonidiella aurantii), the Italian pear scale (Epidiaspis leperii), the oystershell scale (Lepidosaphes ulmi), the european fruit scale (Quadraspidiotus ostraeiformis), the San Joss scale (Q. perniciosus), the northen oystershell scale (Q. piri), papaya coffee, (Le Pelley, 1968; Valand, at al.,1989) and alternative hosts include tea, Citrus, guava, mango (Hill, 1983) and the mulberry scale (Pseudaulacaspis pentagona) peach trees as well as woody ornamentals in the southeastern United States (Wood, 2009). In the early part of this century, white peach scale destroyed numerous peach orchards in Florida and completely decimated a grove of 10,000 peach trees in south Georgia (Dekle, 3e1965) . Besides fruit, decorative and wood cultures, mulberry Scale is capable to damage grassy vegetable cultures: a pumpkin, carrots, stock beet, an eggplant and ornamental plants including Crytomiun and other ferns, *Clermontia parviflora,* Pipturus, *Solanum santiwongsei* (Zimmerman, 1948).

Fig.1. Adults of the Mulberry scale (white peach) *Pseudaulacaspis pentagona* (Targioni).

Mulberry scale (white peach), *Pseudaulacaspis pentagona,* is known by a variety of common names including white scale and West Indian peach scale. In Bermuda, this pest is known as oleander scale because of the massive damage it caused to oleander plants in 1920.

Family of scale insects called armoured scales; body of female protected by a hard, scale-like covering formed from cast-off nymphal skins and wax; females sessile and devoid of legs and antennae. In 2006, the government of Rwanda has set up policies for develop sericulture as one of the priority in the agriculture branch. Since, it can be very effective in creating new job opportunities, employment in family, poverty alleviation and rural development. Previously, for establish mulberry plantation for silkworm rearing, planting materials were imported from neighboring and others countries, without any control application of phyto-sanitary standards. Consequently, the delivered planting materials were carried some harmful pests, such as: mulberry scale (white peach) - Pseudaulacaspis pentagona. The purpose of this research study consist to investigate incidence and transmibility of mulberry scale, and develop recommendations about prevention and control measures against these pest in mulberry plantation.

Distribution

Mulberry scale (white peach), *Pseudaulacaspis pentagona concerns* family *Diaspididae* is the largest family of scale insects with over 2650 described species in around 400 genera (Copland and Ibrahim, 1985; Ibrahim, 1985.). As with all scale insects, the female produces a waxy protective scale beneath which it feeds on its host plant. Diaspidid scales are far more substantial than those of most other families: Incorporating the exuviae from the first two nymphal instars and sometimes faecal matter and fragments of the host plant, these can be complex and extremely waterproof structures rather resembling a suit of armour. For this reason these insects are commonly referred to as armoured scale insects. As it is so robust and firmly attached to the host plant, the scale often persists long after the insect has died.

Fig. 2. Adult female of the Mulberry scale (white peach) *Pseudaulacaspis pentagona* (Targioni).

Eggs. Eggs are deposited on the surface of the host plant. They range in color from orange to white indicating female and male offspring eggs of an intermediate color may also be evident which can produce offspring of either sex.

Larvae. The larvae will hatch from the egg case within approximately three to four days after being laid. The young crawlers will soon settle on an area of the host plant and insert their stylets into the plant to begin feeding. The larvae will undergo two to five molts, depending on their sex.

Adult female: The test of the female is slightly convex, white, ca 1.5-2.8 mm in diameter with central or sub-central yellow exuviae. Beneath the test, young adult females are pear shaped, orange-yellow; egg-laying females are almost circular. In adult females, the pygidium has 3 pairs of well-developed lobes, notched on the outer margin. The plates between the lobes are partly pointed or fimbriated. Five perivulvar pore groups are present. There are high numbers of pores associated with the first pair of spiracles (Ghauri, 1962; Kosztarab and Kozar, 1988,) describes adult males. Male scales are smaller than females, narrow, with allel sides and three parallel longitudinal ridges, white with a yellow spot at one end. Adult males each have one pair of wings, long antennae and limbs, no mouthparts and long genitalia.

Fig.2. Adults male of the Mulberry scale (white peach) *Pseudaulacaspis pentagona* (Targioni).

Life cycle: The life cycle of the Mulberry scale (white peach) depends upon the climate in which it resides. Intermediate adult females overwinter and produce a clutch 80-100 of eggs underneath their scales. Six-legged nymphs, called crawlers, reported hatch from eggs in about 4 days, but observations suggest that it may take 30-60 days. Crawlers settle in about 2 days and begin develop through several stages (instars), the first lasting 7 to 8 days. Adult females develop from the second nymphal stage in about 12 days, and winged males develop through this stage for about 5 days before emerging as winged adults 7 or 8 days later. Development from egg to adult can occur within 35 to 40 days (Beardsley, J.W. and R.H. Gonsalves. 1975; Beardsley, at al., 1976). Female mulberry scales will undergo two molts before reaching sexual maturity as adults. Males will undergo five molts before reaching adulthood. Once mature, however, the males will live for only one day. To facilitate the mating process, females will release sex pheromone timed to the eclosion of the males. The males are then attracted to the pheromone and are capable of mating with several different females in a short period of time. Males seek female scale insects and mate. Mated females begin laying eggs after about 16 days. Three – four generations occur annually.

RESULTS AND DISCUSSION

The research conducted on *P. pentagona* heavy infestations are often found as thick crusts on tree trunks and older branches in temperate regions, and rarely on the roots. The leaves and fruits are not usually infested. The large white colonies of females and males on the branches that make up a heavy infestation are easy to recognize. Larvae and females of scale c the help long pricking trunk they exhaust cellular juice (Metcalf, 1962). It causes dying off of capillary and breaks descending juice movement that involves pathological changes in cells and leads to easing of plants, occurrence necroses.

Branches of populated plants prematurely lose plasticity and natural process of cell's formation is broken down. Due to growth of new cells internal pressure that conducts in the beginning to longitudinal, and then and to cross-section become lifeless fracture of bark. Occurrence of numerous cracks strengthens transpiration and open ways for penetration of pathogenic microorganisms. The quantity of quality fodder leaves thus decreases; harvest of leaves is sharply reduced. Younger plants are more susceptible to *P. pentagona*. In the case of heavy infestations, branches or entire trees may die. From the literature, it is known that heavily infested plants may die some years after the onset of infestation.

CONCLUSION:

Mulberry scale (white peach), *Pseudaulacaspis pentagona*, concerns never amaze the healthy, since the well developed plants also build up the protective bodies which are frightening off insects. For them, the titbit are the plants weakened and overfed with nitrogen in which balanced metabolism is broken in a kind of wrong conditions of the maintenance (bad light, wrong watering, too hot or, on the contrary, too cold maintenances, etc.).

Distribution of mulberry scale occurs, mainly, to the infected planting material: saplings and cuttings. It can be delivered with a various planting material (saplings, adult plants etc.), and also with fruits, leaves and other vegetative parts of plants.

RECOMMENDATION

- Strengthen quarantine measures: for all plant materials arriving in Rwanda should be checked carefully and fumigated in the import points. In case live insects are detected in planting materials, they must destroyed or returned to the original country;
- It is imperative to completely exclude importation of planting materials from zone of phyto-sanitary risk – potential owners mulberry scale with soil.
- In case of mulberry scale (white peach) - *Pseudaulacaspis pentagona* concerns are confirmed, necessary preventive measures must be applied, by put into practice one of resolved in Rwanda pesticides.
- Infested trees should receive optimum quantities of mulch and fertilizer to enhance vigor. Infested branches can be cut off and left on the ground for parasite emergence.
- A drenching spray of insecticidal oil followed by a second application 3 to 4 weeks later is effective against young scales. Soaps and other oils are also effective.
- If you have found out that the plant is amazed scales, it is necessary to isolate at once from the others and to cut off those sites which are amazed especially strongly. Then it is essential to cover the soil round a plant with polyethylene cellophane and accurately to collect all insects, visible with the naked eye, by means of the wadded tampon moistened in the concentrated solution of laundry soap. The same solution (approximately 20 g soaps on 120 ml of water) should be repeatedly necessary and to process regularly all plant for a long time (Reinert, 1974).
- Chemicals used on scales are usually the same as those used on mealybugs and may include diazinon, dimethoate, formothion, malathion and nicotine. Whenever any chemical is used, always consult the label, to determine the appropriate crop, pest, dose, and precautions. Process

- In any way, it is not necessary to use during treatment fertilizers with the high maintenance of NITROGEN, stimulators and growth regulators, as their application only promotes faster reproduction of the wrecker.

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IMPROVEMENT OF MULBERRY PROPAGATION TECHNOLOGY

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(POSTER)

ABSTRACT

Mulberry is one of the plants, highly sensitive to the change of different environmental factors. Among such factors air and soil temperature cause scientific and

practical interest. The body temperature of poikilothermes organisms depends on the ambient temperature. Increase of body temperature intensifies the vital processes and accelerates development (in known limits). Covering the land surface with rice husk, mulch or black and white polyethylene leads to a congestion of temperature and results in increased summary temperature. It is very well appreciable, where plots are covered by black and white polyethylene where average temperature reaches up to 24,9–22,5^{0}C, sprouting buds and growth in cutting are observed when in soil total temperature reaches 5040 ^{0}C.

Keywords: Mulberry, temperature, poikilothermes organisms, cuttings growth and sprouting

INTRODUCTION

The growth of mulberry trees, as well as of any agricultural plant, is mainly influenced by various factors under which it is growing. These factors influence the growth and generative processes, efficiency of plantings and quality of leaves. Mulberry is one of the plants, which are highly sensitive to the changes of different environmental factors, such as: light, air and soil temperature, water in the soil and atmosphere, air movement, increase of salt in subsoil water, radiation. Among those factors, air and soil temperature causes scientific and practical interest (Grekov *et al*., 2005).

Mulberry is propagated either through seeds or vegetative propagation. The later is the most common method of propagation because of various advantages like maintenance of particular characters of the plant, relative speed in raising saplings in large numbers for plantations, adaptability to a particular habitat, development of resistance to pests and diseases and modification of plant growth. In sericulture there are various methods and technologies of mulberry reproduction, such as seedling, grafting, layering, softwood cuttings, hardwood cutting and others.

For Rwandan conditions the most suitable method is hardwood cuttings. The application of that method by farmers in different regions shows different results. In some regions with dry climatic conditions, mulberry cuttings rooted around 30-40 % only, which is not economically profitable. Based on that, a research on hardwood cuttings technology improvement was carried out with the perspective of transfering the technology to sericulture cooperative and farmers.

MATERIALS AND METHODS

Study area: This study was conducted at the sericulture unit found at Rubona research station, previously under the Rwanda Agriculture Board. Rubona station situated at 2.26 (2° 15' 49 S; 29.81 (29°48' 27 E) is located in the mid-altitude agro-ecological zone in southern Rwanda, 125 km from Kigali, the capital city. The station has a subequatorial climate and has an altitude of 1700 m over sea level, average monthly temperatures all year is around 18-21 °C. Rainfall ranges between 1300—1800 mm year, and dry season starts from June up to August – September.

Land preparation: a nursery bed for mulberry cuttings was prepared by digging ditches of 20-25cm deep and 1,500kg organic manure, 5kg phosphate per/ha were applied as base fertilizer. The soil was then leveled from both sides to make a ridge of 10-15cm high and 80cm wide and the whole bed was covered by different type of materials (black/white polyethylene film and rice husk) and a control. The borders of film were held with the soil so that film may not be moved.

Preparation of cuttings: Only one-year old shoots were used in this method. The shoots were cut manually into cuttings. The diameter of shoots suitable for cuttings were not less than 1cm where the length of the cutting was 15-20cm and the cutting would have minimum 3 buds. To stimulate rooting, the base of the scion is soaked in a 100-300ppm NAA solution; if the solution is not available then cuttings are soaked in water 2-3 days before planting.

Planting of cuttings: Cuttings were planted in the soil on a cloudy day or in the evening, in order to avoid sunstroke. The scion was inserted under an angle of 45^0 into the hole with its base buried in the soil about 12-15cm deep and 10 cm into the ground. The distance between and within rows was 15cm.

Experiment variants: A) Plot covered by black polyethylene; **B)** Plot covered by white polyethylene; **C**) Plot covered by rice husk (as mulch)**; D**) Control.
Calculation of the sum of heat was by formula:

***Sum of temperature* = (T-C) *v*,**

Where: T-average temperature for sprouting
C -minimum temperatures for sprouting
v- duration of sprouting

Data analysis method: Data collected from our work was analyzed using common-method of statistical analysis of qualitative and quantitative data (Tabachnick, B.G. & Fidell, L.S. 2007).

RESULTS AND DISCUSSION

In conformity with the law of thermodynamics, organisms themselves do not possess any energy source. In open biological systems constantly there is a process of energy exchange with the environment. Internal metabolic processes also are accompanied by transformation of one forms of energy into others. For using efficiently the nutrients, it is necessary for organism to absorb certain energy (Blumendfeld, 1997). However in open systems of reaction and corresponding power, transformations occur constantly and consequently. It is necessary to know the right time of the congestion energy for the growth and sprouting of organism especially for the cold-temperature (poikilothermes) organisms which depend on an ambient temperature. However, increase in temperature of their body, accelerated vital processes and growth (in known limit) (Rubinin, 1984; Nicolis G., Prigojin, 1979; Homidy Kh 2005). For example in plants, the temperature substantially influences germination of seeds, photosynthesis, evapo-transpiration, growth, and other processes. The thresholds of development and the sum of effective temperatures for each kind are specific. They are caused by historical fitness of a kind to certain conditions of a life. In moderate zone, seeds of plants for example peas, clover, development threshold is low, and their germination begins with the temperature of soil ranging from 0 to 10^0C. More southern cultures: the corn, millet, starts to sprout only at 8-10^0 C. The growing rate of plants depends on the sum of temperature at certain period of time; for example for grape, 3100°C are required, with the peak of – 8960^0C.

Mulberry can be grown under various climatic conditions ranging from temperate to tropical. From references it is known, that an atmospheric temperature, ranging from 24^0C to 28^0C is found to be optimum for good growth of mulberry. Growth and sprouting of buds can not be

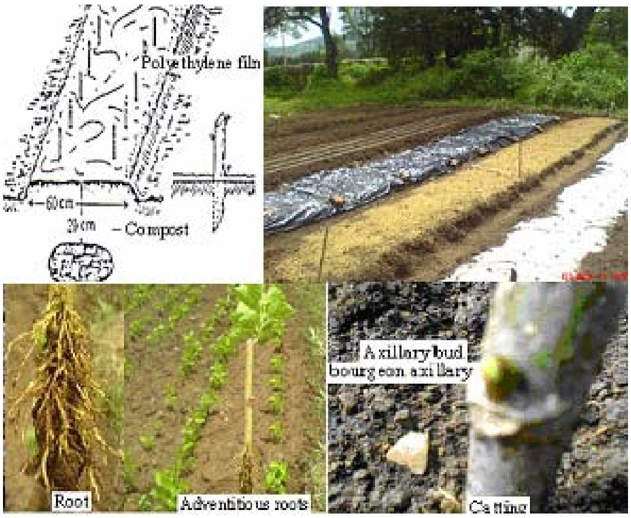
Table 1. Ways of increasing and preserving total temperature in the soil and its influence on mulberry trees

Date	Variants of the experiments																			
	Black polyethylene					White polyethylene					Rice husk mulching					Control				
	Time of gathering date (^{0}C/hour)																			
	07h	12h	18h	Sum of temperatur	Emerging, %	07h	12h	18h	Sum of temperatur e, ^{0}C	Emerging, %	07h	12h	18h	Sum of temperatur e, ^{0}C	Emerging, %	07h	12h	18h	Sum of temperatur e, ^{0}C	Emerging, %
10.02*	24	28	32	192		22	25	29,5	180		20	24	25	120		19	24,5	26	168	
11.02	22	24,5	27	120		18	20	25	168		15,5	16,5	19	84		14,5	16	18	84	
12.02	23	26	34	264		20,5	24	28	180		19,5	23	25	132		18,8	22,5	25	148,8	
13.02	18	22	25	168		18	21,5	24	144		16,5	18,2	22,5	144		16,5	18,0	22	132	
14.02	22	24	29	168		20,5	22	26	132		18,5	20	22	84		17,8	20,5	23,2	129,6	
15.02	20	24	32	288		18	21	26	192		16	19	22	144		15,3	19,5	23,2	189,6	
16.02	23	26	34	264		19	23	28	216		17	21	24	168		16,3	21,5	25,2	213,6	
Total:	21,7	24,9	30,4	1664	18	19,4	22,3	26,6	1212	12	17,57	20,24	22,78	876	0,00	16,88	20,35	23,22	1065,6	0,00
17.02	22	25	31	216		20,3	24	27,5	172,8		18,3	22	23,5	124,8		17,6	22,5	24,7	170,4	
18.02	23	27	32	216		21,5	25	28,5	168		19,5	23	24,5	120		18,8	23,5	25,7	165,6	
19.02	15	19	22	168		15	17	17	48		13	15	13	0,00		12,3	15,5	14,2	45,6	
20.02	17	19	25	192		14	16	21	168		12	14	17	120		11,3	14,5	18,2	165,6	
21.02	13	15	17	96		11	13	15	96		9	11	11	48		8,3	11,5	12,2	93,6	
22.02	17	24	28	264		14	21	25	264		12	19	21	216		11,3	19,5	22,2	261,6	
23.02	22	25	32	240		20	23	26	144		18	21	22	96		17,3	21,5	23,2	141,6	
Total:	18,4	22,0	26,7	2856	27,7	16,5	19,8	22,8	2272,8	24,2	14,54	17,85	18,86	1504,8	17,2	13,84	18,36	20,06	2109,6	22,5
24.02	24	28	36	288		22	26	31	216		20	24	27	168		19,3	24,5	28,2	213,6	
26.02	26	32	39	312		23	28	35	288		21	26	31	240		20,3	26,5	32,2	285,6	
27.02	22	22	26	96		19,5	20	24,5	120		17,5	18	20,5	72		16,8	18,5	21,7	117,6	
28.02	18	25	31	312		15,5	20,5	27,5	288		13,5	18,5	23,5	240		12,8	19	24,7	285,6	
01.03	23	27	33	240		21,5	25,5	29	180		19,5	23,5	25	132		18,8	24	26,2	177,6	
02.03	24	29	36	288		22	26,5	32	240		20	24,5	28	192		19,3	25	29,2	237,6	
03.03	24	32	38,5	348		23,5	29,5	34,5	264		21,5	27,5	30,5	216		20,8	28	31,7	261,6	
Total:	23	27,8	34,2	4740	79,5	21	25,1	30,5	3868,8	55,5	19	23,14	26,5	2764,8	33,5	18,3	23,64	27,7	3688,8	43,5
04.03	22	22	24,5	60		22	22	22,5	12		20	21	22	48		19,3	20,5	19,7	59,6	
05.03	19	25	27,5	204		18,5	23	24,5	144		16,5	21,5	21,0	108		15,8	21,5	21,7	141,6	
Grand Total:	**20,5**	**23,5**	**26,0**	**5004**	**95,0**	**20,2**	**22,5**	**23,5**	**4024,8**	**64,0**	**18,25**	**21,25**	**21,5**	**2920,8**	**38,5**	**17,55**	**21**	**20,7**	**3840**	**50,0**

* Dates have been collected in 2011-2012

obtained at temperatures below 13^{0} C and above 38^{0}C. In temperate regions mulberry leaves are available for rearing purposes from April to October, while in the tropics, growth of mulberry is continuous throughout the year.

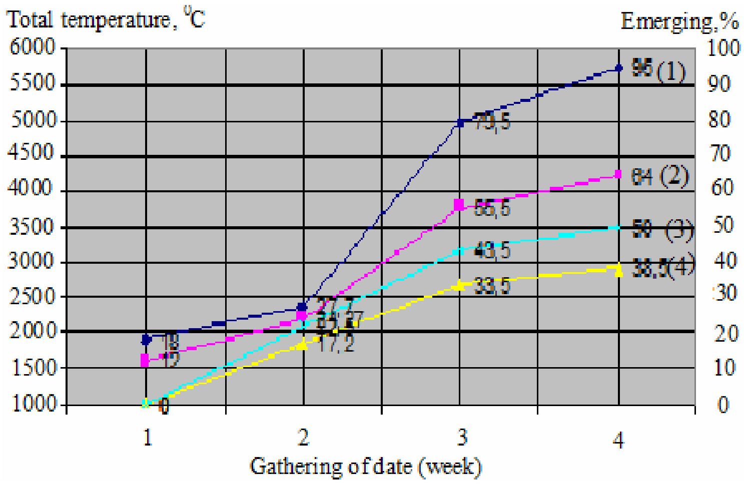
Mulberry can be grown without irrigation in places with a rainfall range from 600 to 2500 mm. However, mulberry could be grown even under dry conditions, if adequate irrigation and macro and micro nutrients are provided. Humidity range from 65 to 80% is considered ideal for mulberry growth. This is the reason why the mulberry leaf quality is much better in the rain season than in dry season in temperate and tropics countries. Researches on influence of soil temperature on growth and sprouting of the multiplied materials (seeds and vegetative) are very poor and necessary temperature conditions for different mulberry varieties are completely absent. For revealing the influence of total soil temperature on growth and sprouting of mulberry hardwood cuttings, a research was carried out and results are presented in table 1.



Pict. 1. Hardwood cutting

From the received data it is visible, that the general temperature of soil, during the interval of 25 days (in three weeks) were 23,2^{0}C in black polyethylene and mostly did not exceed 20,1^{0}C (data of a control variant), that is much more low than minimum (24^{0}C) optimum temperature for good growth of mulberry. After the surface land has been covered with rice husk or by black and white polyethylene in order to accumulate the temperature in the soil and increase the general temperatures, appreciable data were received in variant where the plots were covered by black and white polyethylene: average temperature reached 24,9–22,5^{0}C.

The analysis of cuttings growth and buds sprouting accordingly to the temperature were observed at a set of the sum temperatures soil of 1450-1600^{0}C. Those differences in experimental variants of this quantity to heat typed occurred after different days; after planting cutting. For example: Plots covered by black polyethylene after 5-6 days, in variant covered by white polyethylene after 6-8 days, and in control has typed this to quantity of heat only after 11-12 days after planting. In experiment with black polyethylene, buds sprouting of cuttings reached their maximum (95 %) after 25 days after planting when the sum temperatures of the soil has reached 5004^{0}C (picture 1).



Diag.1. Influence of total temperature on awakening mulberries

(1) Black polyethylene; (2) White polyethylene; (3) Control; (4) Rice husk mulching

The least effective has been appeared in plot covered by rice husk after 25 days. The total temperature of the soil was 2920,8 ^{0}C, that induced the growth of cutting only 38,5%, because it is first of all linked with the nature of covered materials (Diagram 1).

Conclusions:

- Average daily fluctuation of soil temperature (17,5-21,0°C) during 25 days of research at Rubona station (RAB), Southern Province cannot optimize the growth and sprouting of mulberry cuttings;
- Minimum temperature (above 23°C) for the growth and sprouting of mulberry cuttings was reached by covering the soil surface by a black polyethylene;
- Optimum sum temperature for normal growth and sprouting of mulberry cuttings is more than 6900^{0}C/month.

Recommendation:

1. To improve the technology of mulberry multiplication, different mulching methods have been studied and positive results have been yielded. Using black polyethylene as cover of the soil raise the heat, retain the soil moisture and reduce evaporation;
2. If the number of roots on one cutting is more than 10-12 and 10-15 cm of length it is the right time to remove the cover. This happens in about 35 days after planting. At this time the polyethylene cover may be removed and additional fertilizer could be applied at a rate of 2 kg of urea and 1 kg of potassium phosphate per ha (in liquid form). Other activities such as weeding, bud adjustment, control of pests and diseases, water spraying, etc. are done as usually.
3. The land for nursery purpose should be prepared in advance and should be fertile, light soil, having underground water level below 1 m. The nursery should be ploughed in a depth of 30-35 cm and Farm yard manure at a rate of 30-40 tons per ha added, or alternatively 150-200 kg phosphorus, 100-150 kg potassium and 80-100 kg nitrogen per 1 ha should be applied. The planting of cuttings in the nursery should be made only when soil temperature in a depth of 15 cm reached 12-15^{o}C;
4. Around 100.000 cuttings can be planted in 1 ha of nursery at a spacing of 10 cm within row and 80 cm between rows. The planting of cuttings is made manually by a “Planting spike” having a diameter of 6-8 cm. The newly planted cuttings are immediately well irrigated. From 100 cuttings grown in the nursery about 70-80 standard saplings can be obtained.

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Section 2. Silkworm genetics and breeding

Building Value Chains in Sericulture: the nutritional analysis of *Bombyx mori* pure strain artificial diet as a tool to obtain new silkworm hybrid constitution

By

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(ORAL PRESENTATION)

ABSTRACT: One of the most important characteristics of the silkworm *Bombyx mori* is its ability to convert plant proteins into silk. This feature can be exploited in order to give an added value to the silk production chain both by using directly the silk fiber for textiles or bio-medicals or by transforming this organism into a bioreactor to produce recombinant proteins through transgenesis.

To achieve standardized conditions, to shift rearing cycles to a continuous industrial production, to eliminate disease risk outbreak under controlled conditions are the preliminary steps to persuade biotechnological companies to invest into sericulture. The use of artificial diet under germfree conditions meets the above-quoted requirements.

As the artificial diet becomes the only source to build the insect's body mass and to produce energy to sustain its life, analysis of nutritional efficiency is of basic importance. In the present work, starting with 10 productive strains belonging to the CRA-API's germ-plasm collection, we reiterated a selection process throughout following generations both on leaves and on artificial diet. During the 5th instar weights of larvae, leftover food and feces were measured and recorded and used to calculate nutritional indexes. After cocooning main productivity parameters were evaluated and best performing individuals were isolated, backcrossed and reared separately. Furthermore, two strains were selected on the basis of their nutritional efficiency and productivity data and they were crossed to produce a hybrid characterized by high nutritional efficiency and productivity on artificial diet. The same hybrid performance on mulberry leaf are also discussed.

Keywords: germfree diet, gravimetric method, nutritional indexes

Materials and methods

Silkworm breeds

As starting material 10 monovoltine strains belonging to the CRA–API collection and whose productivity has been proved during many years were chosen. After 2 preparatory experiments carried out both on mulberry leaves and artificial diet (CRA – API patent) 6 of them were discarded and the remaining selected for more in–depth analysis. These strains identified by CRA—API's progressive collection numbers were 118, 120, 124 and 129.

Nutritional parameters

Data were recorded during the V^{th} instar according to gravimetric method (Waldbauer 1968; Ramesha et al. 2010; Ramesha et al. 2012) except for the weight of ingesta that was calculated according to Candy and Baker (2002). For each strain a fixed number of healthy larvae were selected and split randomly in 3 repetitions to assess nutritional traits. Fresh sample weights were recorded daily for larvae reared on mulberry leaves and artificial diet in standard conditions. In germ—free conditions (Sumida and Ueda 2007) data were recorded once at the beginning and then at the end of V^{th} instar. Weights of ingested food, leftover food, litter and cocoons were used to compute most important nutritional indexes and to compare strains among each other.

Productive parameters and within strain selection

The 4 selected strains were reared in controlled conditions (to calculate indexes) all over the year but also in bulk on mulberry leaves or artificial diet to evaluate silk productivity. Larvae were reared according to the sericulture best practice and, after spinning, cocoon and shell weights in concert with silk ratios were recorded. Taken together, these records were processed on an electronic data sheet by using a filter and logical operator AND to fix a threshold for each value. According to this 10 (TOP10) best performing individuals for each sex (for all strains) were chosen and back—crossed to produce a selected offspring. The process was reiterated every generation and TOP10 individuals compared with the mass.

Rearing methods

Mulberry leaves

Larvae reared on mulberry leaves in bulk were fed and cleaned according to standard methods until spinning. For indexes calculation, after 4^{th} ecdysis, 75 healthy larvae were chosen, randomly split in 3 repetitions and reared in plastic boxes covered with lids. Weights of fresh and leftover food as well as litter were recorded daily. In addition, to evaluate natural weight loss due to evaporation the same amount of leaves was stored over night (2 repetitions) in the same boxes used to rear the worms. Weight difference was used to properly correct Ingesta value (Candy and Baker 2002).

Artificial diet

Larvae reared on artificial diet in normal conditions as bulk were fed according to Cappellozza et al. (2005) and obtained cocoons were used for within strain selection. For indexes calculation in normal conditions, after 4^{th} ecdysis, 30 healthy larvae were chosen, randomly split in 3 repetitions and reared in plastic boxes covered with lids. Gravimetric data were recorded daily. For indexes calculation in germ—free conditions larvae were reared according to Sumida and Ueda (2007) until beginning of V^{th} instar when 3 repetitions of 10 larvae were used to estimate nutritional efficiency. Both in normal and germ—free conditions diet was administered according to nutritional needs of the larvae (Schmidt and Reese 1986). Weight loss due to evaporation was estimated as for mulberry leaves.

Discussion and conclusion

To date, after several generations of selection, it is possible to state that during spring—time, when the mulberry leaves are at their best quality, that food is superior to artificial diet with respect to productivity. Furthermore in germ—free conditions productivity is less than in normal conditions. The started selection process appeared to be effective since TOP10 sub—populations expressed heavier cocoons and shells than mass, particularly in strains 129 and 124. On the other hand, nutritional parameters, were significantly different among strains only at the beginning of the selection while differences disappeared throughout the offspring. Results suggested to cross 124TOP10 with 129TOP10 to produce a new hybrid suited for silk

production on both artificial diet and mulberry leaves and for biotechnological applications requiring a sterile back—ground on artificial diet.
Selection process will be continued and the hybrid will be compared to pure lines in the oncoming season.

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Genetic approach for development of sexlimited breeds of silkworm *Bombyx mori* for tropical climates.

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In a pilot hybridization experiments two superior breeds were developed one belongs to multivoltine designated as MU1 and another a bivoltine breed denoted as MG_{408} and these two breeds are known for superior productivity and viability traits. In order to develop the sexlimited breeds the above breeds are crossed to sexlimited multivoltine Pure Mysore (PM SL) and sexlimited bivoltine CSR_{18}. Regular inbreeding the hybrids followed by recurrent back crossing it was possible to isolate multivoltine sexlimited breed MU1(SL) and bivoltine sexlimited MG408 (SL). After the fixation of the traits and at the end of the 12th generation the sexlimited breeds were studied for RAPD analysis utilizing 8 ubiquitous UBC primers. The RAPD analysis have clearly demonstrated that strain specific bands were distinct indicating the genetic differences between sexlimited breeds and the parents. The rearing performance of the sexlimited breeds along with parents and molecular genetical approaches for evolving sexlimited breeds are herein discussed.
Keywords: Sexlimited breeds, hybridizatiuon,RAPD.

Passport data of six Bulgarian strains of silkworm *Bombyx mori* L. on the base of population genetic parameters

By

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(ORAL PRESENTATION)

ABSTRACT: Six silkworm strains created in Bulgaria were tested with polyacrilamide gel electrophoresis (PAGE) to assess the genetic structure of the populations on some isoenzyme loci. Among ten investigated isozyme loci, six loci (Bes B, Bes D, Bes E, Pgm, Mdh A, Bph A) proved to be polymorphic and manifested intra- and inter-strain polymorphis. The other four loci (Bes A, Hk A, Adh A, Ast A) were monomorphic in all strains tested. The mean number of alleles per polymorphic locus ranged from 1.5 to 1.9. The expected heterozygosity was higher than the observed one. Passport data of each of the strain on the base of population genetic parameters were indicated. Phylogenetic relationships between strains were revealed by the UPGMA and Neighbor-joining dendrograms.

Keywords: *Bombyx mori* L., isozymes, genetic variability, phylogeny.

Introduction

Isozymes and other molecular markers are very useful to study the genetic diversity of mulberry silkworm *Bombyx mori* L. (Chatterjee *et al*., 1993; Eguchi, 1995) and to differentiate the particular strains (Goldsmith, 1995; Xia *et al.*, 1998). Assessment of heterozygosity in each silkworm strain is important for efficient management and conservation of genetic resources (Graner *et al*., 2004).

The choice of parental strains in the silkworm breeding programs in Bulgaria was mainly based on the study of some qualitative and quantitative traits as total larval duration, cocoon shape, cocoon colour, weight of single cocoon, weight of single shell, shell ratio, fecundity and etc. The assessment of the parental strains, however, should be complex and should be realized simultaneously by different parameters. One of the main composite parts of such a complex assessment is the passportisation of various strains of isoenzyme specters of key metabolic enzymes.

The aim of this study was to assess the genetic structure of populations of six silkworm Bulgarian strains on the basis of isozyme polymorphism and to describe population genetics passport data of this strains.

Material and Methods

Six silkworm strains created in Bulgaria and maintained by the Sericulture Experiment Station germplasm bank - Vratza, and Agricultural University – Plovdiv were tested with 7.5% polyacrilamide gel electrophoresis (PAGE) (Daevis *et al*., 1964). There were:

- Vratza 1, Vratza 37 and Vratza 40 from Sericulture Experiment Station – Vratza;
- Gergana 1, Gergana 2 and Ogosta 1 from Agricultural University – Plovdiv.

All individuals were nourished at a standard regime of silkworm breeding. On the fifth day of the fifth instar, 80 - 88 larvae were selected randomly from each strain in order to analyse the following enzyme systems:

- EST, EC 3.1.1 (nonspecific esterases, four loci: Bes A, Bes B, Bes D and Bes E), MDH, EC 1.1.1.37 (malate dehydrogenase, one locus: Mdh A) and ACP, EC 3.1.3.2 (acid phosphatase, one locus: Bph A) – from hemolymph;
- PGM, EC 5.4.2.2 (phosphoglucomutase, one locus: Pgm A), HK, EC 2.7.1.1 (hexokinase, one locus: Hk A), ADH, E.C. 1.1.1.1 (alcohol dehydrogenase, one locus: Adh A) and AST, EC 2.6.1.1 (aspartate aminotransferase, one locus: Ast A) - from silk glands.

The tissue extracts were prepared according to Stoykova *et al*. (2003), Staykova *et al.* (2004). Tested enzyme systems were visualized according to Shaw and Prasad (1970) – for nonspecific esterases and malate dehydrogenase, Spencer *et al*. (1964) - for phosphoglucomutase, Staykova *et al.* (2010) – for acid phosphatase, Eaton *et al.* (1966) – for hexokinase, Schmidtke and Engel (1972) – for aspartate aminotransferase and Shaw and Koen (1965) – for alcohol dehydrogenase.

Several genetic variation parameters as allele frequencies, mean number of alleles per locus, proportion of polymorphic loci at the 99% (P), observed ($\mathbf{H_o}$) and expected ($\mathbf{H_e}$) heterozygosity, deviation from the Hardy-Weinberg equilibrium, Nei's genetic distance (D) (Nei, 1972), and Wright's fixation index, F_{ST} (Wright, 1965) were computed by BIOSYS-1 software (Swofford and Selander, 1981). Phylogenetic trees were constructed using Nei's (1972) genetic distance, by UPGMA (Sneath and Sokal, 1973) and Neighbor-joining (Saitou and Nei, 1987) methods using the PHYLIP (Felsenstein, 1993) software package.

Results and Discussion

Among the ten investigated isozyme loci, six loci (Bes B, Bes D, Bes E, Pgm A, Mdh A, Bph A) proved to be polymorphic (Table 1), whereas four of them (Bes A, Hk A, Adh A and Ast A) were monomorphic. The six polymorphic loci manifested intra- and inter-strain polymorphism. The Mdh A locus was identified as polymorphic only in Ogosta 1.We determined population genetic passport data on studied loci concerning allele frequencies, mean number of alleles per locus, percent of polymorphic loci and heterozygosity for each of the tested strain as follow:

In the gene pool of the strain **Vratza 1**, we found two alleles of the locus Bes B (Bes B_1 and B_3), tree alleles of the locus Bes D (Bes D_1, D_2 and D_3), tree alleles of the locus Bes E (Bes E_0, E_1 and E_2), two from tree alleles of the locus Pgm A (Pgm A_2 and A_3) and four alleles of the locus Bph A (Bph A_0, A_1, A_2 and A_3) (Table 1). The mean number of alleles per locus was 1.9±0.30, the percent of polymorphic loci – 50%, and the observed heterozygosity 0.183±0.070 (Table 2).

In the gene pool of the strain **Vratza 37**, we established all tree alleles of the locus Bes B (Bes B_1, B_2 and B_3), two from four alleles of the locus Bes D (Bes D_1 and D_2), two from tree alleles of the locus Bes E (Bes E_0, and E_1), two alleles of the locus Pgm A (Pgm A_2 and A_3) and all five alleles of the locus Bph A (Bph A_0, A_1, A_2, A_3 and A_4) (Table 1). The mean number of alleles per locus was 1.9±0.40, the percent of polymorphic loci – 50%, and the observed heterozygosity 0.102±0.046 (Table 2).

For the strain **Vratza 40**, loci Bes B and Bes D were monomorphic and presented by alleles Bes B_2 and Bes D_1 respectively. In the gene pool of this strain we established tree alleles of the locus Bes E (Bes E_0, E_1 and E_2), two alleles of the locus Pgm A (Pgm A_2 and A_3) and four alleles of the locus Bph A (Bph A_0, A_1, A_2 and A_3) (Table 1). The mean number of alleles per locus was 1.6±0.30, the percent of polymorphic loci – 30%, and the observed heterozygosity 0.082±0.051 (Table 2).

In the gene pool of the strain **Gergana 1**, we found tree alleles of the locus Bes B (Bes B_1, B_2 and B_3), two alleles of the locus Bes D (Bes D_1 and D_3), two alleles of the locus Bes E (Bes E_0, and E_2), all tree alleles of the locus Pgm A (Pgm A_1, A_2 and A_3) and two alleles of the locus Bph A (Bph A_1 and A_2) (Table 1). The mean number of alleles per locus was 1.7±0.30, the percent of polymorphic loci – 50%, and the observed heterozygosity 0.112±0.052 (Table 2).

For the strain **Gergana 2**, locus Pgm A was monomorphic and presented by allele Pgm A_2 in the gene pool. For this strain we established tree alleles of the locus Bes B (Bes B_1, B_2 and B_3), tree alleles of the locus Bes D (Bes D_1, D_2 and D_3), two alleles of the locus Bes E (Bes E_0 and E_2) and two alleles of the locus Bph A (Bph A_1 and A_2) (Table 1). The mean number of alleles per locus was 1.6±0.30, the percent of polymorphic loci – 40%, and the observed heterozygosity 0.100±0.050 (Table 2).

For the strain **Ogosta 1**, loci Bes E and Bph A were monomorphic and presented with alleles Bes E_1 and Bph A_2 respectively. In the gene pool of this strain we found two alleles of the locus Bes B (Bes B_2 and B_3), two alleles of the locus Bes D (Bes D_1 and D_2), tree alleles of the locus Pgm A (Pgm A_1, A_2 and A_3) and two alleles of the locus Mdh A (Mdh A_2 and A_3). Mdh A locus demonstrated polymorphism with very high frequency of the Mdh A_2 allel only for Ogosta 1. Mdh A_3 was very rare. For all others strains this locus was monomorphic (Table 1) and presented with Mdh A_2 allel. The mean number of alleles per locus was 1.5±0.20, the percent of polymorphic loci according to the criterion 0.99 was 40%, and the observed heterozygosity 0.086± 0.042 (Table 2).

The expected heterozygosity (H_e) by polymorphic loci was higher than the observed one (H_o) in all tested strains (Table 2). The results about genotype frequencies were calculated by Biosys 1 and showed statistically significant deviations from the Hardy-Weinberg equilibrium, as confirmed by Chi-square test ($P < 0.01$) for the most loci in six strains. This fact in addition to the deficit of heterozygotes may indicate a high level of inbreeding in the studied populations. The F_{ST} values ranged from 0.0228 (Mdh A) to 0.3571 (Bes E). The mean F_{ST} value over all loci was 0.2904, which shows that 29.04% of the overall genetic diversity observed was among strains, as opposed to 70.96% within strains.

The values of genetic distance (Nei, 1972) were calculated using the allele frequencies and ranged from 0.023 (between the strains Vratza 37 and Gergana 2) to 0.238 (between strains Gergana 2 and Ogosta 1) (Table 3).

In UPGMA and Neighbor-joining dendrograms strains studied are grouped in two clades originated from Vratza 40. Gergana 2 and Vratza 37 were clustered in the one clade and Gergana 1 and Vratza 1 were clustered in the second one (Fig.1 and 2). The strain Ogosta 1 is outlying from all others.

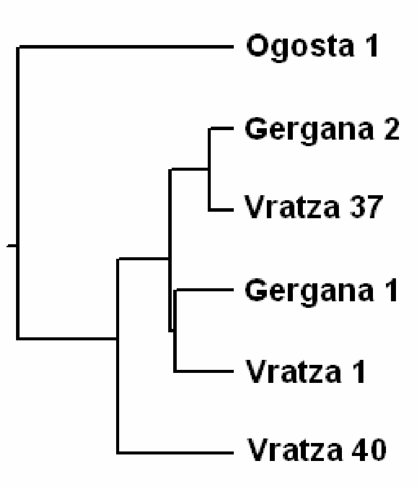

Fig.1. UPGMA dendrogram (Sneath and Sokal, 1973).

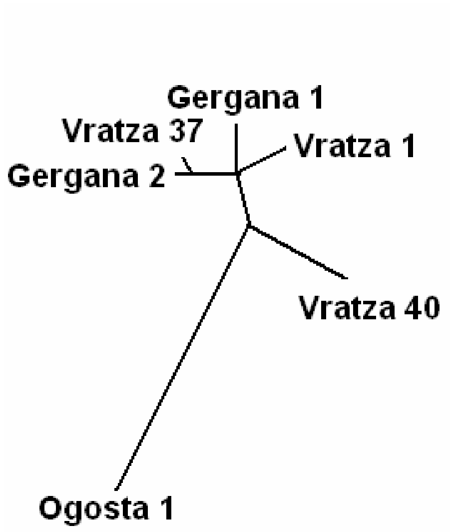

Fig.2. Neighbor-joining dendrogram (Saitou and Nei, 1987).

Our results for the six *Bombyx mori* L. strains revealed polymorphism in four enzyme systems (six loci) and confirmed polymorphism of the some isoenzyme loci described earlier by Yoshitake and Akiyama (1964), Eguchi *et al.* (1988), Egorova and Nasirillaev (1993), Staykova (2008), Staykova *et al.* (2010, 2012). The alleles Bph A_1, A_2, A_3 A_4 and A_0 pointed at this study correspond to the alleles Bph A, B, C, D and O, described earlier (Staykova *et al.*, 2010, 2012). The specific intra- and inter-strain polymorphism on the isoenzyme loci and some population genetics characteristics as frequencies of alleles, mean number of alleles per locus, proportion of polymorphic loci and heterozygosity could be use for composing passport data of each strain in order to use in the breeding programs of mulberry silkworm *Bombyx mori* L.

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Table 1. Allele frequencies in strains tested

Locus	Strains					
	Vratza 1	Vratza 37	Vratza 40	Gergana 1	Gergana 2	Ogosta 1
BesA						
A_0	0	0	0	0	0	0
A_1	1	1	1	1	1	1
A_2	0	0	0	0	0	0
BesB						
B_1	0.567	0.183	0	0.691	0.200	0
B_2	0	0.183	1	0.147	0.200	0.528
B_3	0.433	0.633	0	0.162	0.600	0.472
BesD						
D_0	0	0	0	0	0	0
D_1	0.350	0.750	1	0.824	0.833	0.556
D_2	0.350	0.250	0	0	0.100	0.444
D_3	0.300	0	0	0.176	0.067	0
BesE						
E_0	0.467	0.833	0.483	0.662	0.600	0
E_1	0.350	0.167	0.283	0	0	1
E_2	0.183	0	0.233	0.338	0.400	0
PgmA						
A_1	0	0	0	0.265	0	0.097
A_2	0.667	0.900	0.817	0.500	1	0.236
A_3	0.333	0.100	0.183	0.235	0	0.667
MdhA						
A_1	0	0	0	0	0	0
A_2	1	1	1	1	1	0.972
A_3	0	0	0	0	0	0.028
Bph A						
A_0	0.100	0.088	0.194	0	0	0
A_1	0.317	0.618	0.597	0.529	0.550	0
A_2	0.400	0.206	0.048	0.471	0.450	1
A_3	0.183	0.074	0.161	0	0	0
A_4	0	0.015	0	0	0	0
Hk						
A_1	0	0	0	0	0	0
A_2	1	1	1	1	1	1
Adh						
A	1	1	1	1	1	1
Ast A						
A	1	1	1	1	1	1

Table 2. Mean number of alleles per locus, proportion of polymorphic loci, observed (H_o) and expected (H_e) heterozygosity

Strains	Mean sample size per locus	Mean no. of alleles per locus	Percent Polymorphic loci (P=0.99)	H_o	H_e
Vratza 1	85.0±0.0	1.9±0.30	50.0	0.183±0.070	0.297±0.102
Vratza 37	88.0±0.0	1.9 ±0.40	50.0	0.102±0.046	0.196±0.074
Vratza 40	86.0±0.0	1.6±0.30	30.0	0.082±0.051	0.153±0.083
Gergana 1	84.0±0.0	1.7±0.30	50.0	0.112±0.052	0.237±0.083
Gergana 2	80.0±0.0	1.6±0.30	40.0	0.100±0.050	0.186±0.079
Ogosta 1	86.0±0.0	1.5±0.20	40.0	0.086± 0.042	0.156±0.076

Table 3. Nei's (1972) genetic distance (above diagonal) based on isoenzymes

	Vratza 1	Vratza 37	Vratza 40	Gergana 1	Gergana 2	Ogosta 1
Vratza 1	*****	0.061	0.164	0.059	0.070	0.151
Vratza 37		*****	0.093	0.072	0.023	0.233
Vratza 40			*****	0.119	0.094	0.234
Gergana 1				*****	0.054	0.237
Gergana 2					*****	0.238
Ogosta 1						*****

Identification of molecular markers (SSR) associated with thermo tolerance in silkworm *Bombyx mori*

By

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There has been increased attention on the effects of the abiotic environment on the survival, growth and reproduction of animals; the reason being that climate changes are likely to affect species fitness and distributions. Being a poliklothermic animal temperature plays a major role on the growth and productivity of silkworms. DNA markers have become fundamental tools for research involving silkworm improvement programs. Microsatellites or simple sequence repeat (SSR) markers are highly polymorphic, abundant, and distributed throughout the genome. In the present study, one thermo susceptible (CSR2) and four thermo tolerant genotypes (Nistari, Cambodge-Multivoltine; SK4C, BHR3-Bivoltine) were identified after exposing them to different temperature regimes. The identified genotypes were used for

marker analysis. The thermo susceptible genotype (CSR2) and the tolerant genotype (BHR3, SK4C, Nistari and Cambodge) were crossed and their (4) F2 population was used for marker analysis. Parents were surveyed with 83 SSR (Simple Sequence Repeat) primers to identify polymorphic markers. Among 83 SSR markers, eleven primers were found polymorphic within parents. These markers were utilized for bulked segregant analysis (BSA) and also for individual analysis. Among the polymorphic SSR markers, five primers viz., LFL1123, LFL0329, LFL407, S0801 and S0813 were able to distinguish the tolerant and susceptible bulks and individuals progenies. Of which, three markers viz., LFL1123, LFL0329 and S0813 have shown similar pattern in all four different genetic background tested. Hence these markers are associated with thermo tolerance in silkworm. Using these markers tolerant (Donor) and susceptible (recurrent) parents were identified and breeding initiated to develop thermo tolerant silkworm breeds through marker-assisted selection.
Keywords: Silkworm, Thermo tolerance, SSR marker

EVALUTION OF NEW SEX LIMITED BREEDS YUVA5 AND YUVA14 OF SILKWORM *BOMBYX MORI* WITH SHORT LARVAL DURATION BY HYBRIDIZATION

By

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A indigenously maintained bivoltine Sex-limited inbreed race SL-MG characterized for plain larvae spinning colored dumbbell female cocoon and white dumbbell male cocoon and two popular pure races of silkworm Bombyx mori, that is multivoltine Pure Mysore (PM) and bivoltine NB4D2 with known genetic background were utilized in a cross breeding experiment to evolve new bivoltine Sex-limited breeds suitable for tropical environmental conditions. An appropriate testcrossing and backcrossing initiated at different generations in the initial stages of the experiment followed by rigorous selection procedure at every generation till F12, for ten economic traits resulted in the isolation of new bivoltine sex-limited breed YUVA5 is characterized by plain larvae, spinning yellow female and white male dumbbell cocoons and YUVA14 is characterized by plain larvae, spinning yellow female and white male dumbbell cocoons with moderate larval duration.
Keywords: Indigenous, bivoltine, multivoltine, silkworm, testcrossing, backcrossing, sex-limited race.

USE OF PARTHENOGENETIC CLONES FOR MULBERRY SILKWORM IN GENETIC STUDY

By

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Parthenogenetic clones of mulberry silkworm are characterized by isogeny and extraordinary constance of phenotypic feature (Astaurov B.L., 1977; Strunnikov V.A., 1977). This makes the clones especially valuable material for scientific and practical sericulture in particular for study of genetic dependence of some feature of mulberry silkworm. Such studies are necessary in study of locomotor activity of mulberry silkworm imago and its interrelation with basic reproductive, biological and technological features. (Kaydanov L.Z., 1975; Gorohovskaya U.A., 2001; Zorina Z.A. et al., 2002; Larkina E.A. et al., 2010). The parthenogenetic clones were used for confirmation of existence of such interrelation. Parthenoclones (females) being the exact copy of their mothers are characterized by stability and evenness of features. When coupling of isogenic parthenoclonic females with mails of different degree of activity an impact of mother's genotype to the studied feature is excluded and descendants with father's genetic heredity are born. So genetic determinancy of feature and their interrelation with other features of mulberry silkworm is proved. It is reputed possible to use crossings with parthenoclones as unique test for genetic dependence of some other features of mulberry silkworm.
Keywords: mulberry silkworm, parthenogenetic clone, feature, determinancy, locomotor activity, interrelation, genotype, heredity.

THE PROBLEM OF SEX REGULATION IN SILKWORM *BOMBYX MORI* L. AND SOME WAYS OF ITS SOLUTION

BY

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The article describes the results of studies on the large-scale sex regulation in worms. A simple and efficient way of obtaining of new genetic translocation slice X-autosomy gene $+W_2$ marker pigmentation of eggs on the W-chromosome, no adverse impact on economically useful traits. Among them are new marked by gender (coloring eggs) breeding lines with improved reproductive and productive traits, which are highly productive, more silk than the cocoons hybrids for industrial use exclusively male.

At present day use of method of artificial sex regulation could be one of efficient tool for accelerating of mulberry silkworm selection process.

The silkworm has a property of sexual dimorphism, namely, cocoons of male silkworm by an average mass on ~ 20% more silk than the female cocoons. Theoretical and practical interests of the experimenter chooses only one desired offspring sex scientists geneticists have suggested an idea to develop new methods of artificial sex control in worms.

Thanks to focused research Astaurov B.L. (1940, 1974), Strunnikov V.A. (1969,1977), Tazima Y. (1967) has succeeded in developing a harmonious system get parthenogenesis and androgenesis the females, males under the action on the non-fertile eggs at strictly selected temperatures and expositions.

In order to accelerate the introduction of industrial rearing of the male larvae in the laboratory of silkworm breeding URIS started the research aimed on improving marked by sex on stage eggs and balanced on the two no allele Z-lethals silkworm breeds. The work was carried out in two directions:

1. Obtaining of new fragment of X-autosome translocation with the gene $+W_2$ pigmentation

of eggs on the W- chromosome.

2. Creation a new breeds worms with a large cocoon and more silk controlled by sex on stage of egg.

Solution of the task is argued, first, by specificity of silkworm male to have cocoons with an average weight of 15-20% lighter then females cocoons. Light cocoons male hybrids can lead to much lower yields in the production of green cocoons. We are trying to eliminate this disadvantage by use in new selection a large cocoon breeds as donors.

Secondly, by the reduction in weight of cocoons-females and reproductive properties in new obtained marked by sex due to some negative influence of previously received and entered in their genotypes translocation.

By new simple technique for new translocation were received X-autosomes on W-chromosome in 3 families' №510, №24, №12. These families all larvae emerged from the white eggs, were males. Females of these families became the first new genetic translocation lines 1m and 2m.

New male hybrids created on the base of a large cocoon breeds and lines in order to increase the productivity of silkworm in industrial silk production. New hybrids are characterized by increased survival value of larvae. Among the signs of hybrids of silkworm special importance is placed on characteristics of silk productivity. It is worth recalling that the cocoons male 18% lighter cocoons of the female. Despite this biological feature of the larvae of newly created male hybrids gave average weight of cocoons said 2.08 -2.23 g, practically the same and even higher national, regional wide used Tetrahybrid 3 (2.13g) and considerably higher than imported from abroad - Chinese hybrid (1.79g).

An important indicator in the evaluation of new hybrids is the cocoons harvesting and raw silk yield from 1 box of reared silkworm eggs. Examinees hybrids had the great advantage on cocoons harvesting and raw silk productivity compared with foreign Chinese hybrid and (78.0-79.0 kg and 18.2-19.7 kg vs. 65.2-70.0 kg and, 14.8 kg-15.2 kg).

Artificial regulation of sex worms allows solve actual problems of theory and practice of selection, breeding and hybrid eggs production such as:

-breeding of highly productive, labelled by sex and balanced by Z-lethals silkworm breeds;

-production of 100% highly heterozisis hybrid eggs of silkworm with the introduction of

the precise method of dividing the silkworm sex on stage in eggs;

-increase by 18-20% in amount of cocoons by switching to a large-scale rearing only male silkworm larvae;

-increase the leading technological properties of industrial dry cocoons (raw silk output,

cocoon filament length, filament size) on silk winding factories.

Keywords: *Bombyx mori* L., translocation, X-autosome, gene $+W_2$ marker pigmentation, sexual dimorphism, Z-lethal, male hybrids.

EXPRESSION OF POLYMORPHIC PATTERN OF GENOMIC DNA AND DENDROGRAMIC MAPS FOR SCREENING OF BIVOLTINE SILKWORM HYBRIDS UNDER IMPOSED THERMAL STRESS

By

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(POSTER)

The silkworm is a monophagous, poikilothermic and lepidopteran insect as well as economically important insect produces an elegant and superior quality silk fibre . India is tropical continent The cocoon production, disease resistant and temperature tolerance is mostly confined to a genetic endowment and nutritional value of the mulberry leaf and influenced by external environmental conditions. Among the silkworm breeds ,the multivoltines are known and prone to produce poor quality silk with high degree of disease resistant, where as the bivoltine breeds are highly to sensitive to the external environmental fluctuation and produces a quality silk production and therefore an experimental design was programmed for screening and to understand the pattern of expression of polymorphism of gDNA of the adult silk moth of the selected bivoltine silkworm breeds and hybrids and for which five different markers have been choosen and used in the present screening study. Evidence of the resulting data shows that the least 1-F (dissimilarity index)value among all the hybrids prepared from control parents after six continuous generations at 28±1°C ambient temperature was 0.133 recorded between JROP × NB_4D_2 and CSR_2 × NB_4D_2 hybrid, however the highest value was 0.688 between JROP × NB_4D_2 and CSR_4 × KA hybrids. The relationship between all the ten selected bivoltine hybrids with the respective control parents after six continuous generations at 28±1°C temperature in the dendrogramic map, the information is clearly suggested and supported by Bootstrap values. CSR_2 × KA cross is closer to CSR_4 × KA hybrid, as well as CSR_4 × JROP and CSR_4 × NB_4D_2 are placed in the same position. Further, CSR_4 × CSR_2 hybrid is divided in the same branch of tree in dendrogram with CSR_2 × JROP. Nevertheless, the hybrids KA × JROP, CSR_2 × NB_4D_2, KA × NB_4D_2 and JROP × NB_4D_2 are placed in the same positions. Whereas, at 40±1°C, The Bootstrap values was 0.188 between KA × NB_4D_2 and CSR_2 × KA hybrid, whereas the highest value is 0.632 between CSR_2 × NB_4D_2 and CSR_4 × KA hybrids. The relationship of all the ten selected bivoltine hybrids prepared from thermal stress based parents after six continuous generations at 40±1°C temperature is shown clearly in the dendrogram and suggested by Bootstrap values. CSR_2 × KA cross is closer to CSR_4 × NB_4D_2 hybrid, as well as CSR_2 × JROP and KA × JROP are placed in the next close positions to them but, it is not the same. Furthermore, the hybrids CSR_4 × JROP, JROP × NB_4D_2, KA × NB_4D_2, CSR4 × NB_4D_2, CSR_4 × KA and CSR_4 × CSR_2 are placed in the same positions were discussed based on the

expression of polymorphic pattern of genomic DNA for screening and identification of the bivoltine silkworm hybrids for thermal stress conditions in indian context is concerned.
Keywords: Polymorphism, gDNA, Bivoltine Hybrids and Thermal stress.

PARTHENOCLONING AND SELECTION IN CONTEMPORARY SERICULTURE

By

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The reanimation or recovery of sericulture that we observe now in different countries may change the role of genotype cloning in breeding and selection of silkworms. That refers, first of all, to ameiotic parthenogenetic cloning discovered by Astaurov (1936). Unlike transnuclear cloning, Astaurov technique is much more simple, effective and reliable. The parthenoclones selected in his laboratory over half a century ago demonstrate stable manifestation of their characteristic morpho- and physiological traits in succession of many dozens of generations. This feature of cloning is very attractive for the breeder, all the problem being reduced to selection of clones with the maximum or minimum expression of the desired character. The solution can be greatly simplified at the presence of a parthenoclone with a high (about 100% hatching) ability to thermal parthenogenesis. The clonal females being crossed with males carrying a trait under selection, we can set some clones with the desired character from F1 or F2 founder-females. For example, after crossing clone P29 with analyzer strain L50 we obtained in the 70's from one F2 female the clone P50, which is homozygous for the recessive markers in five different linkage groups and widely used in our genetic research. This is an encouraging result, because ability to thermal parthenogenesis requires a high level of individual heterozygosity and direct parthenocloning of inbred females proved impossible in practice (Klymenko, 2001).

As a unique feature of P29 clone may be considered the fact that it could, through meiotic parthenogenesis, give rise to about 2% hatching of absolutely homozygous males (sons), which didn’t contain lethals and could transmit, if crossed, the clonal ability for parthenogenesis to inbred lines (Strunnikov, 1987). Thus, an additional valuable direction in selecting clones was found. But in recent years, after repeated attempts, it became clear that the clone P29 and its "old" derivatives are not able more to produce parthenogenetic sons. Immediately we put in action the selection of new clones and in late 2012 we succeeded in obtaining clone P14 that has all its characteristics not inferior to clone P29. Using clones P29 and P14 we plan to create clonable parthenozygotic silkworm genotype pool (clonable germ plasm), in which any characters could be fixed by parthenocloning at various levels of selection and inbreeding. In the course of this work if it is shown that a certain level of heterozygosity is needed for cloning (Klymenko, 2001), the ovary-implant cloning technique can be used for conserving unique features (or induced mutations) of inbred line females (Klymenko, 2001; Zabelina et al., 2011), or androgenesis (Astaurov, 1937) – for cloning homozygous males. The cloning of heterozygous males and any other genotypes may be implemented by the proposed parthenogenetic reactor, which based as well on clone P29, more exact, on the highest ability of its unfertilized eggs to be activated by heat shocks (Klymenko, 2001).

With parthenozygous genotype pool we could conserve any unique native or man-made gene complex. The use of mutagenesis and transgenesis with this pool would allow rapid fixation and maintenance of the bioforms induced. Parthenocloning could give us the basis to introduce necessary standards for the products of biotechnological and pharmacological sericulture, particularly for the products obtained from the silkworm egg.

Organization of the proposed parthenozygotic genotype pool in BACSA countries could be a subject of discussion at the Congress.

EXPRESSION OF POLYMORPHIC PATTERN OF GENOMIC DNA AND DENDROGRAMIC MAPS FOR SCREENING OF BIVOLTINE SILKWORM HYBRIDS UNDER IMPOSED THERMAL STRESS

By

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The silkworm is a monophagous, poikilothermic and lepidopteran insect as well as economically important insect produces an elegant and superior quality silk fibre . India is tropical continent The cocoon production, disease resistant and temperature tolerance is mostly confined to a genetic endowment and nutritional value of the mulberry leaf and influenced by external environmental conditions. Among the silkworm breeds ,the multivoltines are known and prone to produce poor quality silk with high degree of disease resistant, where as the bivoltine breeds are highly to sensitive to the external environmental fluctuation and produces a quality silk production and therefore an experimental design was programmed for screening and to understand the pattern of expression of polymorphism of gDNA of the adult silk moth of the selected bivoltine silkworm breeds and hybrids and for which five different markers have been choosen and used in the present screening study. Evidence of the resulting data shows that the least 1-F (dissimilarity index)value among all the hybrids prepared from control parents after six continuous generations at 28±1°C ambient temperature was 0.133 recorded between JROP × NB_4D_2 and CSR_2 × NB_4D_2 hybrid, however the highest value was 0.688 between JROP × NB_4D_2 and CSR_4 × KA hybrids. The relationship between all the ten selected bivoltine hybrids with the respective control parents after six continuous generations at 28±1°C temperature in the dendrogramic map, the information is clearly suggested and supported by Bootstrap values. CSR_2 × KA cross is closer to CSR_4 × KA hybrid, as well as CSR_4 × JROP and CSR_4 × NB_4D_2 are placed in the same position. Further, CSR_4 × CSR_2 hybrid is divided in the same branch of tree in dendrogram with CSR_2 × JROP. Nevertheless, the hybrids KA × JROP, CSR_2 × NB_4D_2, KA × NB_4D_2 and JROP × NB_4D_2 are placed in the same positions. Whereas, at 40±1°C, The Bootstrap values was 0.188 between KA × NB_4D_2 and CSR_2 × KA hybrid, whereas the highest value is 0.632 between CSR_2 × NB_4D_2 and CSR_4 × KA hybrids. The relationship of all the ten selected bivoltine hybrids prepared from thermal stress based parents after six continuous generations at 40±1°C temperature is shown clearly in the dendrogram and suggested by Bootstrap values. CSR_2 × KA cross is closer to CSR_4 × NB_4D_2 hybrid, as well as

$CSR_2 \times$ JROP and KA $\times$ JROP are placed in the next close positions to them but, it is not the same. Furthermore, the hybrids $CSR_4 \times$ JROP, JROP $\times NB_4D_2$, KA $\times NB_4D_2$, CSR4 $\times NB_4D_2$, $CSR_4 \times$ KA and $CSR_4 \times CSR_2$ are placed in the same positions were discussed based on the expression of polymorphic pattern of genomic DNA for screening and identification of the bivoltine silkworm hybrids for thermal stress conditions in indian context is concerned.
Keywords: Polymorphism, gDNA, Bivoltine Hybrids and Thermal stress.

Genetic Labeling of Georgian Mulberry Silkworm Breeds with Molecular Biological Method

By

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Genetic labeling is necessary for determination of accurate and objective breed and species of mulberry silkworm, for genofund documentation, their description, preservation and efficient application in selection, rapid and correct detection of desired genotypes from hybrid population. Protein can be used as reliable molecular marker for genotypes, since it yields less to external conditions of body development. Due to its high biological specificity, protein can be used as a marker of taxonomic units (breed, genus, family etc).

Grain proteins of 21 Georgian breeds of mulberry silkworm and hybrid were studied by the method of isoelectric focusing.

In electrophoresis specters of hemolymph of Mziuri group breeds 3 proteins are found, which enable us to identify a breed or group of breeds.

In the Digmuri group mulberry silkworm breeds proteins specters are practically identical.

As a result of correlative study of specters of hemolymph proteins specific proteins were exposed in some breeds and hybrids, which can be used as breed markers.
Keywords: mulberry silkworm, silkworm, hemolymph, protein

Identification of suitable foundation cross for bivoltine seed crop stabilization in Eastern and North Eastern India

By

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(POSTER)

ABSTRACT: In India about 90% of the silk comes from polyvoltine x bivoltine hybrids. In Eastern India especially in the state of West Bengal rearing of bivoltine parent during seed crop for preparing polyvoltine x bivoltine eggs is very difficult owing to unpredictable, fluctuating and harsh climatic condition prevails in most of the seed crops. To overcome this, suitable bivoltine foundation cross (FC) namely SK6 x SK7 was identified. A total of 31920 dfls of SK6 x SK7 was reared in different seed crop seasons for two years (2007-2009) in state of West Bengal, Assam, Meghalaya, Jharkhand and Orissa. During favourable seed crop seasons (Dec-Jan & Feb-Mar), SK6 x SK7 yielded an average of 42 kg / 100 dfls as compared to 27 kg in NB4D2 (control). Remarkably in the most unfavourable seed crop season i.e., Sep-Oct, it yielded an average of 34 kg / 100 dfls when other bivoltine rearing is near to fail. Further multi x bi hybrid combinations prepared with this FC namely, Nistari x (SK6 x SK7) were evaluated at farmers level (13.75 lakhs dfls) in different commercial seasons at West Bengal for two years shown encouraging performance. During favourable season an average cocoon yield of 41 kg / 100 dfls was obtained in N x (SK6 x SK7) compared to 37kg / 100 in N x NB4D2. During autumn crop, an important commercial crop (Oct-Nov/ Agrahayani), N x (SK6 x SK7) yielded an average of 47kg / 100 dfls as compared to 43kg in N x NB4D2. Further during unfavourable seasons (June-July & September) it yielded an average of 31 kg / 100 dfls, even though in these seasons multivoltine hybrids are recommended. Thus with SK6 x SK7 (FC), bivoltine seed crop stabilization - the bottleneck for the development of sericulture industry in Eastern and North Eastern India particularly in West Bengal can be overcome and bivoltine seed cocoons can be raised at Eastern and North Eastern India states itself, hence avoiding transportation of seed cocoons from far flung places to save money and energy.
Keywords: Seed crop, Foundation cross, Multi x bi hybrid

INTRODUCTION

Unlike temperate countries, India is a vast country with varying climatic conditions in different agro–climate zones. The precipitation rate, temperature and humidity vary from season to season and zone to zone. Among different zones, tropical regions experience the highest temperature as well as humidity (Ghosh *et al*., 2001). Indian Sericulture is mostly multivoltine oriented and more than 90% of the silk is obtained from rearing multivoltine x bivoltine hybrids. Eastern India, especially West Bengal, one of the major sericulture practicing states in India, experiences wide fluctuation in temperature, humidity and precipitation rate. The climate of this region can be broadly divided into three categories viz., the hot-dry season that stretches from March to early June; the hot humid season that stretches from mid June to September and winter from November to February (Moorthy and Das, 2007). In general, the areas located in the plains of West Bengal, where maximum sericulture is being practiced are very hot and humid during summer and fairly cold and dry during the winter. These conditions affect both growth of mulberry and silkworm rearing. In the plains of West Bengal, rearing of seed and commercial crops is a all-the-year-round process. Five commercial silkworm rearing crops are carried out in a year out of which, multivoltine x bivoltine hybrids can successfully be reared during three seasons i.e., Autumn (Oct-Nov), Spring (Feb-Mar) and Early summer (Mar-Apr) and in other seasons viz., Summer (June-July) and rainy (Aug-Sep), multivoltine x multivoltine hybrids are reared. Multivoltine x bivoltine hybrid yields more cocoon and fetches an higher prize as the silk reeled from multivoltine x bivoltine is qualitatively better than from multivoltine x multivoltine. However

for preparing multivoltine x bivoltine hybrid layings, bivoltine seed cocoons are required, but raising of bivoltine seed cocoons are difficult in tropical climate as they are susceptible to temperature and pathogens (Das *et al.,* 2006)
Especially, the seed crop of autumn (the major commercial crop when there is the 30% dfls of annual consumption) has to be conducted during Sept-Oct, when both temperature (>35 º C) and humidity (>90%) are high, which threats rearing of bivoltine parent silkworms, resulting in unsuccessful raising of bivoltine seed cocoon which in turn affects production of multi x bi silkworm eggs. Therefore seed preparation agencies of this region are bringing bivoltine cocoons (male component) from other parts of India spending lot of money, manpower and time.

The foundation crosses may not be a true hybrid; however because of two (similar types of) parents involved they are tolerant to environmental condition and easy to rear than the single parent. Hence in this study, as an alternative to single bivoltine parents, bivoltine foundation crosses (FCs) are tried during different seed crops to find out suitable foundation crosses (FC), which can give a sustainable yield and can be used for multi x bi dfls production.

MATERIALS AND METHODS

Four bivoltine breeds spinning oval shape cocoon (SK3, SK1, MC1, MC3) and seven spinning dumbbell shape cocoon [SK6, SK7, MJ1, MJ2, BHR1, BHR2, BHR3] were used to prepare six bivoltine foundation crosses viz., BHR2 x BHR3, SK6 x SK7, BHR1 x BHR3 MJ1 x MJ2 (Dumbbell FC), MC1 x MC3, SK3 x SK1 (Oval FC). These foundation crosses were evaluated during three seed crop seasons viz., Sep-Oct, Dec-Jan and Feb-Mar. for two years at Central Sericultural Research and Training Institute (CSRTI), Berhampore, West Bengal. Data on the economically important traits were collected from each seasons and have been pooled and analyzed. The ranking of the foundation crosses was done as per Mano *et al*. (1993) evaluation index.

After laboratory evaluation, best four (BHR2 x BHR3, SK6 x SK7, MJ1 x MJ2 and SK3 x SK1) were shortlisted and further evaluated at three Regional Sericultural Research stations (RSRS) situated in three different states of India viz., Ranchi (Jharkhand), Jorhat (Assam) and Koraput (Orissa) in three seasons for two years. Out of four , SK6 x SK7 were found to be the best in respect of survival and other cocoon traits. Furthermore it was taken for evaluation at field level.

Field trial

After laboratory and RSRS level evaluation, the potentiality of SK6 x SK7 was tested in different sericulture farms of different states of East and North Eastern India viz., West Bengal (State sericulture farms & Seed rearers), Jharkhand (RSRS farm), Orissa ((NSSO-farm) Assam (RSRS farm), Nagaland (REC farm), Tripura (REC farm), Chattishgarh (State farm) and Megalaya (REC farm). The bivoltine cocoons (SK6 x SK7) raised at above mentioned places was brought to Silkworm Seed Production centres (SSPCs) of Central Silk Board (NSSO) in West Bengal, Grainages of State Sericulture department (DOS,W.B) and Licenced Seed Producers (LSP) for use as male component in preparation of multi x bi layings. The trial was conducted during Dec-Jan, Feb-Mar and Sep-Oct seed crop seasons. In addition May-June and June-July crops were undertaken in a limited scale. Using SK6 x SK7 as a male component a total of 13.75 lakhs dfls of multi x bi dfls [Nistari x (SK6 x SK7)] prepared and reared in different commercial seasons by the farmers of Murshidabad, Malda and Birbhum districts in West Bengal

RESULTS

Performance of bivoltine foundation crosses in different seed crops at laboratory

The analysis of the performance of the bivoltine foundation crosses reared during three seed crop seasons viz., Sep-Oct, Dec-Jan and Feb-Mar are shown in the table 1, 2 and 3. In Sep-Oct (seed crop), SK6 x SK7 ranked first with pupation % of 92.0 with cocoon yield of 13.85kg/10,000 larvae and shell% of 20.65 compared to 12.9% pupation, 1.62 kg cocoon yield /10,000 larvae and 17.60 % shell in the control breed, NB4D2 (Table 1).

During Dec-Jan (Seed crop) season also, SK6 x SK7 ranked first with pupation % of 95.25 with cocoon yield of 15.75kg/10,000 larvae and shell% of 21.14 against 77.3% pupation, 10.2 kg cocoon yield /10,000 larvae and 18.44 % shell in the control breed, NB4D2 (Table 2).

In Feb-Mar (Seed crop) season again SK6 x SK7 ranked first with pupation % of 96.00 with cocoon yield of 15.96 kg/10,000 larvae and shell% of 21.63 against 79% pupation, 10.23 kg cocoon yield / 0,000larvae and 18.53 % shell in the control breed, NB4D2 (Table 3).

Average of three seasons (Sep-Oct, Dec-Jan & Feb-Mar) data indicated that SK6 x SK7 has shown higher pupation% (94.4) with 21.16%s shell followed by MJ1 x MJ2 with 88.5% pupation and 19.46% shell against 56.4% pupation and 18.19% shell in control,NB4D2 (Table 4).

Evaluation index calculated for six traits for three seasons indicated SK6 x SK7 ranked first with index value of 61.12 followed by SK3 x SK1 (58.07) and BHR2 x BHR3 (52.09) (Table 5).

Performance of foundation crosses in RSRS level

Mean performance of four bivoltine foundation crosses reared at three RSRS in three seasons is presented in table 6. Results revealed that SK6 x SK7 shown higher pupation (81.9%) with shell% of 20.45 and ranked first with EI value of 57.2. SK3 x SK1 has secured second rank (EI value: 53.2) with pupation of 65.43. However, MJ1 x MJ2 showed better pupation (76.42%) after SK6 x SK7 which had lowest EI value (43.2)

Performance of SK6 x SK7 in different state farms

Dec-Jan seed crop

During Dec-Jan (2007-2009) seed crop, a total of 5025 dfls of SK6 x SK7 was reared in different places of DOS (Department of Sericulture) farms, seed rearers of Murshidabad district and farms managed by NGO's in West Bengal. In this season, SK6 x SK7 yielded an average cocoon yield of 42.5 kg /100 dfls and yield ranged between 33-53kg/ 100 dfls (Fig.1).

Feb-Mar seed crop

During this season (2008-2009), 8700 dfls of SK6 x SK7 were reared in different places and yielded an average of 45 kg/100 dfls. The yield ranged between 37-52kg/100 dfls (Fig.1).

Sep-Oct seed crop

During Sep-Oct (2008-09), the most unfavourable and important season of the year, a total of 17595 dfls of SK6 x SK7 was reared and yielded an average of 34kg/100 dfls. The yield ranged between 22-48.2kg /100 dfls(Fig.1).

May-June and June-July seed crops

In addition, SK6 x SK7 was also tested in two other seasons, when bivoltine cannot be reared due to high temperature and high humidity (May-June and June-July) conditions prevail. A total of 600 dfls of SK6 x SK7 were reared and yielded 30 and 22kg/100 dfls respectively.

Performance of multi x bi hybrids at farmers' level

A total of 13.75 lakhs dfls of Nistari x (SK6 x SK7)-multi x bi hybrid was reared in three commercial seasons by the farmers of Murshidabad, Malda and Birbhum district of West Bengal. Whose, 302000 dfls were reared during Feb-Mar and obtained an average of cocoon yield of 40kg/100 dfls (Range: 33-46.3kg/ 100 dfls) against 37kg in control, N x NB4D2. During April crop, 330600 dfls were reared and an average yield of 38.5kg/100 dfls was obtained, whereas 30kg was obtained in control hybrid, N x NB4D2. In the most important commercial crop (Oct-Nov), the highest amount of 742400 dfls was reared by farmers and it obtained an average yield of 44 kg/100 dfls (Range: 37-54.5kg) against 40 kg in the control, N x NB4D2 (Table 7) .

DISCUSSION

The cocoon crop stability and other yield attributes in the silkworm, *Bombyx mori* largely depends on a wide range of environmental conditions and attaining this objective is a challenge in tropical countries (Ren *et al.*, 1988). Basically, a silkworm breed has to satisfy the cocoon producer, egg producer and reeler. But it is a well-known fact that in the silkworm, *B. mori* most of the economic traits are under the control of polygenes and especially silk productivity and viability are negatively correlated. Hence, the fluctuating environmental conditions of the tropics with socio-economic conditions of rearers emphasized the need of alternative to overcome the hurdles of rearing parent bivoltine in adverse seed crop seasons. In silkworm, there is a clear demonstration that hybrids are superior in many aspects over the parental strains (Gamo and Hirabashi, 1983). However foundation crosses are not a true hybrid, since they are crossing between similar types of parents to avoid segregation at the commercial level and to boost heterosis.

In the silkworm, *B. mori*, the silk yield is contributed by more than 21 traits (Thiagarajan *et al.*, 1993) and there exists an interrelationship between multiple traits in silkworm. So in order to judge the superiority of the silkworm breed/ hybrid impartially, a common index method was found very much essential (Bhargava *et al.*, 1994). The evaluation index (E.I) method developed by Mano *et al.* (1993) was found to be very useful in selecting potential parents/hybrids in silkworm breeding programme. In this method characters are given equal weightage because in hybrids expression of traits will be uniform, in other words no variability within traits. Many workers used this E.I for selecting potential hybrid (Kumaresan *et al.*, 2000; Rao et al., 2006; Moorthy *et al.*, 2007; Rayar, 2007). Based on EI values, SK6 x SK7 performed best as it ranked first in laboratory and at the RSRS level with the highest survival and cocoon yield.

Results of the present study clearly indicated that foundation crosses are superior over single parents (NB4D2) in respect of cocoon yield and other economically important parameters. Out of six FCs evaluated in laboratory, SK6 x SK7 outyielded control (NB4D2) as well as other FCs in all seed crop seasons at laboratory and also at RSRS level. Result obtained from field trials conducted at different states of Eastern and North Eastern India in different seasons also proved the capacity of SK6 x SK7 to tolerate the prevailing environmental impediments. This study also inferred that bivoltine FCs can be recommended instead of single bivoltine parent for bivoltine seed crop stabilization. However, genetic worth of any linebreed will be judged based on performance of its hybrid. The multi x bi hybrid [Nistari x (SK6 x SK7)] prepared using SK6 x SK7 as one of the parent yielded a better cocoon yield than control in all the evaluated seasons, proving its worthiness as male component. Thus with SK6x SK7, the bivoltine seed crop stabilization , the impediment for Eastern India can be overcome and seed growers can rear this FC in their region itself therefore avoiding transportation loss, time and saving money.

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Table 1: Mean performance of bivoltine foundation crosses during Sep-Oct seed crop season at laboratory

Foundation cross	Fecundity (no)	Pupation %	Cocoon yield /10000 larvae(kg)	Cocoon wt (g)	Shell wt (g)	Shell%
BHR2 x BHR3	488	81.00	12.11	1.498	0.285	19.03
SK3 x SK1	550	62.45	9.85	1.600	0.325	20.31
SK6 x SK7	512	92.00	13.85	1.550	0.320	20.65
MJ1 x MJ2	488	83.10	12.05	1.456	0.265	18.20
MCI x MC3	492	80.25	1.53	1.450	0.261	18.00
BHR1 x BHR3	479	80.20	11.25	1.420	0.265	18.66
NB4D2 (Control)	420	12.98	1.62	1.250	0.220	17.60
CD at 5%	9.2	8.56	1.03	0.041	0.014	0.65

Table 2: Mean performance of bivoltine foundation crosses during Dec-Jan seed crop season at laboratory

Foundation cross	Fecundity (no)	Pupation %	Cocoon yield /10000 larvae.(kg)	Cocoon wt (g)	Shell wt (g)	Shell %
BHR2 x BHR3	520	90.40	14.20	1.585	0.320	20.19
SK3 x SK1	574	84.00	14.03	1.688	0.358	21.21
SK6 x SK7	569	95.25	15.75	1.656	0.350	21.14
MJ1 x MJ2	519	91.00	14.23	1.570	0.318	20.25
MCI x MC3	510	90.52	14.10	1.558	0.310	19.90
BHR1 x BHR3	522	91.20	13.85	1.545	0.298	19.29
NB4D2 (Control)	489	77.33	10.20	1.350	0.249	18.44
CD at 5%	12.1	3.16	0.608	0.037	0.009	0.603

Table 3: Mean performance of bivoltine foundation crosses during Feb-Mar seed crop season at laboratory

Foundation cross	Fecundity (no)	Pupation %	Cocoon yield /10000 larvae.(kg)	Cocoon wt (g)	Shell wt (g)	Shell%
BHR2 x BHR3	515	91.00	14.20	1.596	0.330	20.68
SK3 x SK1	565	84.00	14.03	1.680	0.365	21.73
SK6 x SK7	560	96.00	15.96	1.660	0.360	21.69
MJ1 x MJ2	521	91.50	14.00	1.540	0.325	21.10
MCI x MC3	514	92.50	14.12	1.562	0.320	20.49
BHR1 x BHR3	520	92.00	14.06	1.559	0.301	19.31
NB4D2 (Control)	495	79.00	10.23	1.360	0.252	18.53
CD at 5%	10.51	2.85	0.72	0.045	0.012	0.61

Table 4: Mean performance of bivoltine foundation crosses in three seasons at laboratory

Foundation cross	Fecundity (no)	Pupation %	Cocoon yield /10000 larvae.(kg)	Cocoon wt (g)	Shell wt (g)	Shell%
BHR2 x BHR3	508	87.5	13.50	1.560	0.312	19.96
SK3 x SK1	563	76.8	12.64	1.656	0.349	21.08
SK6 x SK7	547	94.4	15.19	1.622	0.343	21.16
MJ1 x MJ2	509	88.5	13.43	1.522	0.303	19.85
MCI x MC3	505	87.8	9.92	1.523	0.297	19.46
BHR1 x BHR3	507	87.8	13.05	1.508	0.288	19.09
NB4D2 (Control)	468	56.4	7.35	1.320	0.240	18.19
CD at 5%	22.1	4.21	0.656	0.051	0.016	0.60

Table 5: Estimation of Evaluation index (EI) values for three seasons and ranking of foundation crosses

Foundation cross	Fecundity (no)	Pupation %	Cocoon yield /10000 larvae.(kg)	Cocoon wt (g)	Shell wt(g)	Shell %	Average	Rank
BHR2 x BHR3	47.53	53.86	55.22	52.74	51.93	51.29	52.	3
SK3 x SK1	65.36	45.39	51.91	61.66	62.23	61.86	58.	2
SK6 x SK7	61.20	60.63	63.25	58.51	60.59	62.55	61.	1
MJ1 x MJ2	48.07	54.71	54.93	49.25	49.47	50.24	51.	4
MCI x MC3	46.78	54.09	41.51	49.37	47.92	46.54	47.	6
BHR1 x BHR3	47.31	54.13	53.51	47.95	45.45	42.99	48.	5
NB4D2 (Control)	34.75	29.18	31.70	30.53	32.41	34.54	32.	7

Table 6: Mean performance of bivoltine foundation crosses in three RSRS in three seasons and their ranking

Foundation cross	Fecundity (no)	Pupation %	Cocoon yield /10000 larvae.(kg)	Cocoon wt (g)	Shell wt(g)	Shell %	Average EI Value	Rank
BHR2 x	542	69.25	9.85	1.485	0.289	19.46	46.5	3
SK3 x SK1	510	65.43	10.05	1.542	0.320	20.65	53.2	2
SK6 x SK7	512	81.90	12.42	1.516	0.310	20.45	57.2	1
MJ1 x MJ2	469	76.42	11.00	1.441	0.275	19.08	43.2	4
SD	30.0	8.58	1.36	0.04	0.02	0.76		

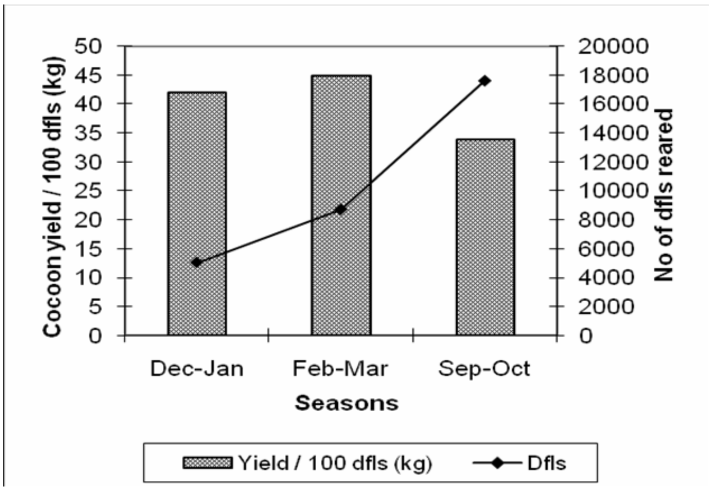

Fig 1: Performance of SK6 x SK7 in different seasons and in different states

Table 7: Season wise cocoon yield data of multi x bi hybrids reared at farmers level

Hybrid (Multi x Bi)	Season	No of dfls	Yield /100 dfls (kg)	
			Range	Average
Nistari x (SK6 x SK7)	Feb-Mar	381600	33 -46.3	40.0
	April	337600	34-45.0	38.5
	Oct-Nov	802850	37-54.5	44.0
N x NB4D2 (Control)	Feb-Mar	34800	30-45.3	37.6
	April	47600	25.5-38.5	30.0
	Oct-Nov	54000	34.5-47.5	40.0

Breeding of hardy bivoltine silkworm breed and identification of polyvoltine x bivoltine silkworm hybrid suitable for variable climatic conditions of the tropics of India

By

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(POSTER)

ABSTRACT: Eastern India experiences wide fluctuation in climatic conditions, which restricted rearing of productive silkworms throughout the year. Especially rearing of parent bivoltine silkworm is major impediment because most of the seed crops are falling under unfavourable season (May- Sep), when temperature and humidity are high.

Realizing the environmental constraints, there is a necessity to develop bivoltine breed with high survival with proper balance of other economic characters for rearing during unfavourable season and with productive traits during favourable seasons. In light of this objective, a breeding programme was designed to improve the survival trait in bivoltine silkworm by introgression of multivoltine genes / characters into bivoltine silkworm adopting back crossing technique and esterase isozyme marker assisted selection.

Accordingly a promising bivoltine breed namely SK4C was developed with 65 & 86% survival with shell% of 20 &21 as compared to 18.58 & 81.7 % survival and shell% of 18.35 & 19.28 in the original bivoltine (recipient) parent SK4 during unfavourable (Sep-Oct) and favourable seed crop seasons (Dec-Mar) respectively. Esterase isozyme pattern in the newly developed bivoltine breed SK4C revealed the presence of a new band with Rm value of 0.247 (Est-3). Which was absent in recipient bivoltine parent SK4 and available in the donor multivoltine parent, Cambodge. It indicates the introgression of multivoltine genes / character in the developed bivoltine. Further this breed was subjected to hybrid evaluation test along with other bivoltine breeds after crossing with three multivoltine parents and reared during three important commercial seasons of the year (Autumn, Spring and Early summer). Of which, the hybrid M6DP (C) x SK4C adjucated first based on multiple trait evaluation index. M6DP (C) x SK4C showed the cocoon yield of 14.5-15.58 kg/ 10000 larvae with shell% of 18.16- 18.95 and raw silk% of 13-15.0 as compared to 11.8-14 kg / 10000larvae with shell% of 16.5 –16.9 and raw silk % of12.3- 13.10 in N x NB4D2 (control). Thus successful directional breeding programme promises immense scope to improve the quantity of cocoon as well as silk. **Eastern India experiences wide fluctuation in climatic conditions, which restricted rearing of productive silkworms throughout the year. Especially rearing of parent bivoltine silkworm is major impediment because most of the seed crops are falling under unfavourable season (May- Sep), when temperature and humidity are high.**

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Keywords: Bivoltine silkworm, Backcross, Esterase.

Introduction:

In Eastern India rearing of productive silkworms is restricted due to prevailing of high temperature and humidity, particularly during the seasons between April and September, when huge leaf biomass is produced. Due to this climatic situation, low productive multivoltine based hybrids are reared by the farmers. However, from November to March, the climatic conditions remain favourable for rearing and the farmers rear multi x bi hybrids (Das, 1994). The important commercial crops seasons of this region are spring (Feb-Mar), early summer (March-April), rainy (June-July and Aug-Sep) and autumn (Nov-Dec).

For production of multi x bi hybrids for rearing during favourable seasons, seed crops are conducted during preceding months of each commercial crop. Climatic conditions of seed crop seasons of this region are highly variable. But to prepare commercial hybrids, bivoltine rearing is essential for seed cocoon production at least during three seed crop seasons viz., September-October, December-January and February-March. During September (seed crop of autumn) high temperature coupled with high humidity and unpredictable rainfall are the common barriers for raising bivoltine seed cocoon crop. Therefore, the seed producing agencies have to depend on the other parts of the country for bivoltine seed cocoons.

Apart from climatic conditions, the genetic potential of silkworm breed plays a vital role in the quality and quantity of silk produced. The bivoltine breeds are known for their high productivity but poor adaptability to tropical climatic conditions, whereas polyvoltine breeds are known for their rather higher viability and low productivity under tropical climatic conditions.

Hence there is a necessity to develop bivoltine breed with high survival and with a proper balance of other economic characters and a hybrid which can give stable crop to be exploited in this region. Silkworms' breeding since long has been aimed towards evolving superior and resistant breeds, either by means of selection alone or by out crossing and back crossing followed by selection in subsequent generations (Raju and Krishnamoorthy, 1993; Das *et al*., 1998; Das et al., 2000). Das (2001) and Chandrasekaraiah and Ramesh Babu (2003) reported introduction of polyvoltine blood into bivoltine is more useful in developing resistant bivoltine breeds and it is also widely used in China.

Keeping this in view, a breeding programme was designed to improve the survival traits in bivoltine silkworm by introgression of multivoltine genes/characters into bivoltine silkworm through backcrossing and esterase isozyme selection.

Materials and Methods:

One oval (CSR2) and one dumb bell bivoltine parent (SK4) were selected as recurrent parents and two polyvoltine breeds viz., Nistari and Cambodge were selected as donor parents. The selected bivoltine parents were crossed with polyvoltine parents and a total of four F1 combinations viz., SK4 x Nistari, , CSR2 x Nistari, , SK4 x Cambodge, and CSR2 x Cambodge were prepared. The F_1 progeny was backcrossed with polyvoltine (BC_1) followed by back crossing with bivoltine (BC_2 & BC_3) to regain productive traits. After back crossing (BC_3), inbreeding was continued till BC_3 F^{10} generation. From F_1 to BC_3 F^{10}, batch rearing was conducted (Moorthy *et al.,* 2007b). Generally the climatic conditions of the experimental place experiences were distinct according to seasons and fluctuating conditions throughout the year (hot summer, wet summer, spring, autumn and winter); hence rearing was conducted under prevailing environmental conditions to get the G x E expression. Furthermore during breeding of subsequent generations emphasis was given to select batches having higher survival along with other quantitative and qualitative traits. In addition characters viz., moth longevity and hibernation character were also included in selection criteria.

In each breeding generation, haemolymph was collected from the 5th instar 3rd day larvae of parents and breeding lines and were subjected to esterase isozyme analysis (Harris and Hopkinson,1977). From each batch, randomly selected larvae were subjected to esterase isozyme analysis and subsequently the batches having high survival with similar banding pattern to multivoltine parent were selected.

After development of breeds, they were reared during three seed crop seasons viz., Sep-Oct, Dec-Jan and Feb-Mar for two years. Data on the important characters viz., fecundity, larval period (d), pupation %, yield / 10000 larvae weight, cocoon weight (g), shell weight (g), shell%, filament length, raw silk% and reelability were collected.

The new bivoltine lines along with some other bivoltine were crossed with three multivoltine breeds [Nistari, M12 (W), M6DP (C)] and eighteen multi x bi hybrid combinations were prepared. These combinations were reared in three commercial crop seasons viz., Autumn (Nov-Dec), Spring (Feb-Mar) and Early summer (April) for two years. The data was subjected to ranking (Mano *et al.,* 1993) for selection of best hybrid.

Results:

The generation wise performances of four lines developed are presented in the fig.1-4. In all the lines, pupation% was recorded higher during F_1 & BC_1 generation and declination was observed in BC_3F^3 to BC_3F^5 generations followed by an approximate stabilization in subsequent ones. Since breeding lines were reared in different seasons, fluctuation in pupation rate was observed. However, shell% was observed low during F_1 to BC_1 and a trend of increase was observed into subsequent generations and later it was attempted to stabilize it The trend was the same in all the lines.

The mean performance of the newly developed bivoltine breeds reared during three seed crop seasons (Dec-Jan, Feb-Mar and Sep-Oct) for two years are shown in the table 1. Results revealed that SK4C showed 34 and 47% increased survival over its original parent (SK4) and control (NB4D2) respectively. In case of shell% it was showed a 9 and 5% increase as compared to the original parent (SK4) and control (NB4D2) respectively. However, SK4N was better in respect of survival than SK4C and it showed 37 and 51% increased survival over its original parent (SK4) and control (NB4D2) respectively. But shell% did not exceed over control and original parent. The other lines viz., CSN & CSC have also shown an improvement in survival over parent and control. They have shown 53 and 46% and 59 and 51% increased survival over their original parent (CSR2) and a control (NB4D2) respectively. The shell% in the both lines could not exhibit itself higher than the parent as well as control. Hence considering the survival and other economical characters of the lines, it is suggested that SK4C was the best.

Analysis of α-esterase isozyme pattern in the four developed bivoltine lines, their parents (Donor and receptor) and control revealed a total of five bands (Plate 1) with Rm (Relative mobility) values of 0.205 (Est-5), 0.223(Est-4), 0.247(Est-3), 0.357(Est-2) and 0.437(Est-1). Of which, the characteristic band with Rm value of 0.247 (Est-3) present only in the multivoltine (donor) parents are also predominantly available in the newly developed bivoltine lines, but not in the receptor parents (Fig5a, 5b). This shows the introgression of multivoltine genes / characters in the developed bivoltine lines.

The mean performance of hybrids (Multi x Bi) developed by crossing between multivoltine and newly developed bivoltine breeds and reared in three commercial seasons (Nov-Dec, Feb-Mar and April) for two years are shown in the table 2. Among the eighteen hybrids M6DP(C) x SK4C showed higher cocoon yield of 14.24 kg/ 10000 larvae with shell% of 18.61 and raw silk% of 14.25 followed by M12(W) x SK4C (13.850 kg, 18.0% shell and 12.86% raw silk) as compared to 12kg/10000 larvae with shell% of 17.08 and raw silk % of 12.5 in N x NB4D2 (control). The evaluation index calculated for eight characters for eighteen hybrids are shown in table 3. According to average evaluation index value M6DP (C) x SK4C ranked first with score of 71 followed by M12(W) x SK4C (60.6) and M6DP(C) x D6(P) N (60).

Discussion

Back crossing and introgression are useful for genetic improvement in breeding programme. In backcross, progeny are selected on the basis of character of interest and then back cross to recurrent parent (Hospital, 2005). The choice of donor is important in the development of improved lines. To choose the donor, it is important that phenotypic evaluation be done several times before selecting the tolerant line that can eventually be a candidate donor. Accordingly in our study the donor parents were evaluated over the year and selected based on their performance and isozyme variability (Moorthy *et al.,* 2007a). The donor parents, Nistari is an indigenous and highly adapted to local environmental conditions strain, while Cambodge is reported to be a resistant strain to high temperature and has the dominant gene for robustness (Suresh Kumar *et al.,* 2004). Reports are available that Pure Mysore, an indigenous polyvoltine breed of the Southern part of India was used as parent to develop silkworm strains tolerant to high temperature (Tazima and Ohnuma,1995).

Wu and Hou (1993) reported that environment prevailing in the rearing localities is the base temperature for developing/understanding the thermo-tolerance of the silkworm. Rajanna and Sreeramareddy (1998) opined that, initiating breeding experiments in native environment would facilitate 'direct response' of the suitable genotype to the prevailing environment and yield consistent cocoon crops. Further according to Falconer (1960), the improvement obtained by selection under favourable conditions will not help in revealing the full potential when the selected strains are transferred to unfavourable conditions. Keeping these points in mind in our study, rearing was conducted in the prevailing environmental conditions of the region to get G x E interaction.

He and Oshiki (1984), reported that that resistance to adverse environment was greater in bi x multi form as compared to its reciprocal. Using bi x multi cross in F1 generation they were able to develop bivoltine breeds suitable for autumn rearing in China. In our study we also used bi x multi form in initial crossing and results clearly indicated that there is improvement of survival in developed bivoltine breeds comparing to their original parents (bivoltine) and control.

Combining phenotypic and genotypic information in the selection may strengthen the chance of introgressing the desired traits to improve an elite line. Tankley and Rick (1980) suggested exploiting differences in isozymic alleles between the donor and recurrent parent and it would be possible to screen the back cross progeny for recurrent parent in the genotype of two or more backcross generation. In our study initially the parents were characterized based on esterase isozyme patterns. During breeding, the characteristic band with Rm value 0.247 (Est-3), which was present only in the donor parents/multivoltine is used for selection of lines. In every generation the breeding lines were selected based on higher pupation and presence of Est-3. Accordingly the Est-3 was transgressed from donor to developed lines. It also confirmed the introgression of survival character /multivoltine character into bivoltine (Moorthy *et al.,* 2008). However, it requires full proof study to establish that the particular band (Est-3) is related to survival characters. Ashwath and Morrison (2001) used digestive amylase, as a surrogate marker to develop high survival bivoltine using multivoltine as a donor. Shao *et al*.(1987) and He *et al.* (1989) also adopted hybridization and back crossing followed by rearing at high temperature and humidity to develop robust silkworm breeds. Though all the lines showed higher survival compared to control and their original parents, other characters were not improved equally in all the lines. In sericulture, cocoon characters are also equally important along with survival, hence selection of the best breeds was carried out such a way that higher survival and other economic characters are comparable with original parent/control. Therefore out of four lines, only SK4C was found the best as it has shown improvement in survival as well as cocoon characters.

Results of hybrids reared in three commercial seasons indicated that M6DP(C) x SK4C, M12(W) x SK4C and M6DP (C) x D6(P)N shown better performance than control and ranked in the first three positions. Advantage of these hybrids are that bivoltine parents with improved survival capacity can easily be reared during preceding seed crop seasons especially during adverse seed crop season compared to the ruling bivoltine breed. So the best performing and identified hybrid [M6DP(C) x SK4C] can be recommended for commercial exploitation to increase the silk production in Eastern India. From this study it is inferred that proper selection of parent, exposure to target environment, crossing patterns and combining selection of phenotypes and genotypes during breeding process will yield desired results.

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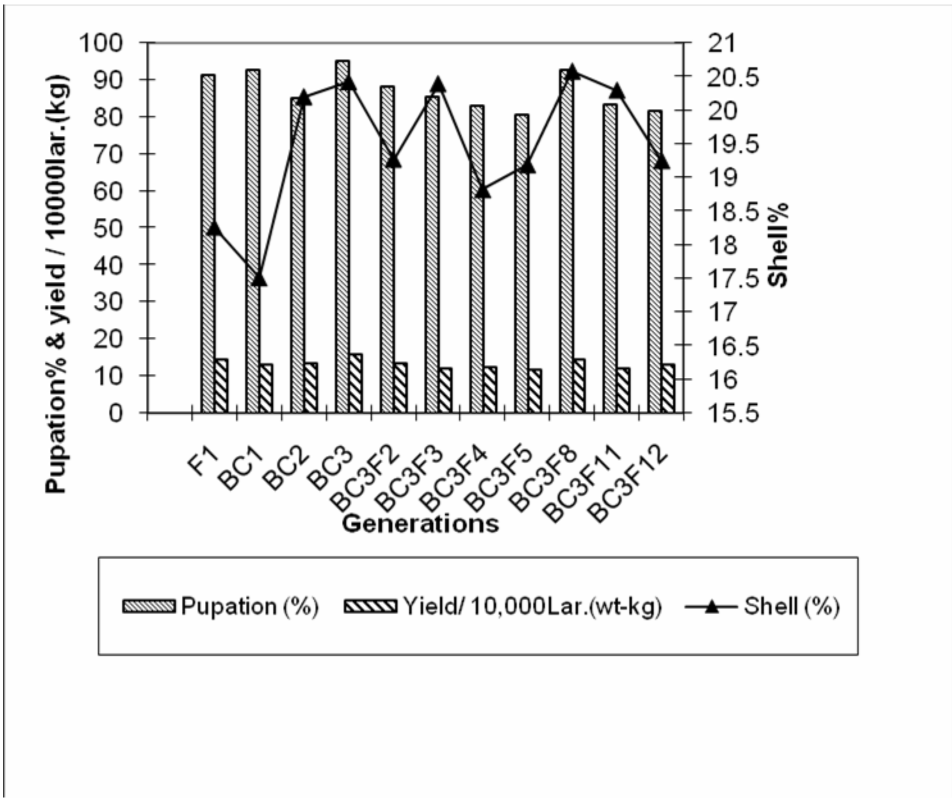


Fig1: Generation wise performance of the line SK4C

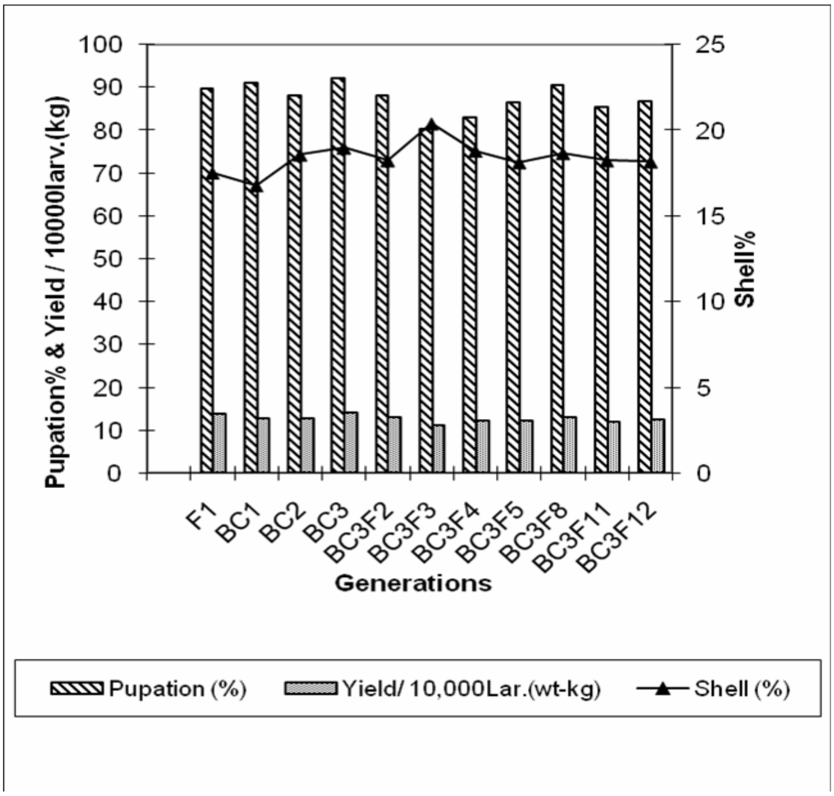


Fig2: Generation wise performance of the line SK4N

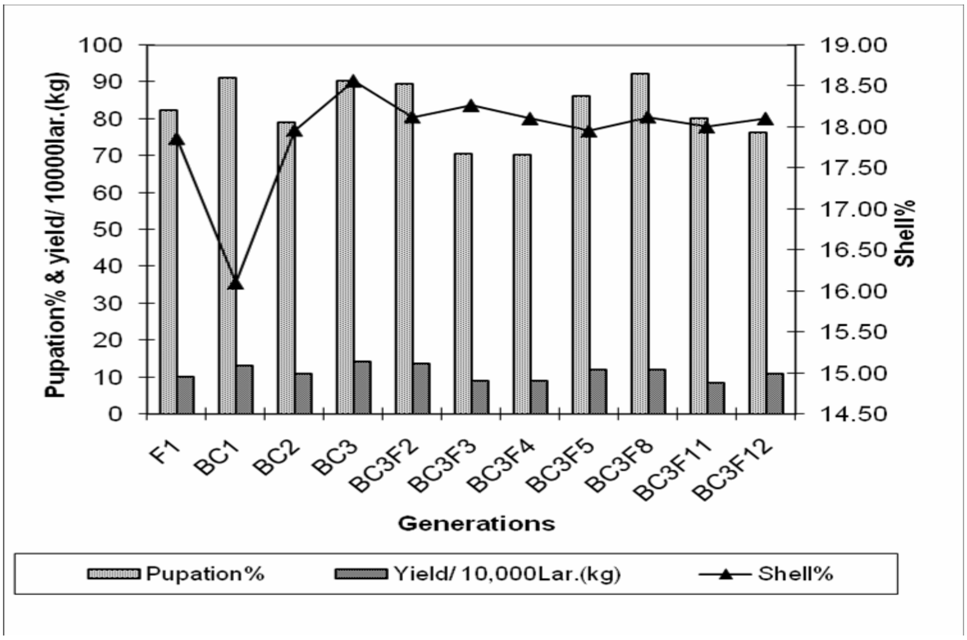


Fig3: Generation wise performance of the line CSN

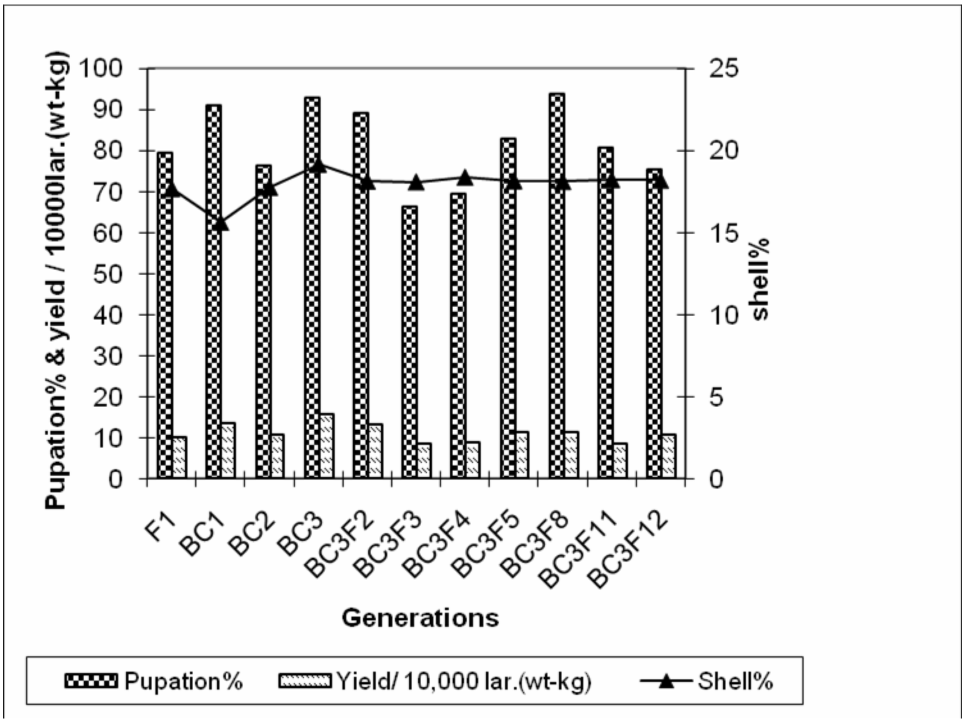
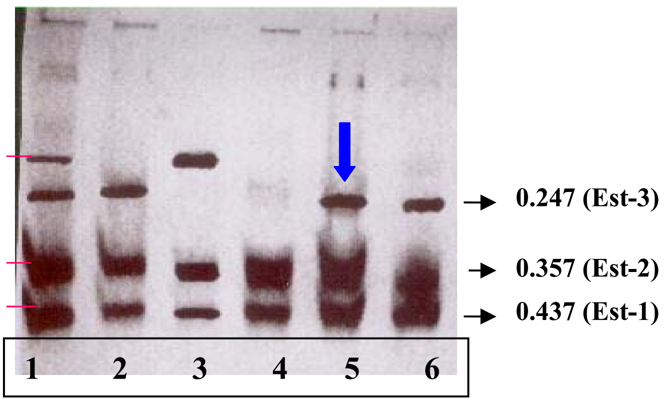


Fig4: Generation wise performance of the line CSC

Table1: Mean performance of developed lines , parents and control reared in three seasons (Dec-Jan, Feb-Mar and Sep-Oct) for two years

Lines / Parents	Fecun dity(no)	Larval Period (d)	Pupation %	Yield/10000 larv.(wt-kg)	Shell %	Reela bility (%)	Raw silk (%)
SK4C	506	24.75	80.09	11.603	20.52	83.73	15.57
SK4N	442	24.50	82.25	9.480	17.47	81.77	12.53
CSN	450	25.08	79.50	10.131	18.17	83.23	12.83
CSC	504	25.00	82.50	10.254	18.05	87.97	13.70
SK4 (parent)	478	25.75	59.90	7.818	18.76	81.00	13.45
CSR2 (Parent)	525	25.00	52.00	8.015	21.00	83.00	15.50
NB4D2 (control)	511	25.75	54.60	7.950	19.55	82.51	14.17
SD	32.0	0.474	13.91	1.449	1.33	2.25	1.20



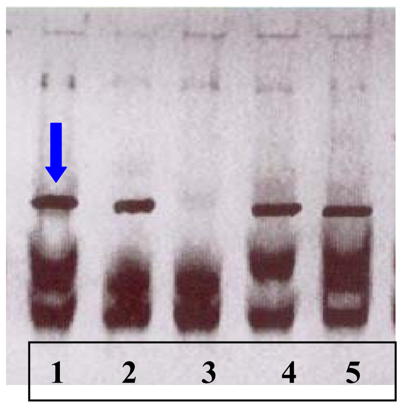


Fig5a. Fig5b.

Fig5a: Zymogram of a-esterase in the developed bivoltines, their donor, recipient parents and control. 1.SK4C; 2.SK4;, 3.SK4; 4.NB4D2; 5.Nistari; 6.Cambodge

Fig5b: Zymogram of a-esterase in the developed bivoltines, their donor, recipient parents and control. 1.CSN; 2.CSC, 3.CSR2.; 4.Nistari; 5.Cambodge.

Where SK4C, SK4N, CSN and CSC are developed lines, CSR2 and SK4 are parents, Nistari and Cambodge are donor parents and NB4D2 is the control.

Table2: Mean performance of multi x bi hybrids reared in three seasons for two years

Hybrids	**Fecundity**	**Yield / 10000Lar.**		**Cocoon wt (g)**	**Shell %**	**Filament length(m)**	**Raw silk%**	**Reela bility %**
		No	**(Wt-kg)**					
M6DP(C) x SK4C	507	8924	14.250	1.565	18.61	797	14.25	87.1
M12(W) x SK4C	447	9014	13.850	1.545	18.00	690	12.86	87.8
M6DP(C) x D6(P)N	464	8948	13.156	1.510	17.82	690	13.05	88.5
M6DP(C) x SK3C	464	8934	13.262	1.474	17.31	695	12.96	86.2
M6DP(C) x CSN	449	8244	12.736	1.514	17.14	697	12.69	85.8
N x SK4C	437	8293	12.778	1.507	17.56	662	13.15	86.1
N x SK3N	444	8937	13.020	1.470	17.34	654	12.12	87.9
N x D6(P)N	449	8752	13.136	1.482	16.94	632	12.58	86.1
M12(W) x D6(P)N	472	8165	12.709	1.509	16.63	667	12.95	86.2
M12(W) x CSN	442	8433	12.821	1.450	17.49	636	12.36	85.5
M12(W) x SK3C	430	8293	12.577	1.439	16.92	644	12.95	86.5
M6DP(C) x SK4N	425	8152	11.994	1.456	17.05	625	12.44	87.0
N x SK3C	424	8659	12.584	1.419	16.77	606	12.23	86.7
N x SK4N	439	8248	11.990	1.438	16.53	651	12.05	85.4
M12(W) x SK3N	431	8548	12.587	1.416	16.98	611	12.05	84.8
N x CSN	431	8668	12.650	1.433	16.84	607	11.81	84.8
M12(W) x SK4N	449	8875	11.488	1.397	16.87	607	12.05	84.6
M6DP(C) x SK3N	426	8330	11.920	1.393	17.14	594	11.10	84.7
N x NB4D2 (Control)	419	8125	12.017	1.646	17.08	711	12.48	85.6
CD at 5%	35.10	661	0.538	0.225	0.336	48.25	2.61	0.97

Table3: Evaluation index values and ranking of multi x bi hybrids reared in three seasons for two years

Hybrids	Fecundity	Yield / 10000Lar.		Cocoon wt (g)	Shell %	Filament length(m)	Raw silk%	Reelability %	Average EI value	Rank
		No	(Wt-kg)							
M6DP(C) x SK4C	79.6	61.5	72.9	63.9	77.3	78.5	76.0	58.2	71.0	1
M12(W) x SK4C	51.3	64.3	66.9	60.7	65.5	56.7	54.9	64.3	60.6	2
M6DP(C) x D6(P)N	59.2	62.3	56.6	55.2	61.9	56.7	57.9	70.3	60.0	3
M6DP(C) x SK3C	59.0	61.8	58.2	49.5	51.9	57.7	56.5	50.6	55.7	4
M6DP(C) x CSN	52.1	40.3	50.4	55.8	48.6	58.1	52.4	46.5	50.5	6
N x SK4C	46.2	41.8	51.0	54.8	56.9	51.1	59.3	49.6	51.3	6
N x SK3N	49.7	61.9	54.6	48.9	52.5	49.5	43.8	65.7	53.3	5
N x D6(P)N	52.3	56.1	56.3	50.7	44.8	45.0	50.7	49.2	50.6	6
M12(W) x D6(P)N	62.9	37.8	50.0	55.0	38.7	52.2	56.3	49.9	50.3	7
M12(W) x CSN	48.9	46.2	51.6	45.8	55.4	45.9	47.4	44.2	48.2	9
M12(W) x SK3C	42.9	41.8	48.0	43.9	44.3	47.4	56.3	53.2	47.2	10
M6DP(C) x SK4N	40.8	37.4	39.3	46.7	46.8	43.6	48.5	57.2	45.1	11
N x SK3C	40.3	53.3	48.1	40.8	41.3	39.7	45.5	54.5	45.4	11
N x SK4N	47.5	40.4	39.3	43.8	36.6	48.9	42.7	43.1	42.8	13
M12(W) x SK3N	43.4	49.8	48.1	40.4	45.5	40.7	42.7	37.7	43.5	12
N x CSN	43.4	53.5	49.1	43.0	42.6	39.9	39.0	37.8	43.6	12
M12(W) x SK4N	52.0	60.0	31.8	37.4	43.2	40.0	42.7	36.1	42.9	13
M6DP(C) x SK3N	40.9	43.0	38.2	36.7	48.6	37.3	28.3	36.8	38.7	14
N x NB4D2 (Control)	37.6	36.6	39.7	76.7	47.4	61.0	49.2	44.9	49.1	8

Genetic analysis by SSR markers of the germplasm of *Morus alba* L. in Spain

By

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(POSTER)

Silkworm (*Bombyx mori* L.) rearing for the silk textile industry was an important economic activity in Spain for several centuries until the 1970s. The industry was concentrated in the Region of Murcia, in the Southeast part of the country. As mulberry (*Morus alba* L.) leaves are the only food source of the insect, a group of ancient cultivars of the species were selected and cultivated in the Region. The present study analyzes the genetic relationships within a group of 44 mulberry accessions mantained in collection at the IMIDA of Murcia. The study was made by the single sequence repeat (SSR) analysis of six microsatellite loci previously characterized. The collection is made of 20 accessions of 8 traditional cultivars from Murcia, 11 new selections from Southeast Spain, 9 cultivars imported from Italy in the 1920s and 4 Japanese cultivars imported in the 1950s. The results showed a total of 29 alleles and 34 SSR genotypes in the collection. The group of Japanase cultivars formed a cluster clearly separated from the rest of accessions. Most of the Spanish accessions were grouped in two specific clusters, and four Italian cultivars were grouped in other one. Two genetic clusters included both Spanish and Italian accessions suggesting the existence of a hybridization process before the collection was formed. As a conclusion, the mulberry germplasm from the Region of Murcia seems to constitute a discrete genetic pool, previously uncharacterized. It can be a source of beneficial traits providing rusticity and tolerance to dry climatic conditions.
Keywords: mulberry cultivars, mulberry diversity, phytogenetic resources

Preservation and Utilization of Silkworm Genetic Resources in Korea

By

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(POSTER)

Genetic resources are current and future ground for evolution of new properties and, thus, they should be well organized and kept with systematic manner, because they may eventually provide ground for the production of new properties kept in the genetic resources. Once lost, it would not possible to recover permanently. Fortunately, more than 3000 silkworm (Bombyx mori) strains are still maintained in Europe and Asia and these carry genetic differences. In the Republic of Korea, more than 300 silkworm strains remain under conservation in a government institute. These strains are annually reared, and scores from indoor rearing are analyzed for consistent character maintenance. Thus, individuals with unstable heritable characters are discarded for better keep pure lines. Nevertheless, still much confusion on the genetic stock exists.
Such abundance reversely may indicate the difficulty and complexity to discriminate one strain from the others. Furthermore, recent advance in molecular techniques again requires reexamination of once well established strains, because new insight into previous strains often results in obscurity.
Key words: Silkworm strain, *Bombyx mori*, Qualitative characters, Quantitative character

Character of Silkworm Strains Registered as Genetic Stocks in Korea

By

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(POSTER)

In order for further systematic maintenance of silkworm stocks kept in Korea we analyzed character quality of a diverse array of silkworm strains originated from several sericulture-practicing countries. The analysis of about ten qualitative characters from 67 strains (13 of Japanese strains, 15 of Chinese strains, 14 of European strains, 6 of Korean and Tropical strains, and 19 of unknown origin) revealed a significant difference in the ten different qualitative characters among silkworm strains. In the analysis of quantitative characters, Japanese and European strains were highest in hatchability, the Korean and Tropical strains were highest in pupation rate, and unknown origin and Chinese strains were highest in cocoon yield and number of egg laid. With the connection of molecular genetic analysis the current data may provide the advanced ground for further systematic maintenance of valuable genetic resources of silkworms, although more breeds should be investigated for further complete pictures.
Key words: Silkworm strain, *Bombyx mori*, Qualitative characters, Quantitative character

Microsatellite Analysis of the Silkworm Strains (Bombyx mori) Originated from Japan

By

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(POSTER)

A total of 78 japanese origin silkworm strains preserved in Korea were typed for eight polymorphic microsatellite loci. We obtained per-locus number of alleles ranging from 5 to 16 with an average value of 9.1, per-locus observed heterozygosity ranging from 0.13 to 1.00, and per-locus polymorphic information content (PIC) ranging from 0.36 to 0.77, indicating that some loci are highly variable. Phylogenetic analysis with the eight concatenated microsatellite loci showed no clustering on the basis of known strain characteristics. A total of 17 strain-specific apomorphic alleles, which discriminate 14 among 78 silkworm strains were obtained from eight loci. These strain-specific alleles, thus, can casually be utilized for the discrimination of applicable strains without any further typing of other loci. Furthermore, a substantial number of homozygote strains, represented by 26 among 73 alleles in eight loci were found. These results collectively suggest that the silkworm microsatellite DNA is actually and potentially important molecular markers for the eventual discrimination of silkworm strains that are preserved as hundreds in Korea.
Key words: Silkworm strain, Bombyx mori, Microsatellite DNA, Allele, Simple sequence repeat

Microsatellite Analysis of the Silkworm Strains (Bombyx mori) Originated from China

By

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(POSTER)

A total of 85 Chinese-origin silkworm strains preserved in Korea were genotyped for eight polymorphic microsatelliteloci. We obtained per-locus number of alleles, ranging from 5 to 14 with an average value of 9.5, perlocus observed heterozygosity, ranging from 0.07 to 0.99,

and per-locus polymorphic information content (PIC), ranging from 0.34 to 0.82, indicating that some loci are highly variable. Phylogenetic analysis with the eight concatenated microsatellite loci showed no clustering on the basis of known strain characteristics. A total of 22 strain-specific apomorphic alleles, which discriminate 19 among 85 silkworm strains were obtained from eight loci. These strain-specific alleles, thus, can casually be utilized for the discrimination of applicable strains without any further typing of other loci. Furthermore, a substantial number of homozygote strains, represented by 27 among 76 alleles in eight loci were found. These results collectively suggest that the silkworm microsatellite DNA is actually and potentially important molecular markers for the eventual discrimination of silkworm strains that are preserved as hundreds in Korea.
Key words: Silkworm strain, Bombyx mori, Microsatellite DNA, Allele, Simple sequence repeat

Complex evaluation of parthenoclones of the silkworm (Bombyx mori L.) hybrids

By

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(POSTER)

ABSTRACT: The experimental and theoretic work is done in the Sericulture and Agriculture Experiment Station – Vratsa, Bulgaria.

The objects of the study are 5 newly-obtained Bulgarian parthenoclone - hybrid races (PKP) of the silkworm – Pohi x Vratsa 35; Povi x Super 1; Pohi x Super 1; Joana x Vratsa 35 and Joana x Super 1. For mother race, it is used the Bulgarian parthenoclones – Pohi, Povi and Joana, which are obtained, and kept alive with thermal ameiotic parthenogenesis. For father races are used male specimens from the Japanese type races Vratsa 35 and Super 1. The Bulgarian hybrid Super 1 x Hesa 2 is used as a control.

Using statistic methods from the conducted survey, it is possible to be summarized that when the Bulgarian parthenoclones are crossed with males from the common race give satisfying results with good basic biological and technological characters. The best parthenoclones are Pohi and Joana crossed with the race Vratsa 35.

Key words: silkworm, Bombyx mori L., parthenocolon, hybrid, complex evaluation

INTRODUCTION

For clarifying the nature of the artificial silkworm's parthenogenesis Astaurov contributed to a great extent with his researches, which began in 1932, and with his suggestion of a thermal method for activating the unfertilized eggs that had been taken from the ovarioles. Made by that method, the parthenogenetic specimens are only of the female sex and belong to the ameiotic (zygote) type (**Astaurov** 1940; 1973; **Klimenko**, 1980; **Nagariaj et al**, 1984; **Murakami**, 1985).

As a result of the conducted selection work referred to the ability of the artificial parthenogenesis and stimulated with high temperatures, are given a number of parthenoclones, some of which have hatchability of 90% and silkworms vitality of 90-95% (**Astaurov**, 1973)

After some research, a number of authors show us that when the obtained female parthenocolons are crossed with male specimen from races with no genetic relationship with the relevant parthenocolon, gives hybrids with high expressed effect of heterocyst (**Klimenko** 1981; **Gulamova et al**,, 1985; **Klimenko et al**,, 1991; Strunnikov, 1991; **Dzeneladze and Tabliashvili**, 1990; **Strunnikov et al**,, 1983; **Breslavski et al**,, 1998; **Vasileva et al**,, 2004; **Singh et al**, 2004)

In the present studying, we present the results of the used complex method for testing the new-created parthenocolon races of hybrids of the silkworm. The aim of this studying is for using the best of the given hybrids for the production of industrial cocoons and raw silk.

MATERIALS AND METHODS

The experimental work has been held at “Sericulture and Agricultural Experiment Station – Vratza”.

The subjects of the research are the following 5 newly-created Bulgarian parthenocolon races (PKP) of hybrids of the silkworm: Pohi x Vratsa 35; Povi x Super 1; Pohi x Super 1; Joana x Vratsa 35; Joana x Super 1. The Bulgarian parthenocolons Pohi, Povi and Joana are used for mother breeds, which are obtained and kept alive by thermal ameiotic parthenogenesis (**Vasileva**, 2006). The male specimens are from Japanese type breeds – Vratsa 35 and Super 1. They are used as father breed, while the Bulgarian hybrid Super 1 x Hesa 2 is used as a control.

There are researches of the characters as hatch-ability of the silkworm’s eggs, vitality of the silkworm, weight of the raw cocoon, weight of the silk shell, length and weight of the silk thread, laboratorial yield of the raw silk and production of raw cocoons from a standard box of viable silkworms’ eggs.

The valuation of the races had been done by the method of the subordinate functional index (SFi) and the method of the evaluation index (Ei), but the ranking (R) - by the method of the summary index (Si) which is characterizing for the average evaluation of the two index methods.

Using the method of the subordinate functional index, the evaluation of the races was made with the help of the formula of **Gower** (1971):

$$SFi = \frac{\bar{x}_i - \bar{x}_{\min}}{\bar{x}_{\max} - \bar{x}_{\min}}$$

where: SFi - subordinate functional index;

$\bar{x}_i$ - average value of the character of the tested race;

$\bar{x}_{\min}$ - average value of the character of the slightest of all tested races;

$\bar{x}_{\max}$ - average value of the character of the best of all tested races.

Using the method of the evaluation index, the valuation of the races was made with the formula of **Mano et.al**. (1993):

$$E_i = \frac{10(A-B)}{S_d} + 50$$

където: E_i - evaluation index;

A - average value of the character of the tested race;

B - average value of the character of all tested races;

S_d - standard diversion of a particular character for all tested races;

10 – standard unit;

50 – fixed quantity.

Complex evaluation (ranking) of the races was made using the formula:

$R = SF_i + E_i$

RESULTS AND DISCUSSION

Table 1 presents comparable digital information about the average values of 9 of the most important quantitative characters that participate in the formation of cocoons and raw silk productivity of the sixth hybrids.

It is notable from the table that parthenocolon hybrid breed Joana x Super 1 has the highest value of the character hatch-ability - 98.33%, but has the lowest values of the character weight of the raw cocoon - 2.163 g, weight of the silk shell – 0.473g, weight of the silk thread – 0.420 g and raw cocoon yield per a box of silkworm's eggs – 40.50 kg. PKP – Pohi x Vratsa 35 has the lowest percentage of hatch-ability – 93.00% from the studied hybrids, but has the highest values of the characters weight of the raw cocoon - 2.379 g, weight of the silk shell – 0.534 g shell of the raw cocoon – 22.46% and weight of the silk thread 0.470 g. The hybrid Super 1 x Hesa 2, used as a control, is characterized by highest values of yield of raw cocoon per a box of silkworm's eggs - 45.14 kg. It is followed from PKP – Joana x Vratsa 35 - 44.18 kg.

Our obtained results are in full agreement with those of the other authors (**Vidunmala et.al**., 1998; **Ramesh Babu et.al**., 2002), which estimate the merits of the given hybrid of the silk moth in subordinate functional dependence of a great number of quantitative characters.

In table 2, there is information about the values of the subordinate functional indexes used for the studied PKP hybrids not only individually for every character, but also for the sum total of the studied characters.

It is obvious that the summary subordinate functional index (SFi), which unites the individual indexes (Fi) from every studied quantitative characters of a given hybrid, varies in too extended boarders respectively from 2.315 for PKP Pohi x Super 1 to 6.225 for Pohi x Vratsa 35 towards 6.822 for the control Super 1 and Hesa 2.

According to us, making a complex evaluation of PKP hybrids by using the summary subordinate functional indexes, the hybrids Pohi x Vratsa 35 and Joana x Vratsa 35 are characterized by comparatively highest adaptable and ecologic plasticity, while the hybrids Pohi x Super 1 and Joana x Super 1 have the lowest.

The information about the individual evaluation indexes (Ei) regarding a given quantitative character and summary evaluation indexes (SFi) for the studied races is shown in table 3.

Clearly, depending on the two summary indexes, defined by different formulas, the studied hybrids have the same position – it means that they have the same merits. Therefore, we can assume that the chosen statistic parameters from the formulation of the statistic models, are defined right and the final results are approximately real. This has so much in common with other races and hybrid silkworms, established by **Ramesh Babu et. al**. (2002).

In connection with the use of the relative merits of the two statistic methods for defining the indexes, we succeeded to define the sum total index, too. It is obtained by summing the values of the two indexes; on whose base was conducted the ranking (testing) of the hybrids (table 4).

Obviously, on the basis of our own complex method for evaluation of the studied 5 parthenocolon races of silkworm hybrids, Pohi x Vratsa 35, Joana x Vratsa 35 and Povi x Super 1 have the highest values of main productive characters. They have fundamental total indexes of 57.81; 56.68 и 54.53. The hybrids Joana x Super 1 and Pohi x Super 1 are with relatively lowest ecological plasticity and productive potential (49.09 и 48.11).

CONCLUSIONS

The statistic methods that we used for testing and ranking the newly-created parthenocolon hybrid races of the silkworm along with the subordinate functional and evaluation indexes, let us uncover and use the best of them for the production of industrial cocoons and raw silk.

After the conducted survey, we can conclude that when the Bulgarian parthenocolons are crossed with the male specimens form a common breed, give good results in biological and technological characters. The best parthenocolons are Pohi and Joana crossed with the race Vratsa 35.

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Table 1.Averege values of some quantitative characters in parthenocolon in silkworm races

Hybrids	**Eggs hatch-ability %**	**Vitality of the silkworms %**	**Raw cocoon weight, g**	**Silk shell weight, g**	**Shell ratio, %**	**Silk thread length, m**	**Silk thread weight, g**	**Laboratorial yield of raw silk, %**	**Yield of cocoons per 1 box of silkworms kg**
Super 1 x Hesa 2	96.80	98.87	2.372	0.509	21.45	1346	0.450	42.86	45.17
Pohi x Vratza 35	93.00	96.00	2.379	0.534	22.46	1217	0.470	42.73	43.15
Povi x Super 1	98.00	97.25	2.185	0.483	22.10	1192	0.430	43.00	43.12
Pohi x Super 1	95.00	94.50	2.221	0.488	21.99	1241	0.420	40.00	41.95
Joana x Vratza 35	97.33	93.75	2.339	0.525	22.44	1159	0.470	40.86	44.18
Joana x Super 1	98.33	96.25	2.163	0.473	21.89	1215	0.420	42.00	40.51
Average	96.41	96.10	2.277	0.502	22.06	1228	0.443	41.90	43.01
SD	2.813	2.769	0.161	0.045	1.594	112	0.042	1.834	1.208

Table 2.Subordinate function index values

Hybrids	**Eggs hatch-ability %**	**Vitality of the silkworms %**	**Raw cocoon weight, g**	**Silk shell weight, g**	**Shell ratio, %**	**Silk thread length, m**	**Silk thread weight, g**	**Laboratorial yield of raw silk, %**	**Yield of cocoons per 1 box of silkworms kg**	**Summary subordinate functional index, SFi**
Super 1 x Hesa 2	0.712	1.000	0.967	0.590	0	1.000	0.600	0.953	1.000	6.822
Pohi x Vratza 35	0	0.439	1.000	1.000	1.000	0.310	1.000	0.910	0.566	6.225
Povi x Super 1	0.938	0.683	0.101	0.164	0.644	0.176	0.200	1.000	0.560	4.466
Pohi x Super 1	0.375	0.146	0.268	0.245	0.534	0.438	0	0	0.309	2.315
Joana n Vrayza 35	0.812	0	0.814	0.852	0.980	0	1.000	0.286	0.787	5.531
Joana x Super 1	1.000	0.488	0	0	0.436	0.299	0	0.666	0	2.889
Average	3.837	2.756	3.150	2.851	3.594	2.223	2.800	3.815	3.222	4.708

Table 3. Evaluation indexes values

Hybrids	Eggs hatch-ability %	Vitality of the silkworms, %	Raw cocoon weight, g	Silk shell weight, g	Shell ratio, %	Silk thread length , m	Silk thread weight, g	Laboratorial yield of raw silk, %	Yield of cocoons per 1 box of silkworms kg	Evaluation indexes, SEi
Super 1 x Hesa 2	51.38	60.00	55.90	51.55	46.17	60.53	51.66	55.23	67.88	55.58
Pohi x Vratza 35	37.87	49.63	56.14	57.11	52.51	49.01	56.42	54.52	51.15	51.59
Povi x Super 1	55.65	54.15	44.28	45.77	50.25	46.78	46.90	55.99	50.91	50.07
Pohi x Super 1	48.54	44.22	46.52	46.88	49.56	51.16	44.52	39.64	41.22	45.80
Joana n Vrayza 35	53.27	41.51	53.85	55.11	52.38	43.83	56.42	44.32	59.68	51.15
Joana x Super 1	56.82	50.54	42.91	43.55	48.93	48.83	44.52	50.54	29.30	46.21
Average	50.58	50.00	49.93	49.99	49.96	50.02	50.07	50.04	50.02	53.52

Table 4. Complex evaluation (ranking) of the hybrids

Hybrids	Summary subordinate functional index	Summary evaluation index	Total index	Range
	SFi	SEi	SFi + SEi	
Super 1 x Hesa 2	6.822	55.58	62.40	1
Pohi x Vratza 35	6.225	51.59	57.81	2
Povi x Super 1	4.466	50.07	54.53	4
Pohi x Super 1	2.315	45.80	48.11	6
Joana n Vrayza 35	5.531	51.15	56.68	3
Joana x Super 1	2.889	46.21	49.09	5

Ameiotic and meiotic parthenogenetic development in crossings of Japanese and Chenese types of silkworm, Bombyx mori L. breeds with the polyvoltine breed Bonde 517

By

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ABSTRACT: Subject of this study are the crossings between monobivoltine breeds Super 1 (Japanese type) and Hesa 2 (Chinese type) with the polyvoltine tropical breed Bonde 517.

The activation for obtaining of ameiotic parthenogenetic development is done through the treatment of eggs with water at temperature 46 ºC and exposition 18 min, while the obtaining of meiotic parthenogenesis requires that the eggs should be treated with water at temperature of 46 ºC and exposition 2 min.

Ameiotic parthenogenetic development with higher rates than that of the meiotic parthenogenetic development like in F_1 and F_2 can be observed in all crossings.

The highest percentage of ameiotic and meiotic parthenogenetic hatchability has been observed in the crossings F_2 Super 1x Bonde 517 (23.69% and 5.08%) and Hesa 2x Bonde 517 (18.26% and 5.96%).

Key words: silkworm, Bombyx mori L., ameiotic and meiotic parthenogenetic

INTRODUCTION

The partenogenetic individuals, which were obtained by the method of Astaurov (1940), have only female gender and refer to the meiotic (zygote) type. (Astaurov, 1940;Vereskaia, 1975, 1979;Klimenko, 1980; Strunnikov and collegues., 1980;Tereskaia, 1982; Murakami, 1985; Nagariaj et al., 1984; Sugai et al.,1983; Yonqiang et al., 2001;Vasileva, 2006;).

In the mid 70-ties of the last century Terskaia and Strunnikov (1974) proved that a parthenogenetic development of meiotic type is activated in the eggs, which were placed for a short period of time at high (46 ^{o} C) or low (-11 ^{o} C) temperature. As far as it and the normally fertilized eggs are concerned, there are two types of division- reductive and equational. The offspring is represented by males ZZ only, whereas the individuals with a genotype WW die. (Vereskaia, 1979, Strunnikov, 1987; Strunnikov et al, 1980, 1996; Tereskaia and Strunnikov, 1974, 1975)

The aim of the present study is to find ameiotic and meiotic parthenogenetic development in the straight and reverse crossings of Japanese with a polyvoltine and Chinese with a polyvoltine breed, as well as the crossing of the F_2 offspring.

MATERIAL AND METHODS

The experimental and theoretic work was carried out in Sericulture and Agriculture Experiment Station, Vratsa.

Subject of the study are crossings between the monobivoltine breeds Super 1 (Japanese type) and Hesa 2 (Chinese type) with the polyvoltine tropical breed Bonde 517.

The activation needed, in order to obtain ameiotic parthenogenesis, consists of treatment of eggs with water at temperature of 46 ºC and exposition 18 min, with a following cooling for 5-10 minutes in water with temperature of 18 ºC. Thereafter, the activated eggs are kept in storage for three days at temperature of 15-20 ºC and a relative humidity of 80-85%.

The activation needed, in order to obtain meiotic parthenogenetic individuals, includes treatment of eggs with water at temperature of 46 ºC and exposition 2 min.

The ameiotic and meiotic parthenogenetic development is recorded at the fifth month after the activation of 30 layings of each variant.

The following features are used in order to assess the parthenogenetic development, according to Vasileva (2006):

Presence of parthenogenetic eggs with pigmentation, which can be characterized by the following:

- eggs (healthy) with complete pigmentation- complete parthenogenetic development
- pigmented, shriveled eggs - parthenogenetically developed eggs, but with subsequently dead embryo.
- eggs with a brown pigmentation- eggs which are parthenogenetically developed to a certain stage of development.

Unpigmented (shriveled) eggs- there is a lack of parthenogenetic development.

Hatchability of the parthenogenetic eggs (percentage of hatched eggs, compared with the number of eggs with complete pigmentation);

RESULTS AND DISCUSSION

Ameiotic and meiotic parthenogenetic development, considering the eggs of the crossings Super 1 X Bonde 517 F $_1$and F_2 and the reverse crossing, which we point out in chart 1.

As far as the feature pigmentation at the ameiotic partenogenetic development is concerned, the crossing Super 1 x Bonde 517 F_2- 81,35% has the highest rates, while the reverse crossing Bonde 517 x Super 1 in F_1has the highest rates of 72,65%, as far as this feature and the features complete pigmentation (19.09%) and brown pigmentation (7.28%) are concerned.

The percentage of the pigmented meiotic parthenogenetically developed eggs is lower in the studied crossings, in comparison to the ameiotic parthenogenetic development. It is from 36.79% (Bonde 517 x Super 1- F_2) to 61.77% (Super 1 x Bonde 517- F2).

The percentage of complete pigmentation, considering the meiotic parthenogenetic development of the crossings of Super 1 x Bonde 517 has higher rates than these of the ameiotic parthenogenetic development, except for Super 1x Bonde 517- F_2, while they are lower in the crossings of Bonde 517x Super 1. The higher percentage of complete pigmentation leads to hatchability in the meiotic parhenogenetic development of Super 1 x Bonde 517- F_1 (2.46%), Super 1x Bonde 517- F_2(5.08%) and Super 1x Bonde 517 -F2(1.88%).

In the studied crossings, both these with ameiotic and these with meiotic parthenogenetic development have the biggest number of pigmented, but shriveled eggs. In the ameotic parthenogenetic development, the feature is in the limits 69.90% (Super 1x Bonde 517 -F_2) to 87.09% (Bonde 517 x Super 1- F_2), and far the meiotic parthenogenetic development from 46.92% (Super 1x Bonde 517- F_1) to 90.89% (Bonde 517 x Super 1- F_2).

The hatchability of the researched crosissings, with ameiotic parthenogenetic development, is higher, in comparison to the meiotic parthenogenetic development. Cosidering the crossings of Super 1 x Bonde 517 of the ameiotic parthenogenetic development, a percentage of hatchability is not reported only on the crossing Super 1 x Bonde 517- F2. The reverse crossing Bonde 517x Super 1-F1 has the highest percentage of hatchability 21.51% and there is no hatchability in the crossings from F2.

In chart 2 is shown ameiotic and meiotic parthenogenetic development of the eggs and crossings Hesa 2x Bonde 517- F1 and F2 and the reverse crossings.

The percentage, related to the feature pigmentation of the ameiotic and meiotic parthenogenetically developed eggs in the crossings (Hesa 2 x Bonde 517 and Bonde 517 x Hesa 2) - F1 is lower than in the crossings of- F2. The highest percentage of general pigmentation, related to ameiotic parthenogenetic development is reported on the crossing Hesa 2 x Bonde 517-F2- 80.96%. The percentage, related to the feature complete pigmentation of the ameiotic parthenogenetic development is highest in the crossings from F1, as follows Hesa2 x Bonde 517-24.04% and Bonde 517 x Hesa 2- 15.53%.

From the generally pigmented eggs, the share of the pigmented, shriveled eggs is highest from 66.04% (Hesa 2x Bonde 517- F1) to 84.27% (Bonde 517 x Hesa 2-F2) for ameiotic parthenogenetic development and from 59.37% (Hesa 2x Bonde 517-F1) to 81.34% (Bonde 517 x Hesa 2-F2).

Considering the researched crossings of the Chinese breed with a polyvoltine, tropic breed, a hatchability has been recorded in all variants, with the exception of the crossing Bonde 517 x Hesa 2-F2 for ameiotic parthenogenetic development. The highest percentage of hatchability has been found in the crossing Hesa 2x Bonde 517- F2-18.26% for ameiotic parthenogenetic development and 5.96% for meiotic parthenogenetic development.

CONCLUSIONS

In the crossings of Japanese or Chinese type breeds with polyvoltine, tropical breed and their reverse crossings, an ameiotic parthenogenetic development with higher rates than these of the meiotic parthenogenetic development both in F1 and F2 has been observed.

The highest percentage ameiotic and meiotic parthenogenetic hatchability has been observed in the crossings F2 Super 1 x Bonde 517 (23.69% and 5.08%) and Hesa 2xBonde 517 (18.26% and 5.96%).

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Chart 1. Ameiotic and meiotic parthenogenetic developing eggs for the hybrids Super 1 x Bonde 517 and Bonde 517 x Super 1

Hybrids	Ameiotic parthenogenetic development							Meiotic parthenogenetic development						
		Pigmented eggs							Pigmented eggs					
	Pigments eggs vs. total number %	With full pigment. %	With brown pigment. %	Pigment., shriveled %	Self-hatched ,%	Non-pigmented eggs to a total number %	Hatch-ability %	Pigmented eggs vs. total number %	With full pigment. %	With brown pigment. %	Pigment., shriveled %	Self-hatching,%	Non-pigmented eggs to a total number %	Hatch-ability %
<u>Super1 x Bonde517 F_1</u>	74.31	14.11	8.83	76.78	0.28	25.69	13.29	58.14	31.82	19.96	46.92	1.30	41.86	2.46
F_2 plain larvae, white cocoons	65.38	11.80	17.68	69.90	0.62	34.62	11.61	57.46	15.29	15.78	68.24	0.69	42.54	-
F_2 plain larvae, colour ed cocoons	66.05	16.31	6.08	77.02	0.59	33.95	23.69	61.77	19.44	8.05	71.53	0.98	38.23	5.08

F_2 larvae colouration, white cocoons	69.62	16.69	6.23	76.74	0.34	30.38	-	61.48	5.23	28.47	64.84	1.46	38.52	-
F_2 larvae colourration, coloured cocoons	81.35	15.47	7.16	76.69	0.68	18.65	12.61	47.81	25.03	5.05	69.65	0.27	52.19	1.88

Chart 1 continues

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Bonde 517 xSuper 1F_1	72.65	19.09	7.28	73.12	0.51	27.35	21.51	47.59	6.76	16.72	74.66	1.86	52.41	-
F_2 plain larvae, white cocoons	72.13	14.54	6.92	78.13	0.41	27.87	-	53.79	1.59	15.24	82.69	0.48	46.21	-
F_2 plain larvae, color cocoons	59.58	7.08	6.14	86.37	0.41	40.42	-	36.79	7.82	1.67	88.83	1.68	63.21	-
F_2 larvae colouration, white cocoons	70.28	10.26	4.02	84.52	1.20	29.72	5.19	43.76	1.25	9.68	87.63	1.44	56.24	-
F_2 larvae colouration, color cocoons	67.09	8.87	3.65	87.09	0.39	32.91	5.47	43.07	0.81	6.67	90.89	1.63	56.93	-

Chart 2. Ameiotic and meiotic parthenogenetic developing eggs for the hibrids Hesa 2 x Bonde 517 and Bonde 517 x Hesa 2

Hybrids	Ameiotic parthenogenetic development							Meiotic parthenogenetic development						
	Pigmented eggs vs. total number %	Pigmented eggs				Non-pigmented eggs to a total number %	Hatch-ability %	Pigmented eggs vs. total number %	Pigmented eggs				Non-pigmented eggs to a total number %	Hatch-ability %
		With full pigment. %	With brown pigment. %	Pigment., shriveled %	Self-hatched, %				With full pigment. %	With brown pigment. %	Pigment., shriveled %	Self-hatching,%		
Hesa2 x Bonde 517 F_1	66.59	26.04	5.55	66.04	2.37	33.41	7.50	54.85	3.65	33.85	59.37	3.13	45.15	-
F_2 plain larvae, white cocoons	80.96	15.53	6.53	77.25	0.69	19.04	0.32	62.71	17.71	7.01	74.32	0.96	37.29	-
F_2 plain larvae, color	67.36	11.07	11.86	76.75	0.32	32.64	18.26	65.21	19.73	10.52	68.68	1.07	34.79	5.96

cocoons														
Bonde517 x Hesa2 F_1	51.02	15.53	7.73	76.48	0.26	48.98	5.69	24.72	26.04	3.77	66.79	3.40	75.28	-
F_2 plain larvae, white cocoons	62.81	13.05	19.01	67.54	0.40	37.19	-	39.53	1.51	25.34	72.25	0.90	60.47	-
F_2 plain larvae, coloured cocoons	65.55	11.04	4.36	84.27	0.33	34.45	1.68	41.63	14.35	2.39	81.34	1.92	58.37	-

RESEARCH OF NEW SILKWORM HYBRIDS COMBINATIONS

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ABSTRACT

Hybrid combinations possess advantage in comparison with pure breeds, namely: greater viability and higher productivity and output of raw silk. For hybridization of breeds with a purpose of development of high yielding silkworm hybrid, satisfaction of the requirements of the silk industry, genetic compatibility of silkworm breeds is studied from the collection of National genetic resources and different combinations of silkworm (F_1) hybrids were produced. For hybrids, direct combination was more expressed and hybrid force was exposed. Received results confirm that the theories of heterosis are most inherent for the quantitative signs, such as viability, weight of cocoon and the silk shell.

Keywords: Silkworm breeds, hybrid, disease-resistant, heterosis vigor, cocoon yield.

INTRODUCTION

Sericulture in Rwanda is at an early stage of development. Soil and climatic conditions, human resources and political-economical situation in the country prove that sericulture has a good prospect. Sericulture has a huge potential as a source of income, there is an assumption that production of cocoons in the 5-10 years (by 5-6 time silkworm rearing in year) can reach to 4000-5000 tons of raw silk (600 - 800 tons a year). Thus more than 500 000 of farmers will receive the income from sericulture at 300-400 USD per crop.

In sericulture hybrids are mainly used in production of industrial cocoons. Hybrid combinations possess advantage in comparison with pure breeds, namely: greater viability and good development of larvae, smaller feedings duration and consumption of mulberry leaf, higher productivity and an output of raw silk. For hybridization of breeds directed to the deduction of high yielding silkworm hybrid, the satisfying requirement of the silk industry, first of all, it is necessary to search genetic compatibility of silkworm breeds. For this purpose, silkworm breeds from collection of National genetic resource were crossed and different combinations of silkworm (F_1) hybrids were produced.

MATERIALS AND METHODS

As parental breeds have been selected for different productive properties, silkworm breeds: Progress, IP_1, IP_2, IP_3, Luc, Rubona-1, Rubona-2, Angel and Diamond; after silkworms rearing, the best cocoons have been selected for crossing according the following scheme:

Progress x IP_1; IP_1 x Progress; Angel x Diamond; Diamond x Angel;

Luck x IP2; Luck x IP3; Rubona 1 x Rubona 2.

Cold storage of silk worm eggs, their incubation, rearing and cocoon spinning were done by using the methods of Homidy *et al*., 2000. During this period of incubation, the temperature was ranged from 24 to 25ºC and relative humidity of 75-85% was applied to the silkworm eggs, with appropriate light and ventilation in the incubation room. Only the first brushing was taken for rearing. For the young silkworms, the environmental conditions like the temperature of 25-27 ºC and the relative humidity of 75-85% were subjected to those young silkworms while the temperature of 23-25 ºC and relative humidity of 65-75% were used for old silkworms. During the two first days of spinning the temperature was increased to 24-25 ºC and then decreased to 23 ºC. The rice stalk was used as montages where the silkworms went to spin cocoons.

During this experiment, data on biological characters have been collected on examined silkworm hybrids: hatchability percentage, larva cycle duration, fresh cocoon weight, shell cocoon weight, silk, viability and fresh cocoon yield by one box eggs.

For establishment of laws of occurrence of heterosis of hybrids, the following formula was used:

$$Heterosis = \frac{\overline{X_{F1}} - \overline{X_{MP}}}{\overline{X_{MP}}} \times 100\%$$

Where;

F_1- index of hybrid

MP – Average index of parents

RESULTS AND DISCUSSIONS

Developing highly productive disease-resistant, heterozygote silkworm hybrids remains the basic problem for sericulture research. For deducing of new silkworm breeds, used methodology of purposeful selection by using breeds from genetic collections. A hybridization of new perspective breeds is very necessary to search their genetic compatibility for quantitative and qualitative signs. We have used silkworm breeds from National genetic recourses of silkworm and have developed some silkworm hybrid combinations. The results from biological parameters are shown in the table 1.

Table 1: Biological parameters of examined silkworm hybrids

Name of hybrid	Silkworm eggs hatching,%	Larva cycle duration, days/hours	Spinning duration (days/hours)	Viability of pupa, %	Weight of cocoon, g	Weight of cocoon shell, mg	Cocoon shell percentage, %	Mixed cocoon yield, kg/box	Sorted cocoon yield, kg/box
Progress x IP_1	90	24/00	2/06	91,74	2,31	500,0	21,65	42,92	42,37
IP_1 x Progress	90	24/00	2/06	88,10	2,32	507,2	21,86	38,20	40,88
Angel x Diamond	94	26/02	2/00	92,8	2,52	521,8	20,71	41,73	46,77
Diamond x Angel	95	26/09	2/00	90,8	2,50	511,4	20,46	37,49	45,40
Luck x IP2	99	24/00	2/06	91,1	2,27	543,5	23,94	38,35	41,36
Luck x IP3	92	24/00	2/06	86,65	2,30	533,6	23,20	33,38	39,84
Rub.1 x Rub.2	90	26/01	2/06	92,05	2,52	531,3	21,08	47,28	46,22

The analysis of the biological parameters of tested silkworm hybrids shows that the hatchability of silkworm eggs in all tested hybrids exceeds 90 %, even some hybrids like Luck x IP_2 reaches 99 %.

There was no difference in the larva cycle duration for tested hybrids in young instars. Only in the 5th instar they were divided in two groups: silkworm breeds with large cocoons (Angel x Diamond, Diamond x Angel, and Rubona 1 x Rubona 2) have spent 1day more in comparison to breeds with average in weight of a cocoon (Progress x IP_1, IP_1 x Progress, Luck x IP_2 and Luck x IP_3).

Continuing the analysis of biological indicators of silkworm hybrids, the best percent of pupal viability (more than 90 %) are observed for the hybrids Progress x IP_1 (91,74) and Rubona-1 x Rubona-2 (92,05%) and below 90% for hybrids Luck x IP3 (86,65 %) and IP_1 x Progress (88,10 %)

The largest cocoon weight was received from the hybrids Angel x Diamond and Rubona-1 x Rubona-2 (2,52 g), thus the best weight of cocoon shell (521,8-531,3 mg) were also observed on these hybrids. Calculation of productivity of cocoons from a box shows, that the best productivity of cocoons is received for hybrids: Rubona-1 x Rubona-2 (47, 28 kg/box), Progress x IP_1 (42, 92 kg/box) and Angel x Diamond (41,73 kg/box), hybrids, which show also the highest percent of pupa viability. The analysis of sorting composition of cocoons has shown that for all hybrids, amount of non sorting cocoons is about 1%

Pict.1. Cocoons of new silkworm hybrids

Advantages of hybrids over parents on the basic biological parameters, i.e. effect of heterosis vigor in new silkworm hybrids offspring has been tried to be found. From the literature (Strunnikov V.A. (1974; 1983; 1995), Nagoshi, C. T. & Johnson, R. C. (1986), Birchler JA, Auger DL, Riddle NC 2003, Mingroni, M.A. (2004), Winfridus Bakker (2006) it is known, that the increase in biological parameters for hybrids of the first generation as a result of heterosis is connected with transition of genes in the heterozygotic condition, thus recessive lethal and semilethal alleles. Besides probably the variants of enzyme operating in the sum it is more effective, than in lone (in a homozygous condition). This promotes increase of viability and the other biological criteria of hybrids. Results of effect display of heterosis vigor at silkworm hybrids are presented in the table 2.

Table 2. Estimation heterosis vigor of silkworm hybrids

Hybrids	Viability, %			Weight of cocoon, g			Weight of cocoon shell, mg		
	Mid parent value	Hybrid	*Heterosis,%*	Mid parent value	Hybrid	*Heterosis,%*	Mid parent value	Hybrid	*Heterosis,%*
Progress x IP_1	82,5	91,7	10,1	2,15	2,31	6,78	451,9	507, 2	10,9

IP_1 x Progress	80,0	88,1	9,20	2,19	2,32	3,75	456,2	500,0	8,76
Angel x Diamond	88,2	92,8	4,96	2,25	2,52	2,70	500,1	521,8	4,16
Diamond x Angel	87,5	90,8	3,63	2,25	2,50	3,14	502,1	511,4	1,82
Luck x IP2	85,5	91,1	6,75	2,49	2,27	1,12	461,2	543,5	15,1
Luck x IP3	80,3	86,6	7,27	2,49	2,30	0,32	458,4	533,6	14,1
Rubona 1 x Rubona 2	79,6	91,7	13,2	2,54	2,52	0,72	510,6	531,3	3,90

High index heterosis for all of hybrids, except for an Diamond x Angel (3,65%), is well appreciable on pupa viability of hybrids in range from 6,75 to 13,3 %. The best index heterosis between parents and their hybrids is found on weight of cocoon shell, for some hybrids: Pr x IP_1 and Luck x IP2 reaches up to 10,9-15,1 %. It is noticed that high hybrid force basically is more observed in hybrids of a direct combination than on opposite hybrid combinations.

Preliminary results of research of heterosis vigor on new silkworm hybrids confirm theories of heterosis, that the phenomenon heterosis is most inherent for the viability, that the increase in viability for hybrid generation, is owing to inheritance of a certain set alleles of various genes from the diverse parents that determined with transition of genes in a heterozygotic condition.

CONCLUSION

- Testing silkworm hybrids in identical condition which promotes the realization of their potentials, has divided the hybrids into hybrids which give more silk (Luck x IP2, Luck x IP3) and the producing high yield of cocoons (IP_1 x Progress and Progress x IP_1), the leader had appeared Luck x IP2, has a high crop of cocoons (41,36kg/box) and many silk (9,75 kg/box).
- At hybrids of a direct combination is exposed more expressed hybrid force, the received results confirm that the theories of heterosis, are most inherent for the quantitative signs, such as viability, weight of cocoon and them silk shell.

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Section 3. Silkworm egg production.

Silkworm (*Bombyx mori* L.) Cryopreservation: A study to identify chill resistant embryonic stages in multivoltine eggs

By

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Cryopreservation of silkworm (*Bombyx mori* L.) germplasm is an important complementary approach for safeguarding silkworm biodiversity. Manipulation of the preservation period to lengthen the time of storage or to ensure that the quality of the silkworm genotype is not compromised by short-term chilling of the embryo has received limited attention so far. Identification of the embryonic stages resistant to cold is a prerequisite to achieve successful cryopreservation. To explore this field, Pure Mysore silkworm eggs of various embryonic ages *viz*., 24, 36, 48, 60 and 72 hours were exposed to chilling temperatures of -5°C, -10°C and -15°C for one, two and three days. Exposure of the silkworm eggs to these temperatures have shown varied responses, measured in terms of hatchability. Silkworm eggs of 24 and 60 hours embryonic ages are found to be more cold resistant as exhibited by differential hatchability during different lengths of chill exposure whereas eggs of 48 hours embryonic age are found to be chill sensitive as exhibited by non hatchability at this developmental stage. Studies on the cryo preservation of eggs / embryo of silkworm open new vistas for researchers in time to come.

Keywords: Cryopreservation, silkworm, germplasm, embryonic ages, short term chilling, chill tolerance, chill sensitive

Effect of Biostimulator "Asma -1" on Mulberry Silkworm Embryo ATP-ase Activity

By

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(POSTER)

ABSTRACT: Effect of biostimulator "Asma-1" on ATP- ase activity was studied in case of treatment of mulberry silkworm Mziuri breed grain in two phases (treatment before passing to diapauses and incubation).

The effect of the preparation Asma-1 on the development of Mziuri-2 embryo with the view of ATPase activity differs from that of Mziuri -1. If in case of Mziuri-1 in all experimental versions ATPase activity increases significantly, in experimental versions of Mziuri-2 activity of the above referred ferment is stimulated only in grain treated with 6 hr exposition.

Protein concentration kinetics in Mziuri-2 grain is similar to that of Mziuri-1. In this case too protein concentration suffers significant decrease by the end of incubation. At the same time, in grain treated with Asma-1 before diapauses protein composition suffers less change in the period of embryo development, compared to the control, while in grain treated before incubation, protein concentration by the end of incubation decreases threefold, compared to the starting. This probably refers to more efficient consumption of reserve egg proteins.

Keywords: Mulberry silkworm,silkworm,egg, biostimulator, enzimes, ATP

Introduction

Ferment Mg-dependent-Na,K-ATPase (hereinafter ATPase) plays significant role in normal functioning of a body. ATPase carries out universal functions in a body. Most important is energy release, active transportation of ions in cells which contributes to information and impulse transfer, active movement and many other significant functions. Therefore, activity of this ferment, that is, activity of a group of these ferments should express well main physiological and biochemical changes going on in the organism.

Materials and Methods

Effect of biostimulator "Asma-1" on ATP-ase activity was studied in case of treatment of mulberry silkworm Mziuri breed grain in two phases (treatment before passing to diapauses and incubation). With this in view 200 mg grain was placed in 1,5 ml Ependorf flask and 400-800 µl isolation medium (250 mMsaccharose, 30 mMtris-C, 1 mM EDTA, pH 7,5) was added to it. The mix was crushed by pipete tips till complete disintegration Homogenate was centrifuged at 14000 r/min for 4 minutes.

Supernatant was used for further analyses. 0,1ml supernatant of the studied sample (at 1 mg/ml protein concentration) was poured into the flask and 0.1 ml incubation medium(100 mM NaCl, 20 mM KCl, 30 mM tris-HCL, pH 7,5) and 0.2 ml distilled water were added. The mixture was placed at 37 ^{o}C for 5 min, then 0.1 ml 0.1 m ATP solution were added and incubation was continued for 10 min. ATP-ase reaction was stopped by adding 0.7 % chlorine acid.

To determine quantity of inorganic phosphor (and later ATP-ase activity) the mixture was heated by addition of 1 ml A, 0.4 ml B and 0.4 C solutions. In 20 minutes we measured optic absorption with photo electro colorimeter at 680 nm wave length.

Protein was measured in grain with Bradford method. To the 0.1 ml homogenate 1.5 ml distilled water and 1.5 ml Bradford solution were added (0.02% Cumassie Brilliant Blue 3% chlorine acid) After 10 min standing protein concentration was measured with photo electro colorimeter at 590 nm wave length.

Experimental Results

ATP-ase activity in control sample of Mziuri-1 breed is stable, that is, its rate doesn't change in the period of embryo development (Fig.1). In the experimental version ATP-ase activity increases by 20-73%.

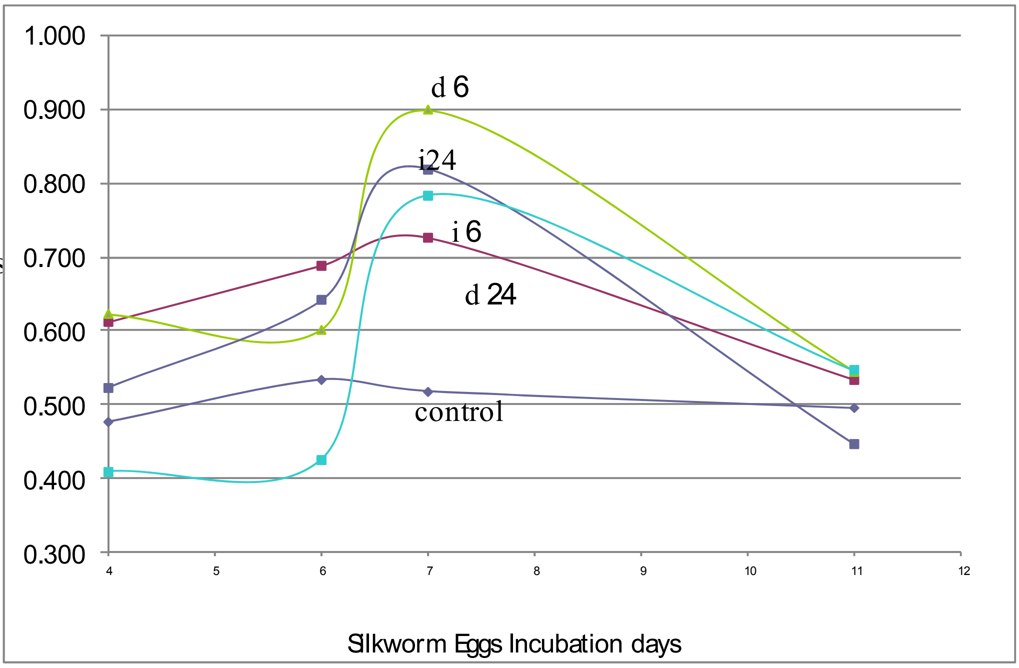

Fig.1 Effect of preparation "Asma-1" on the ATPase activity kinetics in Mziuri-1 grain.

Grain treated with d6 –d24 Asma-1, before diapauses (length of treatment 6-24 hr)

Grain treated with i6-i24 Asma-1 before incubation (length of treatment 6-24 hr)

It should be stated that in distinct from the control, activity of this ferment in the embryo development process increases disproportionally and reaches the peak of activity on the seventh day of grain incubation. Then gradual decrease of ATPase activity is observed and on the 11^{th} day of incubation total activity of this ferment almost equals to that of the control. Highest increase of ATPase activity, 74% is observed in grain treated before diapauses at 6 hr exposition.

Character of protein concentration variation dynamics in experimental versions is approximately similar (Fig.2). Although, stability of protein concentration in d24 and partly d6 versions (grain treated before diapauses with 24 and 6 hr exposition) should be emphasized. In other versions and in the control one, approximately 50% decrease of protein concentration is observed in incubation period. This fall probably is conditioned by spending the reserve protein in egg for embryo energy and for satisfaction of biosynthesis of other components.

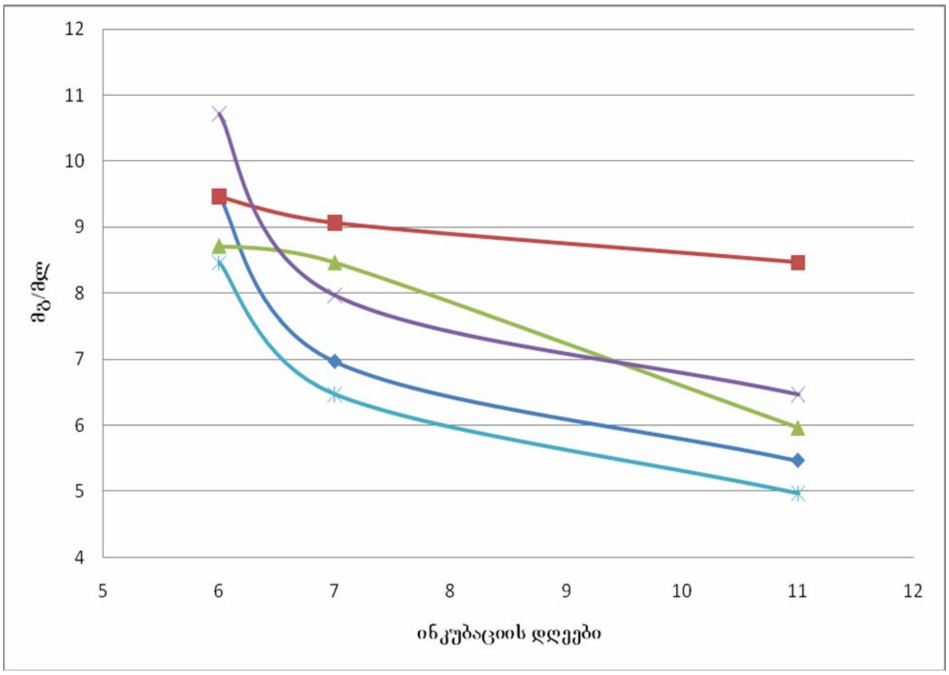

Fig.2. Effect of Asma-1 on protein alteration in Mziuri-1 grain

Grain treated with d6 –d24 Asma-1 before diapauses (length of treatment 6 -24 hr)

Grain treated with i6 –i24 Asma-1 before incubation (length of treatment 6 -24 hr)

In i6 version protein alteration kinetics approaches the control. If we take into consideration the fact that in this version ATPase activity too at the initial period of incubation is slightly lower than that of the control, we can conclude that this version of treatment with biostimulator is the most inefficient. In case of Mziuri-2, effect of the preparation on embryo development somewhat differs from that of Mziuri 1. In control version ARPase activity, similar to that of Mziuri-1, is more stable. Although on the seventh day of incubation, increase of ferment activity is expressed sharper.

In the experimental version it is apparent that ATPase activity of grain treated with 24 hr exposition is lower (especially in the second half of grain incubation) and is even for the whole period of incubation. Activation peak is not observed in the middle of incubation (on 5^{th} -7^{th} days). We have to emphasize activation curve of d24 version, which is lower in the whole period of incubation compared to the control. With this in view, this version is similar to the relevant version of Mziuri-1.

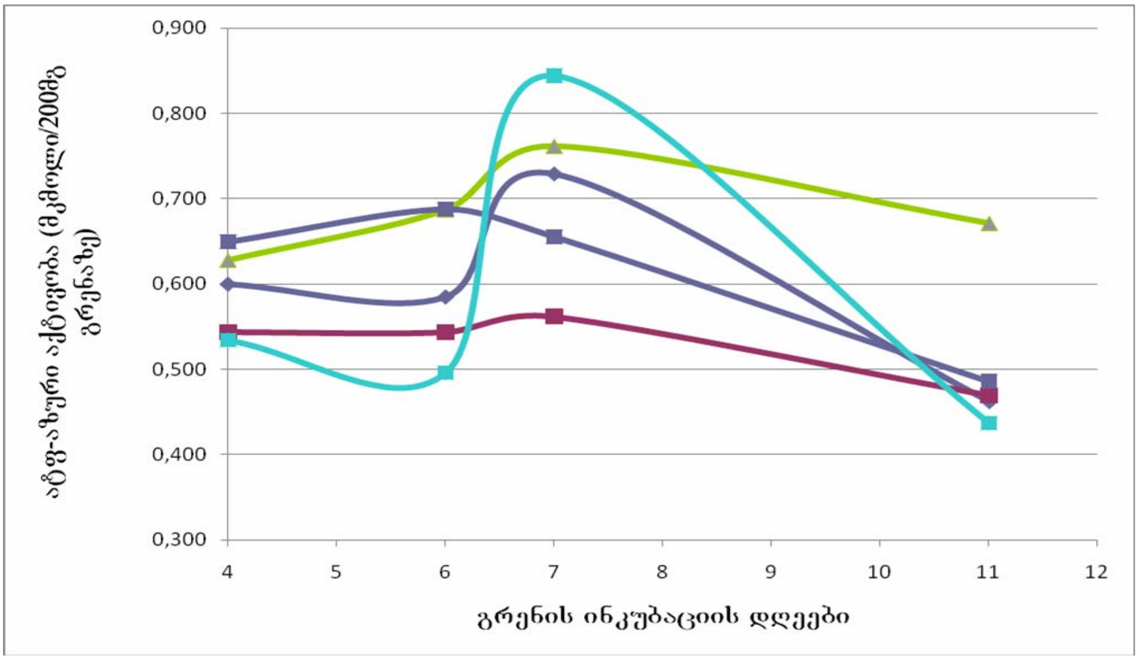

Fig.3. Effect of “Asma-1” on ATPase activity kinetics in Mziuri-2 grain

Grain treated with d6 –d24 Asma-1 before diapauses (length of treatment 6 -24 hr)

Grain treated with i6 –i24 Asma-1 before incubation (length of treatment 6 -24 hr)

In the grain versions treated at 6 hr exposition ATPase activity is high compared with others. The highest effect is shown in i6 version, where starting activity (4^{th} day) is lower than that of control, while on the 7^{th} day its activity almost doubles.

Ferment activity in d6 version, as it was stated above, is relatively stable, is higher than in the control and remains the highest by the end of incubation.

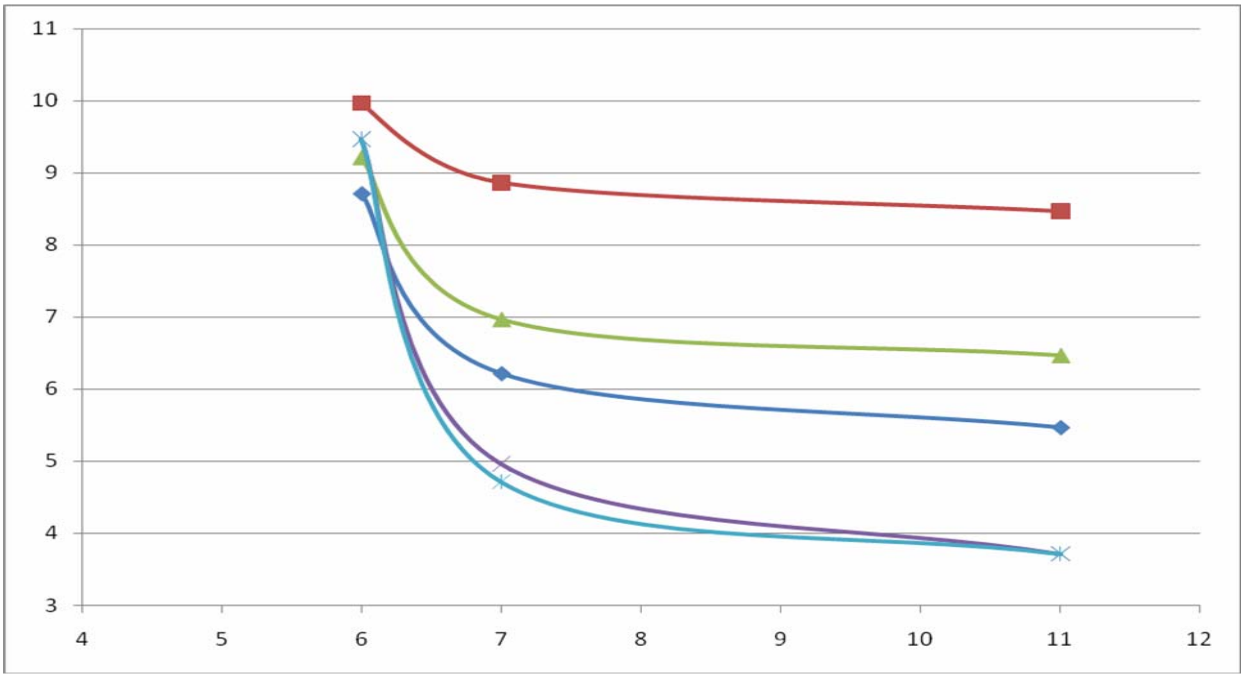

Fig. 4. Effect of Asma-1 on protein alteration in Mziuri-2 grain

Grain treated with d6 –d24 Asma-1 before diapauses (length of treatment 6 -24 hr)

Grain treated with i6 –i24 Asma-1before incubation (length of treatment 6 -24 hr)

Conclusion: Thus, the effect of the preparation Asma-1 on the development of Mziuri-2 embryo with the view of ATPase activity differs from that of Mziuri -1. If in case of Mziuri-1 in all experimental versions ATPase activity increases significantly, in experimental versions of Mziuri-2 activity of the above referred ferment is stimulated only in grain treated with 6 hr exposition.

Protein concentration kinetics in Mziuri-2 grain is similar to that of Mziuri-1. In this case too protein concentration suffers significant decrease by the end of incubation. At the same time, in grain treated with Asma-1 before diapauses protein composition suffers less change in the period of embryo development, compared to the control, while in grain treated before incubation, protein concentration by the end of incubation decreases threefold, compared to the starting. This probably refers to more efficient consumption of reserve egg proteins.

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Section 4. Silkworm rearing and feeding.

Rearing Performance of Eri-Silkworm (*Samia cynthia ricini* Boisduval) (Lepidoptera: Saturniidae) Fed on Different Genotypes of Castor (*Ricinus communis* L.)

By

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Growth, development, reproduction as well as yield of silkworms depends on the availability and supply of preferred host plants with good agronomic and nutritional characteristics that maximizes the production and productivity of silkworm fed on such host plants. In the present investigation, eight different castor genotypes (Abaro, Acc 106584, Acc 203241, Acc 208624, Ar sel, Bako, GK sel and local genotype) were evaluated for their importance as feed and nutritional sources for white plain eri silkworms (*S. c. ricini)* at Melkassa Agricultural Research Center (EIAR), East- Shewa Zone, Oromia Regional State. The experiment was arranged in Completely Randomized Design (CRD) with three replications for each treatment. Fifty worms were used in each replication. Significant difference was obtained in rearing performance of eri silkworms when leaves of different castor genotypes were served as feed material. Among castor genotypes fed to eri-silkworm, genotype Abaro fed worms showed medium to maximum records of matured larval weight (8.17 g), effective rate of rearing (74.68 %), survival rate (76.08 %), cocoon weight (3.34 g), pupal weight (2.86 g), shell weight (0.48 g), silk ratio (14.49 %), fecundity (382.00) and hatchability (88.17 %) as well as shorter larval duration (584.17). Thus, the result obtained by feeding genotype Abaro was found to be superior in improving the rearing performance of eri-silkworms with emphasis to economic traits and therefore this genotype can be recommended for further research and development works in integrating silkworm and oil seed production.
Keywords: Castor genotypes, eri-silkworm (*Samia Cynthia ricini*), rearing performance

TECHNOLOGICAL PROPERTIES OF PEDIGREE COCOONS GROWN IN SPRING AND SUMMER SEASON OF LARVAE REARING

By

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World silk market has definite requirements for cocoons, raw silk and natural silk products. At present silk industry of Uzbekistan supplies cocoons, raw silk and many silk goods (silk threads, yarn, fabrics and others) for local and foreign markets. In this connection our Republic tend to increase export potential of the branch.

Realization of silkworm repeated rearing in summer-autumn season is one of potential reserve to increase silk cocoons production. To fulfill this goal it is necessary prepare high quality elite silkworm eggs at pedigree sericulture stations with the object to manufacture qualitative industrial silkworm eggs at silkworm breeding factories. Doing this we could save hard currency resources which are realized for purchase of silkworm eggs abroad.

Kovalev P. A. and Sheveleva A. A. (1966) demonstrated possibility of rearing in summer season such breeds as: Belokokonnaya 1,2; bivoltine breeds and also SANIISH-8 and SANIISH-9. In Ukraine Akimenko L.M. and Braslavsky M.E. (1981) showed that output of cocoons from 1g of larvae is rather low in spite of sufficiently high larvae vitality (90.5 – 94.5%) at line of breeds adopted for repeated rearing.

Studies on development of efficient methods for sericulture stations on use of different microelements, vitamins for enrichment of mulberry tree leaves at repeated rearings are carried out at the Uzbek Research Institute of Sericulture (URIS). This work shows results of comparative study of technological characteristics of cocoons grown in spring and summer seasons of larvae rearing.

"Oligovit" preparation consisting of 10 vitamins and 10 microelements was used in the process of experiments. More dehydreted and poor quality mulberry leaves were treated by 0.2% solution of the preparation. Increase of cocoons shell ratio was achieved in a result of rearing of larvae of Orzu, Yulduz and Marvarid breeds and also Orzu x Asaka, Yuldus x Markhamat pedigree hybrids. Thus mass of silk shell was on 6.7-7.7% higher than in control variant. Increasing of characteristics of summer rearing is revealed at comparison of technological characteristics of cocoons grown in spring and summer seasons. Shell ratio of dry cocoons in Yulduz and Orzu breeds in spring was 48.82 – 49.49% but in summer season was 50.19-50.94%. Filament metric number at spring was 2631-2873 m/g and at summer – 3105 - 3636 m/g.

On the basis of obtained data it is possible to conclude that using "Oligovit" preparation it is possible to obtain cocoons with increased technological characteristics and at repeated rearing in hot climatic conditions of Uzbekistan.

Keywords: mulberry silkworm, breeds, hybrids, pedigree rearing, vitality, shell ratio, filament metric number.

New studies in Polish sericology

By

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(POSTER)

In 2010 INF&MP with other Polish institutions started new and original studies on the mulberry silkworm. The lecture will present new directions of research and initial results of conducted studies. Moreover, the presentation will show breeding results from 2012 season and comparing breeds form 2004 to 2012.
Keywords: Polish mulberry silkworms, original studies.

Nano-Gold-It's Effect on Cocoon and Silk traits of Mulberry silkworm, *Bombyx mori* L.

By

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In the present century the small particles are a unique phenomena which can be developed by top down processes. These small particles may be considered as nanoparticles which help to develop a technology called nanotechnology. We have introduced this technology, specially the gold (Au) nanoparticles in *Bombyx mori L.* The gold nanoparticles clearly denote that it has a tremendous effect on cocoons and silk traits of *Bombyx mori* L. which reflects an enhancement of fibroin and reduction of sericin proteins in silk cocoons obtained through extrafoliation of nanoparticles. The effect of gold nanoparticles on mulberry silkworm larvae at 50, 100, 200 and 300 ppm dose was studied right from first stage to Vth instar. Gold nano treatment resulted in significant alterations in the percentage of fibroin and sericin proteins in the Vth instar as compared to that of control. At 300 ppm the percentage of fibroin was 78.07 while sericin decreased from 39.46 (control) to 21.92. The function of gold nano in silkworm physiology is not only alterations of fibroin protein but also enhancement of cocoon and silk traits. The aim of this study was to investigate the effect of extrafoliation of mulberry leaves with gold particles on larval duration, mature silk gland weight, pupal weight, cocoon weight, cocoon shell weight fibroin and sericins contents etc. Moreover, the enhanced production of fibroin in *Bombyx mori.* L. will explore a new venture in bioengineering / biomedical field.
Keywords: Gold nano (Au), *Bombyx mori* L., Percentage of fibroin and sericin silk protein synthesis, silk gland weight, cocoon weight, shell weight.

ARTIFICIAL DIETS FOR INSECTS BIOTECHNOLOGY

By

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(POSTER)

Creation of accessible, high-assimilable and high-productive artificial diets has a great significance in insect biotechnology. The artificial diets have series of important advantages versus natural feed substrates: season independent composition constancy, possibility of mechanized production, sufficient lasting storage without alteration of nutritive properties and a lot of functional advantages.

From the other hand creation of high-productive artificial diets for household phytophage - mulberry silkworm could transform traditional sericulture of season depended to really industrial branch of agriculture. The other reviving branch of national economy – production of ecologically pure insect control agents - entomophages, microbiological plant protection means, all kinds of supplementary feedings, baits, traps, etc. are also developmental specific artificial diets.

Facilities and experimental capability for perspective researches were created at the Institute of Zoology of Academy of Sciences of Uzbekistan and Uzbek Research Institute of Sericulture. Rich experience of previous developments on creation of artificial diets for mulberry silkworm are used in the work. Untraditional proteins, carbohydrates- and lipid containing raw materials, sericulture, cocoons processing and food industry wastes are used as main ingredients of artificial diets for phytophages. This simultaneously solves problems of wastelessness in local industry.

As a result of these studies the universal artificial diet for such insects-phytophages as cotton bollworm *Helipoverpa armigera* Hbn. *Agrotis segetum,* other cutworms and also for serious pest of mulberry trees - mulberry pyralid *Glyphodes pyloalis* Wlk. as well as bait matrix and baits for Turkestan termite was designed. Soya and cotton cakes after special processing, silkworm pupae, sericin waste waters of silk-reeling plants, unusable mulberry trees autumn leaves, mulberry trees, corn, sunflower stems and other agricultural raw materials are the perspective ingredients for artificial diets.

Silkworm artificial diets apart sericulture could be used in future in biotechnology of this economically important insect to produce high-quality protein, lipids, carbohydrates, biologically active substances and means of untraditional medicine, and also in gene engineering, epidemiological studies, as sensitive test animal in environment monitoring and extreme conditions of environment (in space experiments, in zones of anthropogenic catastrophes, of contamination by pathogens, weed and pest-killer chemicals, exhaust gases, highland, mines, underwater and other objects).

Key words: insects, artificial diets, biotechnology, sericulture, insect biocontrol, bioorganics production, space experiments, environment monitoring.

EFFECT OF THE HEAVY METALS Co, Pb AND Cu ON THE BASIC BIOLOGICAL CHARACTERISTICS OF MULBERRY SILKWORM

By

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(POSTER)

ABSTRACT: Silkworms of hybrid Super 1 x Hesa were fed on mulberry leaves with a high content of heavy metals, collected from the region of the Works for Non-Ferrous Metals in Plovdiv. The following biological parameters were studied: pupation rate, larval stage, cocooning stage, pupae survival percentage. The high content of heavy metals inhibited vitality as the most important biological characteristic. Extension of the caterpillar stage did not exert a positive effect on cocoon shell weight. The duration of the larval period increased and the cocoon yield decreased.

Keywords: heavy metals, silkworm

INTRODUCTION

The major sources of soil pollution with heavy metals are the big industrial enterprises for ferrous and non-ferrous metal production and the ore mining and enrichment enterprises. Soil pollution is due to the inefficient and insufficient ecological criteria for control in the past. In the last 10 years, a special attention is paid to that fact and new efficient technologies have been introduced, which do not harm the environment, and, severe punishment have been imposed on polluting enterprises, even stopping their production process. Despite those measures, the consequences from the past resulted in turning once fertile lands into useless for agricultural food production. Sustainable land management requires the use of fertile lands polluted with heavy metals, for the production of agricultural goods.

Heavy metals are those having a density higher than 5 g/cm^3, such as iron, copper, zinc, chrome, nickel, cadmium, lead, thallium and mercury. Some of them are of vital importance as catalysts of biochemical reactions in silkworms (boron, iron, copper and zinc). As microelements they have a catalyzing effect and stimulate the biological development, however, when their amount is decreased or increased, an inhibiting effect on growth and development of silkworms is observed. For example, Massua (1983) established age differences in the inhibiting doses of Co and Ni, their content varying from 200 to 8000 ml, for the larvae from the first to the fifth instar. A lethal effect was observed in the larvae after absorption of greater amounts since they cause intoxication. The macro- and microelements play an important role for the proper development of the processes in the organism, such as maintaining the constant pH level. Any change in one direction or another leads to dysfunction of the enzymes (Babenko, 1965; Panayotov, 2004).

MATERIAL AND METHODS

The study was carried out in 2011 at the Experimental Station of Sericulture at the Agricultural University in Plovdiv. The trial involved the establishment of a mulberry plantation in a close vicinity to the Non-Ferrous Metal Works in Plovdiv. Leaves collected from the plantation of the Agricultural University – Plovdiv, located outside the zone of pollution (over 10 km away from the Works, to the west in the direction of the city of Plovdiv), were used for control feeding.

Silkworms of the hybrid 'Super 1' x 'Hesa 2' were reared under controlled regime, following the technology for the different ages, cocooning and cocoon harvesting.

Mulberry leaf samples were prepared by the EPA 3052 method and the content of the elements Zn, Pb and Cd was determined by flame atomic absorption spectrometry according to ISO 11047. For the analysis of the cocoons (the shell and the pupa), a comparative testing was performed by two methods of dissolving in concentrated nitric and hydrochloric acid at a ratio of HNO3 : HCI = 1 : 3 or the so-called *aqua regia*, as well as by EPA 3050B:1996 in nitric acid and hydrogen peroxide. The method EPA 3050B proved to be more suitable for that type of samples since dissolving was better and the obtained sample was clear. That is why the latter method was used for determining the content of heavy metals in the cocoons and pupae.

RESULTS AND DISCUSSION

The results about the content of the heavy metals zinc (Zn), lead (Pb) and cadmium (Cd) are presented in Table 1. Two variants of the mulberry leaves were studied – either freshly harvested or washed in distilled water when picked. Washing was applied to establish the effect of the air dust pollution of the leaves. The results showed that the washed mulberry leaves contained lower amounts of zinc, lead and cadmium – 39 mg/kg less zinc, 47,5 mg/kg less lead and 9 mg/kg less cadmium, respectively in the leaves collected from the area of the Agricultural University, used as a control in silkworm breeding. A similar tendency was observed for the leaves harvested from the plantation established in the region of the Non-Ferrous Metal Works – Plovdiv.

Another interrelation established about the content of the heavy metals Zn, Pb and Cd, is that the content was higher in the mulberry leaves collected from the plantation in the region of the Non-Ferrous Metal Works. In our previous studies, it was found out that the content of heavy metals in the soil samples collected from the plantation in the area of the Non-Ferrous Metal Works was significantly higher. Those results confirmed the studies of Muhammad Ashfa et al. (2009) who investigated the lead cycle in the mulberry-silkworm system. The content of the heavy metals established in the cocoon shell and pupae was lower compared to the content in the mulberry leaves. The highest zinc content was detected in the pupae fed on mulberry leaves from the region of the Non-Ferrous Metal Works (1323 mg/kg). That value was almost ten times lower in the pupae fed on leaves from the plantation of the Agricultural University (133 mg/kg). The same tendency was observed in the lead and cadmium contents in the pupa body. Again, a higher content was established in the pupae fed on mulberry leaves from the plantation in the region of the Non-Ferrous Metal Works. The lowest content of the studied heavy metals zinc (Zn), lead (Pb) and cadmium (Cd) was detected in the cocoon shell, the values being lower when feeding the larvae with leaves from the plantation in the area of the Agricultural University.

It should be mentioned that the cadmium content in the cocoon shell was the lowest and equal in both variants of feeding the larvae of the control (<1.0 mg/kg).

Table 1. Heavy metal content in samples of mulberry leaves, cocoon shell and pupae in the region of the Non-Ferrous Metal Works – Plovdiv and of the Agricultural University – Plovdiv

No.	Description	Zn mg/kg	Pb mg/kg	Cd Mg/kg
1	AU – washed mulberry leaves – K1	71.0	46.5	3.00
2	AU – unwashed mulberry leaves – K2	110	94.0	12.0
3	NFMW – washed mulberry leaves	210	170	12.5
4	NFMW – unwashed mulberry leaves	245	294	22.5
6	AU – cocoons – K	2.94	<4.0	<1.0
7	NFMW – cocoons	37.2	42.9	<1.0
8	AU – pupae – K	133	<4.0	<1.0
9	NFMW – pupae	1323	80.9	24.5

Legend: K – control
NFMW – Non-Ferrous Metal Works
AU – Agricultural University

Table 2. **Data about the most important biological characteristics in mulberry silkworm**

Hybrid Variant	**Larval Stage Duration in h**	**Fifth Instar Duration in h**	**Pupae Survival Percentage**	**Hatchability Percentage**
NFMW – sample Super 1 x Hesa 2	1032	384	72.20	98
Control – AU Super 1 x Hesa 2	744	288	93.05	98

As it is seen from the results presented in Table 2, in both variants of feeding, the egg hatchability was equal. The established differences between the sample and the control in the pupae survival rate, the fifth instar duration and the larval stage duration, were significant.

For example, the larvae fed on leaves polluted with heavy metals, had a considerably extended larval stage of 1032 h versus 744 h for the larvae fed on unpolluted forage. Fifth instar duration in the control was shorter compared to that of the larvae fed on mulberry leaves collected from the region of the Non-Ferrous Metal Works. A significant difference of 20,85% was observed in the pupae survival rate between the control and the sample, the survival rate of the control being 93,05 %. The high content of heavy metals inhibits the development of the most important biological characteristic.

Table 3. Data about the shell weight of fresh cocoons /g/

No.	Variants	n	x ± m	σ	VC%	Min	Max
1	**NFMW**	27	0.18 ± 0.007	0.04	23.06	0.13	0.25
2	**Control**	27	0.35 ± 0.008	0.04	12.52	0.25	0.41

The results of the shell weight of fresh cocoons, obtained when feeding the larvae on leaves from the plantation in the region of the NFMW – Plovdiv are presented in Table 3. The mean values of the control were higher (x = 0,35 ± 0.008 g) compared to the cocoons obtained in the variant with feeding the larvae on leaves from the region of the NFMW (x = 0,18 ± 0.007 g). That was confirmed by the established maximal and minimal values of that characteristic, which were 0,13 g and 0,25 g in the sample and 0,25 g and 0,41 g in the control, respectively. Those marginal values of the fresh cocoon weight show that the variation coefficient is lower in the control (**VC% =** 12,52) and higher in the sample (**VC% =** 23,06).

Table 4. Single-factor dispersion analysis of the effect of the polluted mulberry leaves on the shell weight of fresh cocoons

Indexes	Variation between the groups	Variation within the groups	Total Variation
Sum of squares	Cx 2.22	Cz 4.02	Cy 6.24
Effect of the factor	35.57	64.42	
Degree of freedom	1	52	53
Mean square	2.22	0.07	
Significance	31.71^{+++}		

$^{+++}P \leq 0.001$

The difference of 0,17 g of the shell weight of fresh cocoons, established between the two samples, was statistically significant, and it was confirmed by the single-factor dispersion analysis (F = 31,71 at $^{+++}P \leq 0.001$ (Table 4).

The same Table shows that the cocoon weight was greatly affected by the feeding diet, the effect of the factor being calculated to be 64,42%.

CONCLUSIONS

The analysis of the results about the development of the silkworms of hybrid 'Super 1' x 'Hesa 2', fed on leaves with high content of heavy metals showed that the durations of the larval stage and of the fifth instar were extended. That fact did not exert a positive effect on the cocoon shell weight. The feeding diet had a strong effect on the shell weight.

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Rearing performance and cocoon characters of muga silkworm *Antheraea assamensis* Helfer as influenced by biochemical composition of its different host plants

By

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Two primary host plants of muga silkworm, *Antheraea assamensis, viz*. Som (*Persea bombycina*) and Soalu (*Litsea monopetela*) and two secondary host plants, Diglotti (*L. salicifolia*) and Mejankari (*L. citrate*), were evaluated for rearing performance and cocoon characters during two commercial seasons under the agro climatic conditions of Jorhat, Assam. Significantly the highest ERR was obtained from Som fed larvae (61 %) and lowest in Mejankari (49 %). Male and female mature larval weight was recorded significantly the highest from Soalu fed larvae (11.61 g and 15.04 g, respectively), while it was the lowest from Mejankari (7.89 g and 9.04 g, respectively). Significantly heavier male cocoon weight

was obtained from larvae which were fed with Som leaves, while female cocoon weight was from Soalu (6.77 %). Som performed better in respect of male and female shell weight (0.57 g and 0.51 g, respectively). Analysis of biochemical composition of the host plants was revealed that for all the nutrient constituents as a whole, *P. bombycina* was superior over other host plants irrespective of season and type of leaves, followed by *L. polyaltha*. To show the effect of the leaf biochemical constituents, correlation coefficients between the leaf biochemical constituents and the rearing performance of muga silkworm on different host plants was also estimated.
Keywords: Muga Silkworm, *Antheraea assamensis*, biochemical composition, rearing performance

Section 5. Silk reeling and processing.

Silk "Quality" Revealed Using Dynamic Mechanical Thermal Analysis (DMTA)

By

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(ORAL PRESENTATION)

ABSTRACT: Dynamic Mechanical Thermal Analysis (DMTA, www.oxfordsilkgroup.com/DMTA or en.wikipedia.org/wiki/Dynamic_mechanical_analysis) is able to identify specific molecular signatures allowing us to differentiate 'good' from 'poor' silks. We propose DMTA as an effective tool for evaluating silk "quality" and grading silks. Moreover, DMTA can quantify the effect of industrial processing (temperature, humidity and loading) on the quality of silks, therefore, it helps the silk industry to achieve quality control in silk processing as well as to obtain optimum conditions for producing desirable silk products.

In the case study, we chose three cocoon silk grades (G1, G2 and G3) from the same region in China during the same period of production, and examined the three silk grades using DMTA. We observed statistical differences in the mechanical properties of three grades. We also discovered that lower grade silks display lower temperature transitions which are characteristic of more disordered molecular structure. Interestingly, the temperature annealing treatment under load can "heal" these poor silk structures and reduce the differences between the poor and good silks.

More DMTA based methods such as static-dynamic tests demonstrate how the mechanical load and moisture affects the structures of silk, which are indicative of the mechanical properties of silks and other important practical properties such as optical transparency, reel-ability and dye-ability. This fundamental understanding can be crucial to the silk production and processing.

Our study proves that DMTA is a sensitive and very powerful technique that can be used to link rearing and production conditions to silk quality and silk properties. Importantly, we assert that the technique can be used on both mulberry and wild silks in both fundamental research and in quality control for commercial sericulture.
Keywords: Dynamic mechanical; thermal; glass transition

Introduction

Dynamic mechanical thermal analysis (DMTA) has been applied extensively in polymer science and engineering since the 1950s, and it is arguably the most important analytical tool to bridge between the microstructure and macroscopicl properties for amorphous or semicrystalline polymers [1]. Over the decades, this technique has moved into areas beyond fundamental research. For example, in pharmacology DMTA is used to evaluate the properties of polymer-based drug release systems [2].

As illustrated in Figure 1, DMTA applies periodic deformations dynamically to the sample and measures the response as a function of time, temperature and frequency. As a result, modulus and loss tangent can be plotted with changing time, temperature or frequency. The modulus is a measure of stiffness (the resistance force per unit area); and the loss tangent is a measure of the damping properties, e.g. how much energy is absorbed or converted to internal heat. Modern DMTA is also capable of conducting quasi-static tensile testing and relaxation test (e.g. creep), which are important for engineering applications. With a tailored humidity accessory, DMTA can examine the moisture effect on the mechanical properties of biological samples. The above mentioned tests prove DMTA to be an incredibly powerful tool which could provide key structure and property information on silks and silk composites.

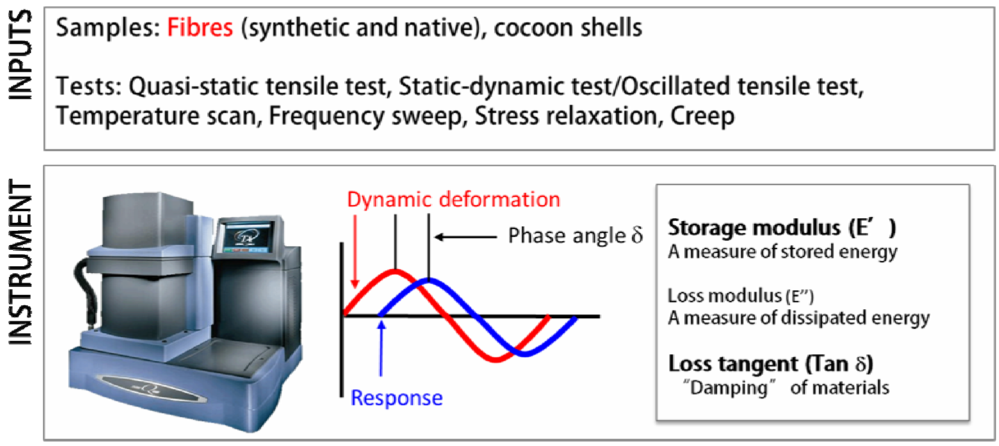


Figure 1 Illustration of the capabilities and the testing principles of DMTA.

Sericulture in China has a history of over five thousand years. Historically it has been more or less an 'empirical' manufacturing process with respect to both the conditions of growing silkworms and the criteria of assessing the agricultural product, cocoons. The biggest silk-producing country, China, has recently established the 2008 standards of classifying fresh cocoons and the 2008 standards of evaluating raw silk quality [3, 4]. The Chinese standards of cocoon classification have evolved from the empirical 'look and feel' in the 1950s to a more machine-testing based procedure. However, the main characteristics remain empirical, e.g. the reelability and the maximum unravelled length [3]. In practice these methods can classify cocoons efficiently, nevertheless they do not lead to an understanding on the underlying science, e.g. what is the origin of the observed differences in the property of silks.

In this paper, we demonstrate that the technique DMTA can be applied in cocoon and silk classification, and DMTA is proposed to be a potential quality control tool for silk industry. In the case study, we chose three graded cocoons (G1, G2 and G3) from the same region in China during the same period of production. Focusing on mechanical properties of cocoon silks, both quasi-static tensile tests and dynamic mechanical thermal analysis were completed on DMTA. In the discussion, structural differences between graded *B. mori* silks are considered, which may shed light on the origin of silk quality and the role of silk farming and post-processing.

Experimental section

Materials

- *Cocoons*

Three different quality cocoons (pupae removed) from Jiangsu Province, China were provided by Prof. Yaopeng Zhang from Donghua University, Shanghai. They were produced during the same period, June 2010; and pupae were removed immediately upon collection. Three cocoon samples (one for each grade, named as G1, G2 and G3) were randomly chosen for experiments and analysis. The rough outer layer of each cocoon was removed before taking the fibres from the middle of the cocoon shell.

- *Raw Silk Fibres*

Silk fibres were manually gently pulled from the middle layer of cocoons and fixed to sample-holders for mechanical testing. The pulling of the fibres inevitably causes some breaking-up of the sericin coating. However, with care, minimal damage to the sericin-fibroin bonding was maintained. Sample-holders are card frames, designed for the DMA tension clamp and cut by laser cutter with precision.

Methods

- *Physical-property Measurement of Cocoons*

Photographs of the three cocoons were taken using a Panasonic camera in order to compare the features of their appearance such as colour and contamination. The size was measured from the photographs; and the weight was measured on a lab balance.

- *SEM Characterization of Silk Fibres*

Images of the morphological features of both cross-sections and surfaces of raw silks were taken on a Scanning Electron Microscope (Jeol Neoscope JCM-5000). A magnification of 1,000 times was used for cross-sectional shots. Image analysis of the cross-sectional areas was done using ImageJ (protocol provided by lab members). The average area from this analysis for each grade was then used for mechanical testing analysis (calculating the stress and modulus).

- *(Quasi-static Mechanical) Tensile Testing*

Quasi-static mechanical tests, or tensile tests, were conducted in a controlled-force mode on a TA Q800 instrument instead of Instron. 5mm gauge length was used for all mechanical tests, including dynamic tests. The engineering “end” effect is not taken into account here as the thickness/length ratio is very small for silk fibres. Tests were set up using the following parameters: force-ramp rate of 0.1N/min; room temperature 25 °C; and relative humidity of 50%. Approximately 15 specimens were tested for each grade.

- *Dynamic Mechanical Analysis*

Dynamic mechanical tests were conducted on the same instrument (TA Q800) as the tensile tests using the following settings: temperature ramps from -100 to 250 °C at 3 °C /min, 0.02 N static load for G1, 1 Hz frequency, 0.2% dynamic strain (equivalent of ~15 MPa dynamic stress at 25 °C). Specimens were all equilibrated at 30 °C for 10 mins under nitrogen purge (to remove the excess moisture).

A cyclical temperature test was conducted on G1 silks using the same other settings as above: the first scan was from -100 to 120 °C, and then the second scan was from -100 to 250 °C after cooling to -100 °C at -10 °C /min. Another cyclical temperature scan (annealing test) was conducted on G3 silk with the first scan to a maximum temperature of 180 °C.

Results and discussion

1. *Morphology of cocoons and raw silk fibres*

Colour/contamination: As shown in Figure 2, cocoon G3 is clearly discoloured (notice the dark brown spots). The colour of cocoons G1 and G2 is white, while cocoon G3 is yellowish.

Size: Cocoon G1 (4.3cm by 2.5cm) is much bigger than that of G2 (3.6cm by 2.0cm) and G3 (3.6cm by2.1cm).

Weight: The weights of the three cocoons are: G1, 0.51g; G2, 0.29g; G3, 0.33g. This suggests that cocoon G1 yields more silk. The size and weight are consistent in a way the top grade produces larger quantity of silk per cocoon.

As also shown in Figure 2 (middle column), silk fibres from G1 have more regular cross-sectional shapes (triangular or bone-shaped), and the two brins are well wrapped by sericin with little exposure of single brins; while as G2 and G3 fibres are not coated evenly by sericin, and the spread or coating thickness of sericin varies a lot around and along the fibre, which can also be seen from the longitudinal view in the right column of Figure 2. In addition, for G2 and G3 silks, there are more cracks on the interfaces between sericin and fibroin and more holes in the fibre cross-sections. The 'cracks' in G2 and G3 are clearly defects and may cause early failure in mechanical testing. From the SEM cross-sectional measurements (data not shown here), it is found that the top grade G1 silks have the thickest average diameter; however, the variability (~10%) of the diameters does not differ between grades.

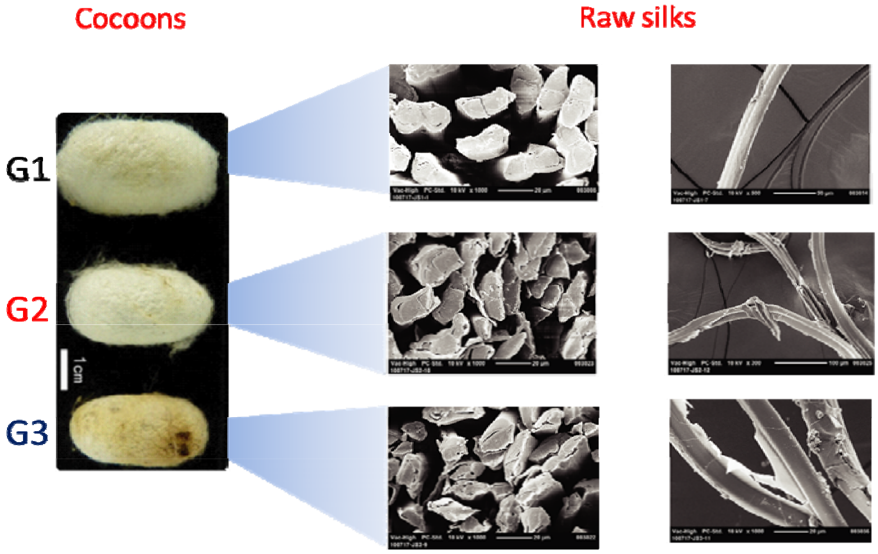


Figure 2 Photographs of the three cocoon grades are on the left, SEM images of the cross-sections are in the middle column, and surface/longitudinal views of the raw silks taken from the middle layer of the cocoons are shown on the right.

2. *(Quasi-static) Tensile performances*

Figure 3 shows three representative stress-strain curves with standard deviation bars for the breaking stress and breaking strain from about 15 silk fibre samples for each of the three grades. G3 has a larger variability in the breaking strain and stress compared with G1 and G2. It is also shown from a two-sample t-test that the initial moduli of G1 (4.95 GPa) and G2 (5.15 GPa) silk fibres are significantly higher than G3 (3.59 GPa); and the post modulus of G1 (796 MPa) silk fibres is significantly higher than G2 (664 MPa) and G3 (635 MPa). Interestingly, the breaking energy increases as the silk grade decreases, and the breaking energy of G3 is significantly higher than that of G1 at the 0.05 confidence level. This increased breaking energy is usually a sign of increased disorder in the molecular structure.

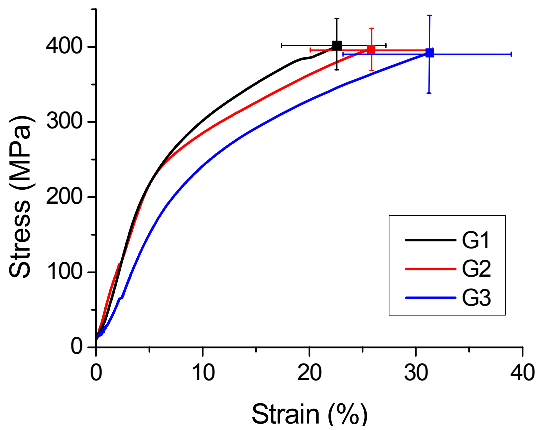
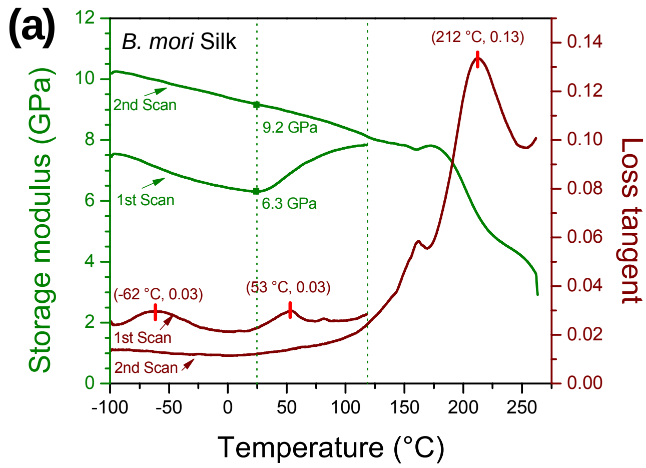


Figure 3 Representative stress-strain curves of 3 grades of *B.mori* silks (from the middle layer of cocoons), error bars show the standard deviation of breaking strain and stress of 15 samples.

3. *Dynamic mechanical thermal analysis of silk fibres*

How does temperature or heat affect the properties of silks? DMTA temperature scan is the most effective way of obtaining this information. Figure 4(a) shows the DMTA results of G1 silks in a cyclical temperature scan: storage modulus and loss tangent change as a function of temperature. In the first scan, as the temperature increases from -100 °C, the storage modulus decreases first with a lower gradient until 50°C, where an increase in modulus is observed, which is attributed to water loss [5]. Then in the second scan (after the water is boiled off), the modulus decreases with increasing temperature from -100 °C to 100 °C. Starting from 150 °C, the modulus drops faster by a factor of about 10 and is accompanied by a Gaussian shape loss tangent peak centred at 212 °C. This loss event is the glass transition of the "dry" silk structure [5].



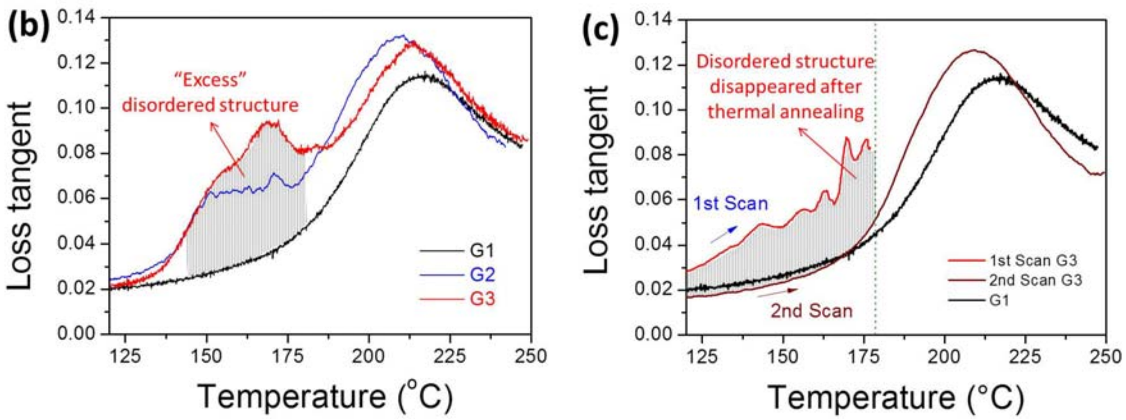


Figure 4 (The figures are reproduced from [5]) Dynamic mechanical properties of silks from tests: DMTA cyclical temperature scan of G1 silk (a); DMTA temperature scans of the three grades G1, G2 and G3 (b); the annealing temperature scan to 180 °C of G3 (c).

How do the different silk grades behave in the DMTA profile? In Figure 4(b), for the major glass transition event, G2 and G3 silks show loss peaks between 151°C and 170°C which are absent for G1, although the three grades have similar loss tangent peaks below 100 °C (not shown here). The loss peaks in this temperature region are associated with more disordered structures, which also appear in the reconstituted silk fibroin films and other poorly reeled silks [6].

However, as shown in Figure 4(c), comparing the first and second temperature scans of G3 silks, these disordered structures can be annealed out through temperature treatment. The explanation is that the combination of heat and mechanical energy can effectively increase the mobility of the molecules and relax the structures into less disordered forms.

4. *The quality of silks*

Instead of using the standard ways of assessing cocoons, we chose to test the properties of the raw fibres of different cocoon grade on DMTA. The link between cocoon grade and the raw silk quality has been established in this study: the raw fibres from better grade cocoon have more uniform fibre morphology, higher tensile modulus, more consistent tensile properties and better dynamic thermal mechanical properties. Further quantification of the relationship between silk quality and properties can be obtained using the methodology established in this paper.

The structural analysis on DMTA implies that lower grade silks have inferior silk structure compared with the normal or high grades. Because only raw silks were examined in our study, the differences in silks are most likely attributed to the production of the cocoons other than post processing, for example, whether a healthy diet was provided to silkworms or other factors such as environmental conditions which affect the growth of silkworms or the cocoon spinning process.

Furthermore, the thermal annealing study suggests that differences between the “bad” and “good” silks can be reduced through thermal mechanical treatments. In fact, it is known that the post-processing of silks has a major influence on the mechanical properties of silks [7].

The effect of static loading or mechanical stress on the properties of silks has been examined in our previous study [8]. It was shown that the loading history increases the storage modulus of silks. In other words, higher loading or loading history makes stiffer silks.

There are two immediate options to apply DMTA in sericulture. Firstly, it could be used by breeders and/or rearers in order to monitor the quality of their 'product' i.e. the average quality of the fibres made by their worms. Secondly, DMTA would be used to monitor the effect, efficiency and efficacy of post-processing technologies such as thermal annealing or dying. For example, a reasonably quick scan of a specifically dyed silk would tell how the dyeing procedure changes the structures of silks and therefore how tightly the dye can bind to silks. Other post-processing procedures, such as throwing, degumming, washing, and even weaving can be interpreted using a set of a few physical parameters including temperature, mechanical stress and water permeation. As we discussed above, the effect of these treatments on silk fibres tend to be reasonably well understood on the scientific level. Perhaps commercially applied DMTA might prove to be equally useful in helping to improve sericulture practises and thus enhance the value chain.

Summary

Using both quasi-static tensile testing and dynamic mechanical thermal analysis, we examined the mechanical properties and the structures of raw silk fibres from three cocoon grades of the Chinese *B. mori* species. It is evident that the tensile modulus of the top grade is higher than the low grade and the tensile performance is more consistent for the top grade, but the breaking energy does not deteriorate with lower grades. The dynamic mechanical thermal properties of silks suggest that low grade silks have a more disordered molecular structure, which could be "annealed out" using thermal mechanical treatment, as shown in the thermal annealing tests.

We conclude that the structural differences in silk fibres from raw cocoons are due to the agricultural process; and DMTA is a sensitive tool for evaluating the quality of silks before or after post processing, as well as the effect of heat and mechanical treatment on silk quality.

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NEW SIMPLE EFFECTIVE TECHNOLOGY POST HARVEST PROCESSING OF COCOONS

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(POSTER)

ABSTRACT

In sericulture practice, various types of drying machine (tools) are used: Shelves –carrier type; band types cocoon drying machine and methods for pupa killing: Infrared rays; Cold air; Radio wave and Poisonous gases. All of these machine or tools use different energy sources for heating up, such as: electricity, gas, black oil etc, which are expensive under the cost price. In this case, we have aimed to manufacture tools, so that processing of cocoons could be accessible and inexpensive, while quality of cocoons remains natural.

For manufacturing cocoon killing tool, a metallic tank (drum) with total volume of 200 L was used. This tool was divided into 2 parts: top part (150 L) where cocoons were placed and undergoing process of killing pupa, whereas the bottom the part (50 L) was filled by water, in the subsequent heated up to boiling. Currently, we are trying to harmonize speed of saturation of water steam in order to achieve effective processing of fresh cocoon. By using water steam, it was observed that 10 minutes was effective for processing cocoons, where the sum of temperature reached 455^{0}C, number of dirty cocoons were only 1, 07 %.

Cylindrical metallic tank (drum) is effective in post harvest of fresh cocoons. Firewoods can be used for water heating. At one cycle, which can take only 20 minutes duration, this tool has possibility to process 22-25 kg of fresh cocoons or probably more than 400 kg/day.

Keywords: Fresh cocoons, post harvest processing, water steam, killing, drying

INTRODUCTION

The purpose of cocoon drying consists to prevent the moth emergence as well as to remove moisture contained in the cocoon's shell and pupa, and thereby permit the preservation of cocoons for a long period under normal temperature and humidity. Furthermore, during process of drying, the nature of cocoon is, without damaging it, properly changed for the purpose of facilitating subsequent reeling process. The drying conditions are very important for the following process of silk filature (Bongale U. (2002); Katsumata F. (1975); Krishnaswami S., Madhava Rao N.R., Suryanarayan S.K., Sundaramurthy T.S. (1972).

The water content in cocoons varies with silkworm breeds, rearing season, sex of the pupa etc. the majority of water is contained in the body. Nevertheless, water contained in cocoon shell evaporates rapidly, and heat is transmitted to pupal body through cocoon shell. After death of pupa, water body content evaporates rapidly. The drying of cocoon starts at the constantly drying period when a certain amount of water is given off from a certain time and then enters into the decelerating period, when water evaporated for a certain time declines in quantity and finally the whole process is completed. Main factors of drying conditions are composed of temperature, humidity and air speed, but also by the time duration and filing thickness of cocoons (Wu Pang Chuan, Chen Da Chuang (1988); Lim S.H., Kim Y.T., Lee S.P. ,Rhee IJ., Lim J.S., Lim B.H. (1990).

In sericulture practice, various types of drying machine (tools) are used: Shelves – carrier type; band types cocoon drying machine and methods for pupa killing: infrared rays; cold air; radio wave and poisonous gases. All of these machine or tools use different energy sources for heating up, such as: electricity, gas, black oil etc, which are expensive under the cost price. In this case, we have aimed to manufacture machines or tools, so that processing of cocoons could be accessible and inexpensive, while quality of cocoons remains natural.

MATERIALS AND METHOD

For manufacturing cocoon killing tool, a metallic tank (drum) with total volume of 200 litters was used. This tool was divided into 2 parts: top part (150 litters) where cocoons were placed and undergoing process of killing pupa, whereas the bottom the part (50 litters) was filled by water, in the subsequent heated up to boiling.

Sequence of technological process:

3. 50 litters of water was poured in the down part of the tool and firewoods were used for boiling water. The boiled water remained up to the ending of this process;
4. In advance, the top part of the tool was filled by 25 kg fresh cocoons, after the water boiled, is established on top of the bottom part tool, water steam passes through the holes of the tank and gradually reaches the top part;
5. Thermometer was placed in top part of the tool (where located the pipe) in which temperature level was constantly monitored. Once 85^0C reached, temperature began to decrease;
6. At the end of this process, the top part tool, which contains cocoons, was disconnected from the bottom, to permit exit of steam and cooling of cocoons cover was cleaned. Afterwards, cocoons were placed on special shelves, where located shade and allowed stored up for full drying;

Technological process by steam killing of pupa

Subsequent to killing pupa process and obtain full drying, cocoons were daily mixed. After 2 weeks from the date of processing, analysis of samples was carried out. From each variant of the experience, 1500 cocoons were taken and subjected to the counting of: number of defective cocoons, number of dirty cocoons after spinning and normal cocoons after processing.

RESULTS AND DISCUSSION

Quality of raw silk in many respects depends from post harvest processing technologies of cocoons, since cocoon shell contains two proteins: fibroin and sericin. As any biological material, these proteins have specific physical and chemical property, use of various physical factors, especially temperatures, (110^0C) the higher which will lead to denaturation of their structure; it means that they lose their initial property.

In sericulture, post harvest processing (pupa killing and cocoon drying) use different technology and methods: hot air, stem, cold air, infrared rays, radio wave, poisonous gases etc. Each technology presents some advantages and disadvantages. For example, for fibroin and sericin, hot air is much more harmful than cold air. However, application of cold air in pupa killing is very expensive, thus unpractical for farmers in rural areas. The method where water steam is used for pupa killing in cocoon is the most effective and not damage structure of cocoon's fibroin. However, this method presents some disadvantage, use of pairs for pupa killing, in some cases increase number of Rusts cocoon. In fact, our purpose consisted to manufacture tool for killing pupa in cocoon by using hot water steam as a source of energy, develop cocoon post harvest technology, carried out research and inspect effectiveness of the tool. Research on temperature of water steam according to the time of processing and its efficiency in pupa killing was began once reached 80^0C on top part of the tool (table 1).

Table 1. Dependence speed of water saturation paired with processing time of cocoons

Time of processing	Experiment variants				
	30 min processing	25 min processing	20 min processing	15 min. processing	10 min. processing
	Temperature of steam, ^{0}C				
0	80	80	80	80	80
1	85	85	85	85	85
2	90	90	91	91	92
5	95	91	93	92	95
7	96	94	96	95	95
10	93	93	94	94	93
13	92	91	92	92	-
15	91	92	90	91	-
17	90	90	90	-	-
20	88	86	89	-	-
22	85	88	-	-	-
25	89	90	-	-	-
30	92	-	-	-	-
Sum of temperature	**1081**	**985**	**815**	**635**	**455**

It is essential to notice that once the top part of the tool, in which contains cocoons, placed over its bottom part, the temperature reached 80^0C in 2-3 minutes.

From 0 up to 7 minutes, steam temperature within the tool rose on the average of 5^0C and reached 95 ± 1^0C, and afterwards dropped. Later than 20 minutes of processing, there was a decrease down to 86 ± 1^0C, while in the following 25 minutes, temperature was again started to increase. Such temperature variation depended by speed of saturation of water steam (Diagram 1).

Sorting of cocoons before processing has shown, that percent of non sorted cocoons in variants varied between 1,0 to 6,0 %, thus percent of dirty cocoons before processing had ranged between 3,31 to 7,28%. The two indicators jointly compose about 10,0 %, and natural data of non sorted cocoons are observed in table 2.

Diagram 1. Dynamics of saturation of steam depending on time of processing in cocoon killing tool

Table 2. Effect of radiation Sum temperature of water steam on quality of cocoons

Variants	Total number of cocoons	Non sorted cocoons		Number of dirty cocoons before processing		Dirty cocoons after processing		Sorted cocoons		Sum of temperature, ^0C
		number	%	number	%	number	%	number	%	
Control*	1500	84	5,60	102	7,20	0,0	0,00	1487	100,0	-960
30 minutes	1500	90	6,00	52	3,68	106	7,11	1384	92,88	1081
25 minutes	1500	31	2,06	107	7,28	88	5,90	1403	94,09	985
20 minutes	1500	22	1,46	49	3,31	89	5,95	1406	94,05	815
15 minutes	1500	15	1,00	76	5,11	32	2,14	1462	97,86	635
10 minutes	1500	18	1,20	76	5,09	16	1,07	1478	98,93	455

*Cold processing at temperature-20^0C/48 hours

Currently, we are trying to harmonize speed of saturation of water steam in order to achieve effective processing of fresh cocoon. Long time processing of cocoons, for example 20 to 30 minutes, has positive correlation with the increase in number of dirty cocoons, when the time of full water saturation reached, transforming into water, and get inside cocoons. In case small amount of black stained cocoons remained during processing of cocoons, quantity of rust cocoons increases, and thereby leads to the decrease in number of sorted cocoons. By using water steam, it was observed that 10 minutes was effective for processing cocoons, where the sum of temperature reached 455^0C. Number of dirty cocoons were only 1, 07 %, thus number of Sorted normal cocoons was 98, 93% accordingly.

CONCLUSIONS

- Application of water steam for processing of fresh cocoons has shown to be efficient, whereby 10 minutes are sufficient killing pupae without alterate cocoon's quality; the percentage of number of dirty and normal cocoons were 1, 07 % and 98, 93% respectively.
- The usage of cylindrical metallic tank (drum) for manufacturing post harvest tools intended for processing fresh cocoon has been found to be effective and inexpensive.

RECOMMENDATION

Cylindrical metallic tank (drum) is effective in post harvest of fresh cocoons. Firewood can be used for water heating. At one cycle, which can take only 20 minutes duration, this tool has capacity to process 22-25 kg of fresh cocoons or probably more than 400 kg/day.

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Section 6. Silkworm pathology.

Horizontal transmission of *Nosema bombycis* infection on rearing parameters of silkworm *Bombyx mori* L

By

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(ORAL PRESENTATION)

ABSTRACT: The horizontal transmission of *Nosema bombycis* on rearing parameters of PM and CSR2 revealed significant results on fifth instar larval duration and Effective Rate Rearing. However, the significant difference was found between healthy (7.24 and 5.77 days and 10.43 and 7.97 days) and inoculated batches respectively. Longer duration of 5.67, 7.45 and 13.40 days were recorded for Pure Mysore and the same instars of CSR2 recorded 4.40, 5.77 and 10.48 days for third, fourth and fifth instar batches respectively. On the other hand, the infected batches of both the breeds were also affected due to *Nosema bombycis* and recorded maximum of 85.87 and 71.62 percent ERR in fifth instar inoculated batches followed by fourth (66.25 and 63.00 percent) and third instar (48.37 and 61.75 per cent).

It is very much vivid from experimental result that, earlier infection due to pebrine causes lower ERR per cent as reflected in the experimental data. Among breeds, Pure Mysore found to be the most sensitive breed to pebrine infection and experienced 14.75 per cent ERR compared to 41.75 percent in CSR2. The decreased in ERR was (12.00, 15.67, 14.33) with increased larval stage (V, IV, III). The interaction effect between breed and instar was found non-significant.

Keywords: *Nosema bombycis* N., Horizontal Transmission, Effective Rate Rearing, Silkworm breeds

INTRODUCTION

The silkworm, *B.mori* has been domesticated since time beyond memory. This continuous domesticated made it susceptible to the attack of a number of pathogens. Pebrine is a deadly disease of silkworm caused by *Nosema bombycis* Naegeli (Protozoa: Microsporidia) it is a unique pathogen transmitted through egg (transovarial transmission), by the ingestion of the contaminated leaf and by contaminated egg surface (transovum transmission). Normally microsporidiosis occurrence in India is of low intensity during summer and high in winter season in tropics due to increase in the lepidopteron insects during winter and rainy seasons.The silkworm larvae infected during early stages of 1^{st} and 2^{nd} instar die upto 5^{th} instar, but if infection occurs during 4^{th} and 5^{th} instar, larvae manages to survive and form cocoons but the silk form the cocoon of infected larvae is usually much inferior (Bhat *et al.,*2009).

MATERIAL AND METHODS

The above study was carried out at the Department of Sericulture, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bangalore during the year 2009-11. The horizontal transmission of *N. bombycis* in both the silkworm breeds (PM and CSR2) was studied on third, fourth and fifth instar larvae. They were orally administered with 10^{-3} spore dilution (@0.1 ml of spore suspension) was smeared through mulberry leaves, leaf cut to the size of 12×10 cm and the smeared leaves were fed to the larvae which had come out of the second moult. After that, total number of days per instar was recorded after inoculation. Further, ERR (%)was recorded ERR was worked out by using the formula

$$ERR = \frac{\text{Total Number of cocoons}}{\text{Number of worms brushed}} \times 100$$

RESULTS AND DISCUSSION

Fifth instar larval duration (days)

Per oral infection of *Nosema bombycis* to PM and CSR2 exerted significant difference of fifth instar larval duration. The data on third fourth and fifth inoculated batches recorded 12.00 to 15.33 days of fifth instar larval duration for fifth and third inoculated batches of PM compared to 10.33 and 12.00 days of CSR2. Even in fifth instar larval duration the pathogen exhibited its chronic nature and affect on all the three instars experimented. Further, PM exhibited longer larval duration from 12.00 to 12.67 days of fifth instar larval duration compared to CSR2 (9.33 to 10.25 days). The interaction effect between the breeds and instars was also found significant (Table 1, Fig 1 & 2). These results are lined with the findings of Baig *et al*(1988b)*.,* according to them a popular BV hybrid NB18 ×NB7 administered with 0.2 ml of spore suspension of 9× 10^{-6} spore per ml after third moult experienced significant variation due to pebrine compare to control batch. As per their opinion the infected larvae recorded 676 h of total larval duration compare to healthy 662. As in the present study the PM breed has recorded more larval duration than CSR2. Further, Patil and Geetha bai (1989) also inferred that, the PM breed grow normally even there is infection. It was well known that, the infected midgut cells are released into the lumen by the elimination of the gut cells and recover from the infection by the regenerative activity of the midgut cells

Effective Rate of Rearing (%)

The data on ERR of both PM and CSR2 affected due to *Nosema bombycis* infection. Maximum of 85.87 and 71.62 per cent ERR was recorded in fifth instar inoculated batches followed by fourth (66.25 & 63.00 %) and third instar (48.37 & 61.75 %). It is very vivid from the experimental results that, earlier infection due to pebrine caused lower ERR percentage as reflected in the experimental data. Among breeds, PM found to be more sensitive for pebrine infection and experienced 14.75 per cent ERR compare to 41.75 per cent ERR in CSR2. The interaction effect between the breed and instar was also found significant (Table 2 & Fig 3). These results are in line with findings of Baig *et al* (1988a) who observed that, the hybrid NB18 ×NB7 with pebrine infection recorded decreased ERR of 77.44 per cent to un inoculated compare to distilled water treatment 79.83 per cent.

Table 1: Effect of *Nosema bombycis* infection on fifth instar larval duration of PM and CSR2 (third, fourth and fifth instar inoculation).

	Pure Mysore			**CSR2**		
Inoculation	**Healthy**	**Infected**	**Mean**	**Healthy**	**Infected**	**Mean**
Third instar	9.67	14.33	12.00	8.50	12.00	10.25
Fourth instar	9.67	15.67	12.67	8.33	12.00	10.17
Fifth instar	9.33	12.00	12.67	8.33	10.33	9.33
Mean	9.56	14.00		8.39	11.44	
	A	B	C	AB	AC	BC
F test S. Em.± CD @5%	* 0.296 0.864	* 0.296 0.864	* 0.362 1.058	* 0.419 1.221	* 0.513 1.496	* 0.513 1.496

Table 2: Effect of horizontal transmission of *Nosema bombycis* infection on effective rate of rearing (%) of PM and CSR2.

Instar	**PM**		**Mean**	**CSR2**		**Mean**
	Healthy	**Infected**		**Healthy**	**Infected**	
Third	82.00	14.75	48.37	81.75	41.75	61.75
Fourth	83.25	49.25	66.25	80.50	45.50	63.00
Fifth	86.75	85.00	85.87	83.25	60.00	71.62
Mean	84.00	49.66		81.83	49.08	
	A	B	C	AB	AC	BC
F test S.Em± CD @ 5%	NS 0.96 2.86	* 0.96 2.856	* 1.220 3.498	NS 1.409 4.040	* 1.725 4.947	* 1.725 4.947

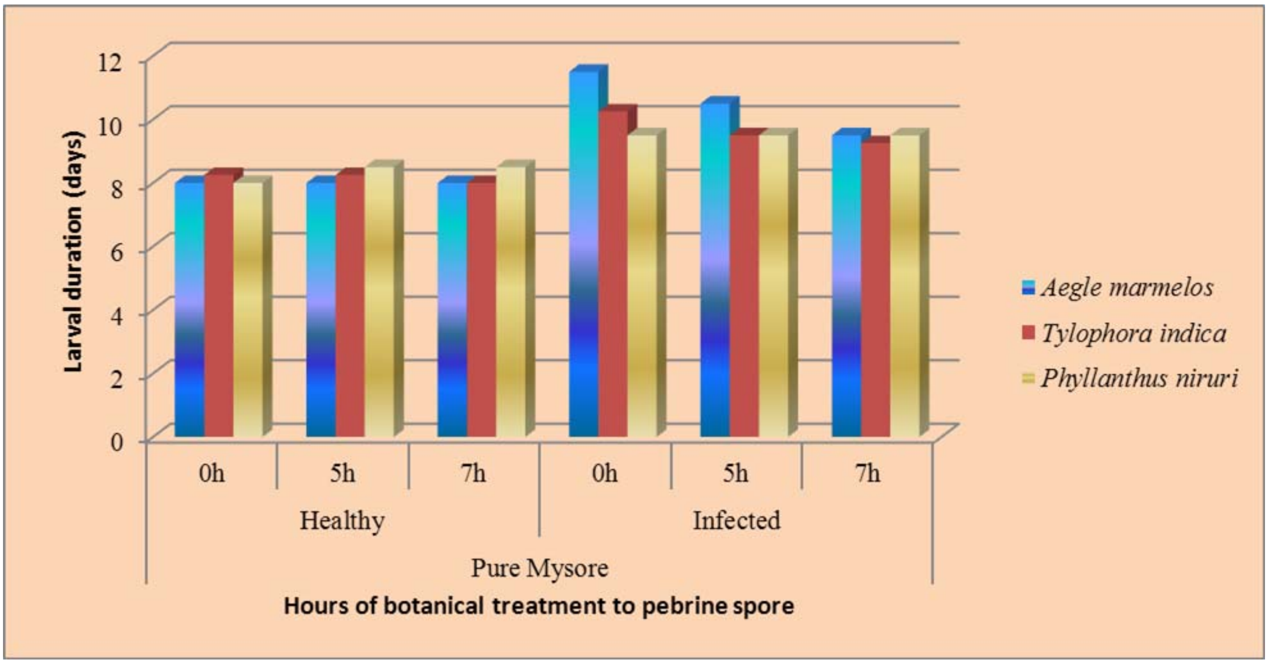

Fig 1: Influence of botanical extract treatment to *Nosema bombycis* Naegeli on fifth instar larval duration of PM (days).

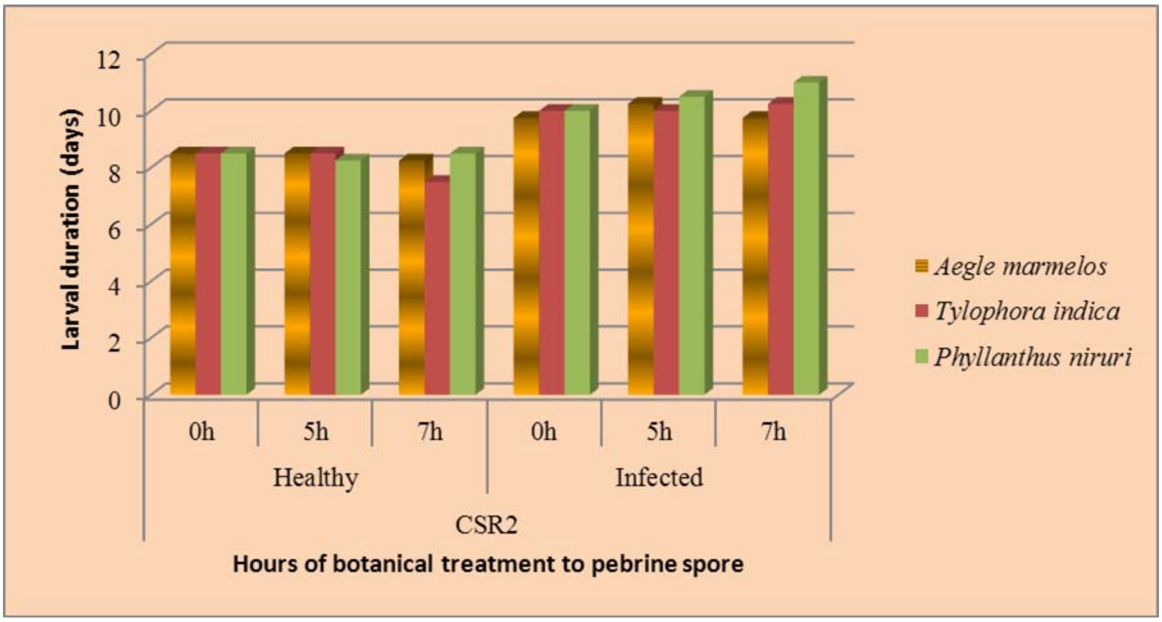

Fig 2: Influence of botanical extract treatment to *Nosema bombycis* Naegeli on fifth instar larval duration of CSR2 (days)

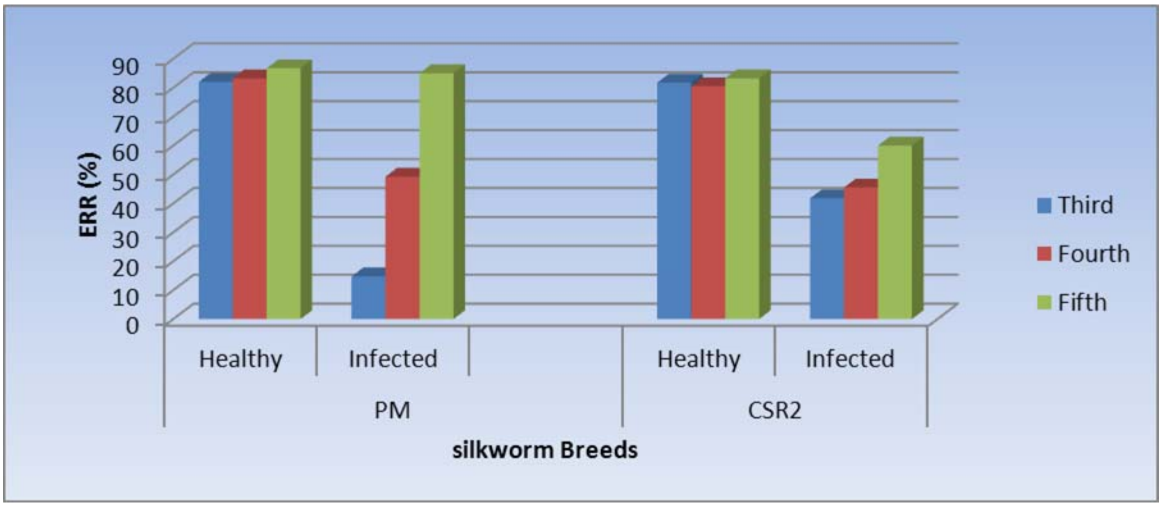

Fig 3: Effect of horizontal transmission of *Nosema bombycis* Infection on effective rate of rearing (%) of PM and CSR2.

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In vitro **and** ***in vivo*** **use of botanicals against** ***Staphylococcus*** **sp and its impact on economic parameters of silkworm**

By

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The occurrence of grasserie (viral), flacherie (bacterial), muscardine (fungal) and pebrine (protozoan) in silkworm are the major reasons for the wide gap in terms of quality, quantity and productivity of raw silk. Of these diseases, bacterial flacherie is one of the serious diseases of silkworm causing cocoon crop loss to the tune of 70 per cent in India and caused by different species of bacteria individually or in combination. *Staphylococcus* sp. is also

responsible for flacherie in silkworm. The use of chemicals for the control of silkworm diseases caused adverse effects on growth and development of silkworms. Botanicals are considered as safe alternatives of synthetic chemicals and drugs against microbial pathogens. Hence, the present investigation was made on the botanicals *viz.,* rhizomes of turmeric (*Curcuma longa)* and leaves of amla (*Phyllanthus emblica*), roots of asparagus (*Asparagus racemosus*), bael (*Aegle marmelos*), boerhavia (*Boerhavia diffusa)*, garlic (*Allium sativum)* and basil (*Oscimum basicilum*) against *Staphylococcus* sp. *via in vitro* by disc diffusion method. *In vitro* studies revealed that Basil showed inhibition zones of 8.0 and 8.5 mm at concentrations of 20,000 and 30,000 ppm followed by Asparagus which showed inhibition zones of 7.0 and 7.9 mm at 20,000 and 30,000 ppm respectively. The *in vivo* use of botanicals against *Staphylococcus* sp. in silkworm and its effect on growth parameters were also studied. Basil recorded significantly lower mortality of 13.33 per cent on larvae followed by asparagus (22.2%). The mortality in pathogen treated control was significantly high (73.30%). The ERR% was found to be significantly more in treatments with basil (78%) and asparagus (70%). The survivability was poor in treated control (24%). The larval and cocoon weight in treatments with basil (3.7g &1.82g) and asparagus (3.6g &1.71g) were significantly higher. The treated control recorded significantly lower larval and cocoon weight (2.7g & 1.10 g). Shell weight was significantly higher in treatment with basil (0.30g) which was on par with untreated control (0.31g) followed by asparagus (0.28g). The shell weight was significantly lower in treated control (0.13g). The treatments with basil (16.48 %) and asparagus (16.37%) showed significantly higher shell ratio and it was low in treated control (12.20%). It is concluded that basil and asparagus showed promising antibacterial activity against *Staphylococcus* sp. thereby control of disease as well as increase in economic parameters of silkworm which results in higher silk production.
Keywords: Flacherie, *Staphylococcus*, silkworm, Basil, Asparagus and growth parameters

Impact analysis of Insect pests on muga silkworm, Antheraea assama (W.w) (Lepidoptera: Saturniidae)

By

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Muga silk worm being out door crop loss due to insect pests is a major problem encountered by the muga farmers. The loss due to these insect pests is alarmingly high in pre seed (Aherua &Jarua) and seed crops(Chotua &Bhodia) compared to the commercial crops(Jetha & Kotia).A preliminary study in 2010 & 2011 revealed 12 (twelve) insect pests belonging to the family Tachnidae, vespidae, Ichnemonidae, Braconidae, Formicidae, pentatomidae, and Mantidae infesting the silkworm. These insect pests are classified depending upon their period of activity and intensity of attack .Amongst the insect pests that attack muga silkworm, the most formidable ones are dipteran endo parasitoid, Exoriseta sorbillans widemann, otherwise called the uzifly with 25% damage in the 4^{th} &5^{th} instars larvae and 20% at harvesting stage of cocoons during chotua crop (March-April) and the wasp, Vespa orientalis with 50% damage during Aherua (May-June) and Bodia (Aug-Sep) crop. Application of insecticides for

control of the insect pests is not advocated in muga rearing as it is leathel to silkworm itself .future research must focus on environmentally sound pest management strategies that are compatible with the needs and limitations of farmers. A detailed description on the pests, cultural methods of control, and integrated pest management for each pest is discussed briefly.
Keywords: Antheraea assama, seasonal incidence, insect pests, integrated pest management.

The ability of AcMNPV to infect *Bombyx mori* (Lepidoptera, Bombycidae) silk glands in a permissive strain is affected by the presence of some viral enzymes

By

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(POSTER)

Some baculoviruses are known to cause liquefaction of larval bodies in Lepidopterans, during the final infection phase. This phenomenon is caused by some viral enzymes that attack the insect cuticle. For the first time we demonstrate that only wild-type baculoviruses, naturally endowed with cathepsin and chitinase, are able to cause silk gland infection in permissive silkworms, while the deletion of the genes encoding these enzymes doesn't result in silk gland infection.
Larvae of a permissive silkworm strain have been infected both with recombinant and wild-type AcMNPVs and the differences in the progression of the virus infection in the larval body have been evaluated by using different approaches. On this basis, we put forward some different hypotheses on the modalities of the virus entrance into the silk glands.
Keywords: baculovirus proteases, silkworm, infection

Section 7. Silkworms as biological models.

Development of silkworm (*Bombyx mori*) as a platform for producing biomaterials and growth factors for Tissue Engineering

By

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(ORAL PRESENTATION)

The discovery of the pluripotency of stem cells in the past decade, opened the way to isolate and grow this type of cells, that after an adequate differentiation process, are able to regenerate whole human organs. This concept created the entirely new disciplines of Regenerative Medicine and Tissue Engineering. An essential requirement for this paradigm to work is the availability of a new generation of 'smart' biomaterials and scaffolds that have not only an estructural role in the support of cells, but also activate their differentiation by providing the needed chemical and topographic signals. There is a growing evidence that silk fibroin is one of the best biomaterials available for this task, in terms of biocompatibility, mechanical resistence and surface bioactivity. Moreover, silkworm larvae and pupae can be used as biorreactors that after inoculation with genetically modified baculovirus vectors are able to produce recombinant growth factors for cellular differentiation. In the present communication, it is exposed the research of the IMIDA of Murcia (Spain) in the development of an integrated platform for Tissue Engineering based on silkworm. This platform produces growth factors (bFGF) and proteins by baculovirus expression in pupae. The remaining silk is processed to extract the fibroin to fabricate several types of cell scaffolds. And the sericin is used as a component of cellular growth media. In this way, all the three products of the cocoon are used in a high value biomedical package, providing a higher value to silkworm rearing.
Keywords: scaffolds, stem cells, Regenerative Medicine

Development of new methods for long term preservation of silkworm bioresources

By

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(ORAL PRESENTATION)

There are many kinds of strains or races in the domesticated silkworm, *Bombyx mori* due to the importance for the sericulture and experimental animals. We can estimate that there are more than 2000 strains of *B. mori* in Japan. These bio-resources usually have to be reared at least once a year for preservation, because the available period to preserve dormant egg is only one year. The rearing of silkworm, however, is needed a number of hard works such as management of mulberry garden, preparing rearing room, every day care for individuals etc.

To reduce these hard work and for safety preservation of them, some studies for the long-term preservation had been done, and reported. Those studies are mainly classifying into two categories: one is using frozen sperm and the other one is frozen ovary. In this study, we focus on the use of frozen ovaries and testes. We show that improvement of cooling procedure of donor tissues and the application of special operation in the transplantation step are effective for getting high survival ratio.

Keywords: ***Bombyx mori***; Silkworm; Cryo-preservation;Bio-resources; Testis; Ovary

SCREENING OF INDUCIBLE IMMUNE PROTEINS FROM SILKWORM BOMBYX MORI BY TWO DIMENSIONAL ELECTROPHORESIS

By

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Amongst all the living species insects occupy more than 50% of the current biodiversity. Insects are evolutionarily successful organisms and occupy almost all habitats in nature. Insect immune response is comprised of cellular and humoral components; the humoral component comprises of antibacterial proteins which are inducible. Antibacterial proteins are an important component of insect immunity. Among the insects, only the dipterans (Drosophila and various mosquito species) have been widely investigated for their immune responses towards diverse pathogens. In the present study, we have attempted to investigate the immune transcriptome of the lepidopteron insect silkworm *Bombyx mori* L. We studied the bacterial infected silkworm haemolymph by SDS-PAGE & 2-DE (Two- Dimensional Electrophoresis) to identify the immune proteins. Differentially expressed protein were isolated and characterized by MALDI-TOF analysis. A novel antibacterial protein in 5th instar 4th day of immunized haemolymph of 31.8 KDa M.W. was characterized and concluded as an active protein involving immunity in *B.mori*.

Keywords: Silkworm, Immune proteins, Two dimensional electrophoresis, hemolymph.

Section 8. Possibilities for Using Silkworm and Mulberry for Non-Textile Purposes.

The role of science in building value chains for sericulture: the silkworm as food for pet animals

By

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(ORAL PRESENTATION)

ABSTRACT: To revitalize sericulture in Europe for new value chains a particular effort in studying alternative uses of silkworm larvae should be performed.
In this paper we focused on feeding a very popular domestic reptile, *Eublepharis macularius* (leopard gecko) with *Bombyx mori* in comparison instead of other more spread food insects. Growth and reproduction behaviour of *E. macularius* in response to the two different diets have been studied. The animals were fed ad libitum on fresh preys and they underwent optimal rearing conditions for their species (temperature and photoperiod),in addition to being kept into individual cages.
The experiment lasted one year, i.e. from the reptile egg hatching to their sexual maturity, mating and pregnancy of the female individuals. We weighed the animals monthly and studied their growth profile and index, in addition to reproduction behaviour.
Furthermore, we carried out chemical and microbiological analyses on the insect food, to differentiate it according to the species.
On the whole, we proved that *Bombyx mori* constitutes a very good food for reptile pet animals.
Keywords: *Eublepharis macularius*, leopard gecko, silkworm

MATERIALS AND METHODS

Geckos: In our experiment we used 6 newly hatched geckos coming from a local company that works with pets and products concerning their rearing (food, cages, accessories). After dividing the geckos in two groups we started feeding them in two different ways: the first group fed on a typical reptile diet made by mixed insects (*Acheta assimilis, Tenebrio molitor, Galleria mellonella, Zophobos morio*), while the second group fed only on silkworms.

Silkworms: We used a four-way polyhybrid created at CRA- API of Padua. The silkworms were fed on leaves during spring and summer or on artificial diet (Cappellozza, 2005 and 2009) during autumn and winter. This allowed the use of the insects throughout the year.

Analysis: We analyzed the various types of insects used to feed the geckos from a nutritional point of view, checking the composition in kilocalories, proteins, carbohydrates and lipids (Baldini, 1996). We compared the two groups of geckos to establish if the different feeding could change or compromise any aspect of their life (growth, maturation, behaviour). A veterinarian visited the geckos every two months to check the various parameters of growth and to assess if there were particular problems during their rearing (Gauthier, 2010).

RESULTS

The comparison between the two groups of animals from a developmental point of view did not display any substantial difference. Both groups grew in a normal way, without presence of particular illnesses or problems. After one year of growth they mated and the females layed the eggs. After 40-60 days the eggs hatched well ad we had new healthy geckos.
The only difference the veterinary could find regarded the fat content of the animals, which was higher in the control group (the one fed with the mix of insects) with respect to the silkworm group.

To test the nutritional properties of the silkworm *B. mori* and to compare it with the other insects used during the experiment we carried out chemical analysis concerning the content of proteins, carbohydrates and lipids in the different species.
Figure 1 describes the results obtained from the analysis. In particular the silkworms contain lower levels of lipids than all the other species, while the level of proteins is high. This finding is important for breeders who attempt to avoid diseases due to a too high level of fats in their pet animals.

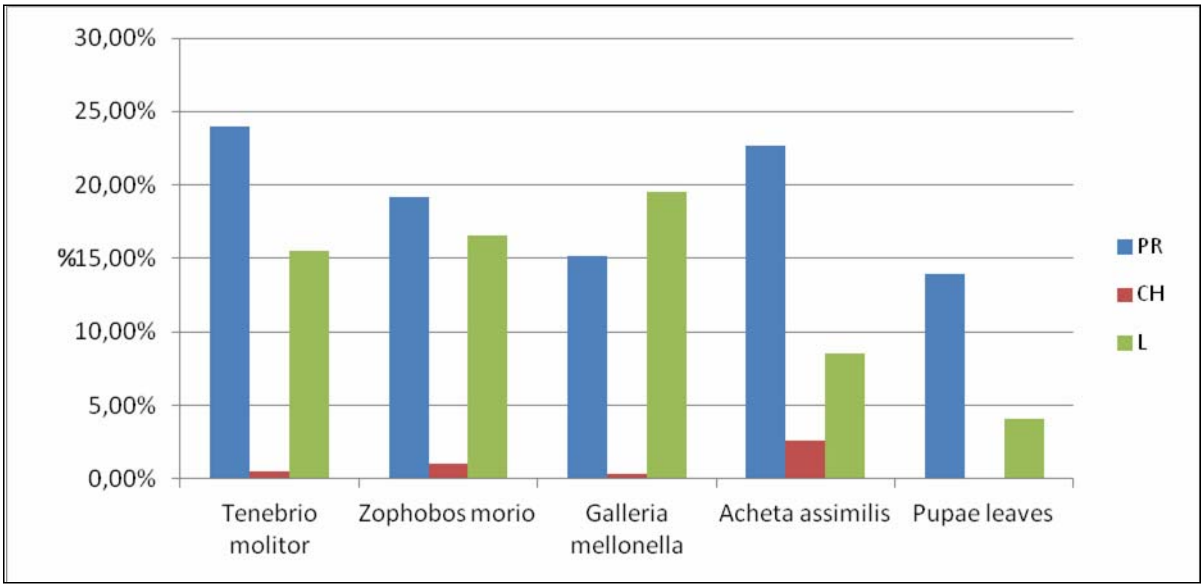

Fig. 1. Comparison of contents among different insect species. In this case the analysis of *B. mori* individuals was carried out on pupae generated from larvae fed on leaves.

PR: proteins, CH:carbohydrates, L: lipids. (from Belluco's master degree dissertation)

In addition to this type of analysis we considered also the content of individuals of each larval instar, to see if the nutritional properties of silkworms can be considered constant during all the rearing period. Data summarized in Table 1 point out that the lipid level remains low during all the developmental cycle, in comparison with the other insects used to feed geckos.

	Kcal	**KJ**	**PR**	**CH**	**L**
Silkworms leaves I instar	72	302	13,5	0,1	1,9
Silkworms diet I instar	72	304	13,1	1,3	1,6
Silkworms leaves II instar	58	245	9,2	2,4	1,3
Silkworms diet II instar	58	243	11,7	<0,1	1,2
Silkworms leaves III instar	66	277	9,2	2,1	2,3
Silkworms diet III instar	57	240	10,4	0,9	1,3
Silkworms leaves IV instar	56	237	9,3	1,6	1,4
Silkworms diet IV instar	69	289	9,4	2,4	1,4
Silkworms leaves V instar	67	283	8,8	2,2	2,6
Silkworms diet V instar	105	440	17,5	0,1	3,8
Pupae leaves	93	392	13,9	<0,1	4,1
Adults leaves M	208	866	17	0,4	15,4
Adults leaves F	102	429	17,3	1,2	3,1
Tenebrio molitor	238	990	24	0,5	15,5
Zophobos morio	230	958	19,2	1	16,6
Galleria mellonella	238	985	15,2	0,3	19,5
Acheta assimilis	178	745	22,7	2,6	8,5

Tab. 1. Nutritional profile of different instars of *B. mori* and different insect species. For each silkworm instar there are two values, obtained from larvae fed on leaves or on diet. These values are calculated for 100 grams of product.
PR: proteins, CH: carbohydrates, L: lipids. (from Belluco's master degree dissertation)

By considering the nutritional aspects, the easiness of having silkworms all the year long and the totally comparable development of the two groups of animals examined in this experiment it is possible to conclude that silkworms can surely be used as a unique food for the leopard gecko, *Eublepharis macularius*.

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The effect of blood Glucose lowering of the silkworm extracts in the db/db mice

By

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(POSTER)

The glucose lowering activity of silkworm extract was examined in db/db mice. which is a sp ontaneously hyperglycemic, hyperinsulinemic and obese animal model. The silkworm extract s and acarbose were administered orally with 180mg/kg, 90mg/kg, 45mg/kg and 22.5mg/kg of silkworm extracts and 50mg/kg of acarbose for 4 weeks.
Feed and water intake were not significant changes statistically when compared between control group and silkworm extracts treated group. The body weight was also not change.
Silkworm extract powder 22.5 mg/kg/day group compared with the control group after administered 4 weeks, a statistically significant decreased the blood glucose level.
Blood biochemical changes of the AST, ALT, TCHO, TG, LDL and HDL did not observed.
But blood biochemical changes of the GLU decreased statistically significant in 22.5 mg / kg / day group compared to the control group. The epididymal fat weight of silkworm extract powder treated were decreased significantly observed in 22.5mg/kg and 180mg / kg / day group compared with the control group. Perirenal fat weight, however, there were no significant changes in the statistical.
Based on these results, it is considered that the silkworm extracts has favorable effect to inhibit the change on the blood glucose levels in diabetes model mice.
Key words: *Bombyx mori*, Silkworm, Glucose, Diabetes, Extracts

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Assessment of quality parameters of chitosan extracted from mulberry silkworm pupae

By

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The quality parameters of chitosan extracted from mulberry silkworm pupae by chemical and enzymatic methods were investigated. The results revealed that the chitosan extracted by chemical method contained moisture content of 7.09 per cent, nitrogen content of 3.32 per cent and ash content of 0.37 per cent which are lower when compared to enzymatic method (8.55 %, 4.04 %, 0.41 %). Higher viscosity of chitosan of 71.4 (cP) was found in chitosan prepared by enzymatic method than chemical method (54.8 (cP)) whereas lower viscosity of 47(cP) was found in chitin extracted from de-oiled pupae. It was found that that the viscosity of chitosan decreases with increase in concentration of NaOH and with increasing temperature. Higher deacetylation per cent of 97% was found in chitosan prepared from oil extracted pupae and lower deacetylation of 46.55 per cent was observed in chitosan prepared from enzymatic method of deproteinization. Higher moisture adsorption of chitosan (13.68 %) was observed in mulberry pupae chitosan in 6^{th} day of the treatment, followed by 7^{th} (13.65 %) and 8^{th} day (13.55) of the treatment. Moisture adsorbing capacity of chitosan increases significantly with duration of exposure upto 7 days of treatment and increases with increase in relative humidity.
Keywords: Chitosan, Silkworm pupae and Quality parameters

Section 9. Economy: Domestic and international markets, prices, trading, economic analyses of projects etc.

Sustainable Design in Bridalwear Sector: Proposal for Reuse of Local Silk Fabrics in Bridalwear

By

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(ORAL PRESENTATION)

ABSTRACT: 70 % of the bridalwear production of Turkey is met by Izmir. The city is already starting to be recognized as a mass producer of the bridalwear like Milano or Barcelona. At the same time, Izmir's bridalwear industry is strenuously growing in production, marketing and branding internationally. Bridalwear sector in İzmir is continuing to increase its importance as a creative industry. This situation is bringing Turkey to an important position as a supplier for Europe and Middle Eastern countries. According to the data of Istanbul Bridalwear Exporters' Association there take place between 600 000 and 700 000 marriages every year. 350 000 of these mass produced wedding gowns are rented, 250 000 are bought. With these numbers, the bridal gown sector's value in Turkey is reaching close to 650 million US dollars. The fact that bridalwear sector is clustered in Izmir has facilitated the use of locally produced fabrics in this industry. There are also silk weaving firms among local fabric producers around Izmir. The silk fabric producers are applying experimental finishing techniques to extend their market. Some of the fabrics are being damaged due to this process. In the content of the research, a proposal for the reuse of the damaged silk fabrics is developed. In this paper, it is intended to present the examples of machine producible embroidery designs of these surplus silk fabrics.

Keywords:Silk, bridalwear, sustainable design

Fashion reflects current trends of contemporary living, and it can be said that ecology and sustainability are becoming important issues in today’s society (Hallett and Johnston, 2010, p: 168). Different solutions as sustainable design strategies are preferred by companies which operate in eco fashion industries. The goal of sustainability is to create a system which can be supported continuously in terms of environmentalism and social responsibility. While environmentalism in the fashion world developed through a donation of a percentage of sales to a charitable cause, fashion designers are now re-introducing eco-conscious methods at the source through the use of environment conscience materials and production. It can be said that sustainable fashion’s principles are to reuse- not bought new; to reduce-by choosing products made with environmentally friendly production processes; to recycle- making garments from a previously existing item (Fletcher, 2008, p: 95). Sustainable fashion, which started as a trend, will become a real part of the market that affects designers, retailers and consumers in a short time (Hallett and Johnston, 2010, p: 168).

“Yesterday’s textiles are tomorrow’s toxins” is a quotation from Quinn (Quinn, 2010, p: 109). He explains that fabrics like fleece, flannel, corduroy, cotton, nylon, denim, wool, and linen may be donated to charitable organizations when their use is no longer possible. The other remainder of the used textiles goes to either a textile recovery facility or an estimated 1 million tonnes of fabric waste ends up in landfills each year. Clothing can take decades to decompose, leaving behind hazardous chemicals and harmful gases (Quinn, 2010, p: 109).

Using textiles creating harmful emissions, and using chemical processes to finish the fabrics is discouraged in fashion industry. Large fashion companies encourage over production of garments in order to reduce unit cost which results in a considerable amount of unsold garments, which are afterwards discarded as waste (Quinn, 2010, p:109).

- An estimated 13.1 million tons of textiles were generated in 2010, or 5.3 percent of total municipal solid waste (MSW) generation.
- An estimated 14.0 percent of textiles in clothing and footwear and 17.1 percent of items such as sheets and pillowcases was recovered for export or reprocessing in 2010.

The recovery rate for all textiles was 15.0 percent in 2010, 2.0 million tons.

It was estimated that 1.3 million tons of textiles in clothing were recovered for recycling in 2009. (http://www.epa.gov/osw/conserve/materials/textiles.htm, 27.02.2013)

New methods of constructing and consuming textiles that challenge traditional ideas about their use, function, life cycle and disposal are developed. Researches on sustainable clothing offer several ways of reusing textiles for the whole of their lifespan. Innovations to create new fabrics from recycled synthetic materials are transforming thermoplastic waste into interim textile products. Even ragged, unusable fibers can be used to produce new textiles (Quinn, 2010, p: 120). Developments in technology offer different fabric construction methods that enable use of various materials. New trends adopted by fashion designers also give way to use of these resources in more appealing and desirable products. Cotton can be made into pieces of fabrics or form a component for new high-quality paper. Knitted or woven woolens and similar materials are "pulled" into a fibrous state for reuse by the textile industry in low-grade applications, such as car insulation or seat stuffing. Other types of fabric can be reprocessed into fibers for upholstery, insulation, and even building materials. Buttons and zippers are stripped off for reuse (http://www.epa.gov/osw/conserve/materials/textiles.htm, 27.02.2013).

The growing movement to produce sustainable textiles advocates environmentalism, economics and social responsibility. Attention is drawn to the impact that the textile production can have on the environment, recommending the use of new production methods that reduce the industry's carbon footprint (Quinn, 2010:109). Some designers are supporting sustainability because the production of more materials is not a viable solution. Textile specialists and fashion designers are working together to encourage manufacturers environment friendly materials and develop socially responsible methods for clothing production. The most important challenge for designers is, to transform discarded industrial fabrics into textiles that are as beautiful as they are sustainable and this process is known as "up-cycling" which means converting waste materials or useless products into new materials or products of better quality or for better environmental value (Hallett and Johnston, 2010, p: 17). Up-cycling is the opposite of down-cycling, which is usually applied as recycling methods. Down-cycling is the process of converting materials and products into new materials of lesser value or quality. Most recycling involves converting or extracting useful materials from a product and creating a different product or material. There are examples of designers recycling the garments that result from overproduction. In this research it is intended to find ways to transform discarded industrial silk fabrics into valuable, desirable and sustainable products by using fabrics of production failure in adherence to industrial production methods.

Natural fabrics have been fashion designers' frequent choice, but silk has remained as the designers' dream. Silk is such a seductive, luxurious and desirable fiber that its price has, at times exceeded that of gold (Hallett and Johnston, 2010, p: 105). Designer Julian McDonald says: "As far as I'm concerned nothing will ever replace silk. It can look tenderly feminine or high-tech, timeless or cutting edge." (Hallett and Johnston, 2010, p: 112) Silk is still a precious natural material used for high value garments such as evening dresses and wedding gowns.

The growing bridal wear industry which is settled around Izmir, is considered as a potential market for the proposed sustainable value added fabric designs. 70 % of the bridal wear production of Turkey is met by Izmir. At the same time, Izmir's bridal wear industry is strenuously growing in production, marketing and branding internationally. This growth is carrying Turkey to an important position as a supplier for Europe and Middle Eastern countries. According to the data of Istanbul Bridal wear Exporters' Association there are between 600 000 and 700 000 marriages taking place every year in Turkey. 350 000 of these mass produced wedding gowns are rented, 250 000 are bought. With these numbers, the bridal gown sector's value in Turkey is reaching approximately to 650 million Dollars.

Number of employees in the bridal wear industry is roughly 80,000. Products are not solely consumed in national market. Some are exported to Spain, Italy, Portugal and Russian Federation. Turkey's annual exports of wedding dresses excluding the shuttle trade counts were around 400,000 units in 2011 (İSEİD, 2012).

Recently Turkish wedding gowns are demanded especially in Middle East and European market (İSEİD, 2012). European economic crisis caused a shift in global wedding gown brands towards Turkey (EGSD, 2012). For this reason Bridalwear industry in Turkey has a potential of increasing employment and being promoted in international markets (İSEİD, 2012). Bridal wear industry operates at evening dresses, bridesmaid and groom dresses, as well as bridal gowns (EGSD, 2012).

Aegean Clothing Manufacturers' Association, and Turkey Federation of Fashion and Apparel have been organizing the largest Bridal wear, groom suits and evening dress fair of Turkey that is known as IF Wedding, since 2006. IF Wedding, has become the 3rd biggest wedding fair of Europe in 2012. This fair received 188 participants from 60 countries in 2011 and has been visited by 15.010 professionals. In this fair international wedding gown companies are represented by their distributors. This growing fair provides a professional international environment for local companies.

Visitor profile of the fair is a combination of retailers (chain stores, boutique owners), producers, whole sellers (agencies & distributors), designers, exporters and importers, textile and apparel associations and public textile institutions, fashion design departments of universities and fashion media (IZFAŞ, 2012). The table 1 shows statistics about the fair.

Table 1: Izmir International IF Wedding Fair Statistics

	YEAR					
	2007	2008	2009	2010	2011	2012
Domestic Participants	75	160	138	156	188	188
Foreign Participants	0	0	0	0	0	14
Domestic Visitors	4.687	14.356	16.400	13.541	13.375	14.053
Foreign Visitors	177	339	504	556	410	902
Number of Visiting Countries	21	34	42	47	59	59
Total Area (m^2)	4.000	20.000	15.000	11.133	12.754	26.600

Resource: EGSD secretary.

The bridal wear industry that has been concentrated around Izmir, is definitely a potential area of consuming textiles. The majority of the companies prefer to use PES or Viscose fabrics. In the content of the research, a proposal for the reuse of the damaged silk fabrics is tried to be developed. It is aimed to raise the quality of the fabrics that are presented to customers without changing the prices while saving the wasted fabrics and reusing them with added value.

The use of locally produced fabrics in this industry may be facilitated as the bridal wear sector is clustered in Izmir. There are some silk weaving firms among local fabric producers in and around Izmir which weave silk traditionally for centuries in Odemis and Kızılcaboluk towns near Izmir. The silk fabric producers are applying experimental finishing techniques to increase fabric variety in order to extend their market however some of the fabrics are damaged during these experiment processes.

The first sample selected for this research is a wasted silk damaged during removal of sericin and the second sample is damaged during the dying process. As they became useless in terms of industrial processing in classical understanding, and lost a percentage of their value, these damaged silk fabric samples are very well matching for upcycling useless textile materials in order to achieve higher quality of products.

One of the upcycling methods employed in this study is decorating fabric surface by using embroidery machines that lays piping pieces on tulle fabric that were cut and wind on reel formerly. Another one is constructing a new surface using same sort of piping and same embroidery machine embroidering the piping on heat-n-gone (melted with heat of press) or wet-n-gone (water soluble) stabilizers. After the removal of the stabilizer the new lace-like fabric is obtained. This kind of manual surface constructing methods was applied in the past. In this research we offer industrial embroidery techniques which developed in the last decade considerably.

The selected piece of damaged silk fabric supplied from Kızılcaboluk, is cut diagonally into parallel pieces in order to obtain piping material. The piping is applied on a tulle fabric via embroidery machine. The principle of this embroidery machine is laying pipes on the fabric as programmed in the design and applying them onto the fabric using stitches. This machine allows designers to lay pipes up to 5 cm of width. The width of the pipes used in this project is set as 1.5 cm due to the pattern design. Pipes were cut with bias cutting machine.

Actually there are 3 ways of cutting pipes out of fabric. These are soldering, bias cutting by a machine processing fabric with cold knives and laser cutting. **Soldering** is preferred with synthetic fabrics. The pipe edges, which are trimmed using heated soldering iron along warp direction, are clean. This method prevents fringes however the touch of the fabric becomes stiff. **Bias cutting machine** operates with a (cold) knife and it is usually preferred with natural fabrics. After bias cutting fringing may be observed however this method is preferred for it does not cause stiffness or burnt on the edges. **Laser cut** is the most flexible method in cutting out piping as it enables variety of forms of it. Either natural or synthetic based fabrics can be cut into pipes using laser. The edges are neatly trimmed. Nevertheless the amount of investment required is relatively high; it necessitates higher skills for operating and it may result with edges burned due to false operating.

Silk piping used in this study is obtained using bias cutting method at an angle of 45^0. Although the lose weave of the fabric caused fringing, these fringes helped to get a different surface design. The pattern selected for embroidering piping on tulle fabric gives users the opportunity of using the fabric as a whole or cut into the repeats in order to be used as an appliqué on a garment. When using as applique the tulle fabric was used as basement which holds the pipes together. The tulle fabric will not appear as a part of the pattern. Bias cut pipes created using silk fabric, gives a far softer touch when it is compared to the polyester piping obtained by soldering which is mainly preferred in the market.

For the first fabric prototype for this study 1,4 m of new tulle fabric is obtained from 1 m of damaged silk fabric which was cut diagonally for piping. The price of the new fabric per meter is calculated around 25 EU. Usual PES version of this pattern is sold at the price of 19 EU. The price of damaged silk fabric was about 3,5 EU per meter while PES is 2,5 EU. Tulle fabric costs less than 1 EU per meter. The rest of the value is added with embroidery process, pattern and seasons piping trend.

For the second fabric prototype constructed for this study 1 m of damaged silk fabric which was cut diagonally for piping. The price of the new fabric per meter is calculated around 25 EU. Usual PES version of this pattern is sold at the price of 19 EU. The price of damaged silk fabric was about 3,5 EU per meter while PES is 2,5 EU. Tulle fabric costs less than 1 EU per meter. The rest of the value is added with embroidery process, pattern and seasons piping trend.

Table 2: Added Value Comparison of Silk and PES fabric samples

	Price of the piping fabric per meter	Embroidery cost	Total cost	Price of the new constructed fabric per meter
First sample	3,5 Euro	6 Euro	9,5 Euro	25 Euro
PES version of the first sample	2,5 Euro	6 Euro	8,5 Euro	19 Euro
Second sample	10 Euro	8,5 Euro	18,5 Euro	50 Euro
PES version of the second sample	2 Euro	8,5 Euro	10,5 Euro	17 Euro

The technologies give us possibility of using a combination of sequin or other embroidery techniques together with piping.

Aware and conscious consumers are increasingly responding well to the sustainable and ethical developments in textile and fashion industry. With consumers making more aware choices, the companies which don't develop their sustainable strategies face risk of losing market share (Hallett and Johnston, 2010, p: 167). As a result of this study, damaged silk fabrics which were about to end their life cycle in the waste, are reconsidered and reused in a wider context than the primary creative and technical processes and were upcycled and into acceptable textile products.

Photo1:Damaged silk fabric sample

Photo:2 Bias cut silk piping (with fringes)

Photo:3 Silk piping embroidered tulle fabric

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Life Cycle Analysis of Embodied Energy on Sericulture in Karnataka India

By

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(ORAL PRESENTATION)

**ABSTRACT: The environmental impact of textile production is an area of increasing focus for both regulation and consumers. Life Cycle Assessment (LCA) is a framework to determine actual and potential environmental impacts associated with products and services and identifying efficient opportunities for reducing burdens. With few exceptions, such LCA data is available on the primary production of textiles. Despite its high profile, no prior LCA studies of sericulture and silk reeling have been performed.
We conducted an LCA of silk yarn production in India using data from a pilot survey performed in Karnataka state. The study focused on cumulative energy demand (CED). Our results indicate that on a mass flow basis the Indian silk studied was a highly resource intensive product. Calculated CED values were above 1800 MJ/kg, significantly higher than for comparison fibres. Survey results further indicate that most sampled farmers diverge from guideline values in fertiliser application. The identified hotspots of energy use in irrigation and reeling energy use suggest that these would be effective areas of focus in increasing silk sustainability.**
Keywords: Raw silk production, Silk reeling, Cumulative energy demand

Introduction

Environmental concerns are increasing over the ecological production costs of fibre materials for textile, composite and other applications. Embodied energy, water consumption, resource use and ecological impact of textile fibre production, processing and disposal are of increasing concern to consumers, manufacturers and government. The potential deleterious impacts of large-scale cotton production on for example water resources are well studied (Chapagain et al. 2006) and undoubtedly influence consumer purchasing decisions. Studies argue the relative merits of manmade fibres over natural fibres or vice versa (Cherrett et al. 2005). In most cases, such studies use the Life Cycle Assessment (LCA) methodological framework.

While silks are commonly perceived as being wonderfully sustainable materials they should be no exception to rigorous analysis taking into consideration fundamental ecological concerns about issues such as water use and heating costs. Hence it is surprising that as yet there has been no cradle-to-gate LCA study of the environmental impact of silk production although specific Material Flow Analyses have been performed on the Indian silk reeling sector (Shenoy et al. 2010). The objective of our research presented here is to examine the energy requirements of raw silk production processes in the context of the quantitative LCA methodology. Cumulative energy demand (CED) is used as the indicator of energy requirements. CED covers the energy requirements through the life cycle, including direct and indirect uses of energy, of most relevant processes and sub-processes that go into the manufacture of the material. It has been widely use as indicator and it is considered a good “entry point” into LCA (Hischier et al. 2010).

Life cycle assessment is an internationally standardised method to evaluate the impact of a good or service. It quantifies relevant emissions and resources consumed during the life cycle of products and their potential impact to health and environment (European Commission, 2010). It is widely used as a decision support tool for various purposes. It has been used to assess the trade-offs of production methods (i.e. organic vs conventional farming) (Meisterling et al. 2009), identify environmental hotspots (Roy et al. 2009) and in green public procurement (European Union, 2011).

The data from the different stages of the product is collected and aggregated according to standard methodologies into relevant impact categories. The choice of which impact categories to study depends on the purpose of the study. Commonly included for textiles are cumulative energy demand (CED), global warming potential (GWP) or water use (Shen et al. 2010).

The LCA can cover all the stages of the life cycle, production, distribution, use and end of life (cradle to grave studies). The boundaries of the modelled system depend on the extent of the life cycle studied. We have focused on the production side (cradle to gate) of silk as it is the most distinctive part of the life cycle and a first LCA of silk dying is available (Sara & Tarantini, 2003).

When LCA is used to compare different production systems or products, care should be taken to ensure the consistency of the datasets, as not all studies use the same methodologies or consider the same boundaries (Bessou et al. 2012). Ultimately the applicability of the LCA will be determined by the scope of the study, its intended application, and the extent to which hotspots and inefficiencies in production are identified.

An LCA requires data collection of different flows of energy and materials in and out of the production system, compiled in a life cycle inventory (LCI) characterizing different process and materials. Databases such as Ecoinvent compile thousands of common datasets that can be used as background data for specific processes concerning silk production. Most of the available data refers to Europe, while silk is mainly produced in a completely different context. Thus primary data from silk producers was required, as well as adaptation of current datasets.

Silk is a natural proteinous fibre, which has been used in textile manufacture for at least 5000 years. Over 90% of commercially produced silk is extrusion spun by the domesticated Chinese silkworm *Bombyx mori*. This is a monophagous insect whose diet is restricted to the leaves of mulberry plants. Therefore inherent in silk production or 'sericulture' is the growing of mulberry. Broadly there are two races of silkworms. Those originating from the temperate regions of China are called *bivoltines* while their more tropical relatives are called *polyvoltines* or *multivoltines*. The bivoltines produce better silks but are also susceptible to environmental stress and diseases when compared to the poly-voltines. Sericulture in the Indian subcontinent, probably because of its typically higher temperatures compared to China's traditional silk regions, uses either polyvoltine or crossbreed (hybrid) crosses between poly- and bivoltines. Such hybrids have an enhanced capacity to endure the warmer climate in addition to being more disease resistant (which in warmer climates are a bigger threat) as well as offering a higher silk yield and better silk quality than pure polyvoltines. Consequently in India the production of bivoltine silk remains as low as 5-10% in spite of ambitious promotional efforts by the government.

With an annual production of 130,000 metric tonnes in 2009 (Central Silk Board 2011), silk constituted 0.2% of the total global fibre produced and 0.5% of the total of natural fibres. While silk's current production volumes are relatively small, the increased interest in tough composites, biodegradable composites, sustainable materials and biomimetic high performance materials indicate that silk has the potential to play an important role in future advanced materials. Silk fibre's superb mechanical properties and its outstanding qualities as a textile are well known (Vollrath and Porter 2009). However in order to count as a 'fibre of the future', silk's environmental impact must be better understood, i.e. fully quantified, for a true comparison with man-made fibres and other substitutes. Hence the importance of quantifying the resources embodied within silk fibres. After all, an obvious ecological benefit of silk relies on it being renewable and biodegradable.

While the green revolution has had a huge effect on yields in all agriculture, the fundamentals of silk farming and reeling in India have changed little since the industrial revolution (Ganga 2003a). Mulberry bushes are cultivated until they are old enough for harvesting of the leaves i.e. typically 2 years in tropical conditions (Ganga 2003b). These leaves are then fed to silkworm larvae. Each newly hatched larva eats about 23g of leaves over a period of about 28 days to become fully grown when it is ready to spin silk for its cocoon. Silk dope (fluid) is produced by the twin silk glands and extruded through the spinneret within the mouth of the silkworm. The double filament silk fibre (i.e. a bave consisting of 2 brins) is spun up to lengths of 1600m into a protective shell or cocoon. The cocoons are harvested and can be sold at a central market to reelers or reeled in-house. Reeling requires boiling the cocoons in water, usually in the presence of alkali or a detergent, in order to soften and partially dissolve the sericin protein which binds the fibres together to form the tough cocoon shell. Softening enables brushes to find and pull the end of the silk filament. The free silk ends of a few cocoons are attached to a reeling machine and unravelled at about 100m/minute. Typically 9 baves are thus collected and twisted into a silk thread, but depending on the quality of the silk as well as the thickness (denier) of the yarn required there can be more or fewer baves used for the thread reeled. The reeling machine may be foot powered, semi-automatic, or automatic. 'Charka' or hand reeling produces lower quality silk and constitutes a declining proportion of Indian production. It is not considered in this study. The reeling process results in a consolidated yarn called 'raw silk' as well as waste products in the form of waste silk and the pupae. Much of the waste silk can be re-reeled into the raw silk in order to boost productivity; however this is at the cost of quality. The pupae are sometimes sold as fertilizer or fish food, being high in protein and fat. Indeed, ancient Chinese sericulture was often associated with pisciculture with the pupae feeding the fish and the pond mud fertilising the mulberry trees.

At each stage inputs in the form of materials and energy contribute to emissions into the air, the water and the land in the form of co-products and waste. Although beyond the scope of this study, it is important to note that most of locally relevant emissions of present-day sericulture consist of chemical run-off into ground water and drainage systems. Capturing, purifying and recycling this water back into the process is possible and should be integrated into modern sericulture. Co-products (leaves, dead worms, pupae, waste silk, etc) are generally used as compost in a closed loop or sold into external processes.

Methods

Goal and Scope definition:

The goal of this study is a first characterization of the environmental performance of Indian irrigated silk production concerning energy use, as well as the identification of potential improvements to the process.

Using the Life Cycle Assessment methodology as defined by ISO 14040:2006(E) (ISO 2006), this study performs a cradle-to-gate analysis of cumulative energy demand (CED) in raw silk. The functional unit is 1kg of reeled raw silk. CED during distribution, use and disposal of the functional unit are considered out of scope. CED in production of fertilizers, disinfectants, consumables and pesticides is in scope but energy from the manufacture of asset classes (e.g. pumps and ploughs) is excluded. Solar energy content in mulberry and extra energy required by draft animals was not considered. Figure 1 illustrates the production stages of silk fibres.

Fig. 1

Life cycle inventory (LCI): In order to compile and quantify inputs for raw silk, the production process was broken down into two logical subsystems: production of the mulberry leaves and cocoons, and production of raw silk. Two inventory questionnaires were drawn up by GK Rajesh (see Appendix 1), one for the farmers and one for the reelers. The questionnaires were taken independently to 20 farmers and 20 reelers and read-out to them in order to mitigate problems with illiteracy; all verbal answers were transcribed for the analysis. The farms were located in the village of Varuna, Mysore Taluk, Mysore District, Karnataka State. The reelers were located in Ramanagaram town of Ramanagaram district, Karnataka State. This area was chosen as it is representative of the major silk producing state in India. Data was collected in July 2011.Background Life Cycle Inventory data for many non-OECD (Organisation for Economic Cooperation and Development) countries is lacking (Wernet et al. 2010). That lack of specific Indian data within Ecoinvent required the adaptation of processes from alternative sources – e.g. following the method of Itten et al for electricity generation (Itten et al, 2012). Point-source emissions in particular are not directly comparable to those of OECD countries, even when an adjustment factor is applied. Certain impact categories in broader assessments such as eco-indicator99 will thus not be reliable without further study of local conditions and inputs. This issue is significantly less pronounced for CED calculations, and Ecoinvent LCI data was used to calculate the CED for manufactured inputs.

Allocation of compost is avoided as it is recycled into the process. Co-products as silk waste, mulberry twigs, and pupae were not considered for this study, as they have a much lower value than raw silk.

Results:

Figure 2 illustrates the flow of energy through the raw silk production process. For simplicity those processes that constitute less than 5% of the CED have been omitted from the flow diagram. The thickness of the red line indicates the relative value of CED for the product flow, demonstrating that the energy consumption of raw silk production is close to equally divided between cocoon production (47%) and heat for the cocoon cooking process (51%). Compost use and compost production almost balance each other out (174kg used vs. 144kg produced per kg of cocoons) with the difference being made up in farmyard manure.

Fig.2

As with many other agricultural products the principal energy costs of cocoon production are in the manufacture of the fertilisers and in irrigation. High yield varieties of mulberry such as V-1 will efficiently utilise fertiliser in applications of up to 375 kg/ha/year. Nevertheless, the average consumption of nitrogen in the fertilisers used by our correspondents was 520 kg/ha/year, well above recommended values.

The quantities of any pesticides used (under 0.04kg/kg raw silk) makes their contribution to embodied energy calculations negligible despite their being predominantly organophosphates. Unusually for most agricultural products, the weed management of mulberry bushes uses little or no energy as no herbicide application or mechanical weeding was undertaken with this permanent crop. Labour required in sericultural activities in India is largely supplied by human or animal power. A substantial part of weed management in Indian sericulture is done either manually or by oxen-drawn plough. Illustrating the early development stage of LCA in non-OECD countries, there is currently no established LCA methodology for the use of draught animals in agriculture. We note that in our examples of sericulture all leaf picking was performed by hand and all leaf transportation to the silkworm rearing shed was by animal drawn cart or by humans carrying the loads themselves.

In all cases examined, some form of irrigation was used. This took the form of either a tube-well driven by an electrical or diesel pump, or a canal system. Energy consumption as a result of irrigation constitutes approximately 32% of the embodied energy in our example, across irrigation systems. The average electricity used in irrigation was 3130 kwh/ha/year.

During the silkworm rearing stage, the silkworm larvae are kept in rearing sheds with electrical lighting. In the prevalent tropical climate, a well ventilated rearing shed is sufficient to keep the microclimate at optimum temperature and humidity suitable for silkworms. The climate is especially suitable to the indigenous 'polyvoltine' silkworm breeds as they are well adapted to the circumstances. Thus the majority of rearing sheds are structures with large voids in the walls, permitting ample air circulation and thus cutting both the costs of construction and the costs of energy otherwise required for climate control by artificial means. These rearing sheds are vigorously disinfected between each cocoon crop (*ca.* 6 times per year) with either one or a combination of bleaching powder, quicklime, parathion and dichlorvos. Rearing bed disinfectants are applied in the form of quicklime and various combinations of herbal extracts with germicidal properties. The beds are usually made of newspaper over a basement made of either nylon or bamboo frames. The newspaper is a consumable and used in large quantities (1.7kg/kg raw silk). Data for energy consumption in the manufacture of newspaper in India is not available and therefore substituted with European values from the EcoInvent database. While this is a fair assumption, it has been noted (Trudeau et al. 2011) that India's paper & pulp mills tend to be less energy efficient than those in industrialised countries.

In our example, silk reeling was the most energy intensive part of the raw silk production process. Reeling is the process by which the cocoon, in which the silk filament is glued in place by sericin protein, is heated in water in order to soften the sericin to a point where unravelling is possible. Water temperature, hardness and pH are critical factors at this stage. It is generally known throughout the silk reeling sector (Datta and Nanavaty 2005) that the temperature of required heating can be changed with the addition of different salts and ions to the soap solution. Cocoons, being buoyant, need to be submerged in a wire mesh cage in order for the cocoon shell to become permeated and the sericin to soften. This takes approximately

10 minutes at temperatures between 60 and 95°C. While electrically powered (e.g. 2kW heating coil) permeation chambers exist (Arya 2011), in our sample set the reelers heat this water with a wood-burning boiler. Charcoal is then used to dry the silk fibres in re-reeling. It is common practice for reelers to produce it in-house from purchased wood (Dhingra, 2003). The wood is locally sourced *Eucalyptus, Neem, Acacia, Tamarind,* etc. In some cases refuse wood shavings from timber mills are also used. Given the desirability of dried wood for the reelers, it is usually air dried. We assume average equilibrium moisture content based on published values (Simpson, 1998).

Reeling machines are either hand driven, semi-automatic or automatic. Hand driven devices require the cocoons to be reeled at 65°-80°C and 180-250 metres/minute semi-automatic: 30°-45°C and 50-80 metres/minute; automatic: 30°-45°C and 120-200 metres/minute (Yong-Woo, 1999). The choice of reeling device therefore has direct implications regarding the embodied energy of the raw silk as well its quality.

Co-products in the form of pupae, waste silk, leaves, stems and dead worms are sold or used as fertiliser and compost.

Discussion

Table 1 details the breakdown of the energy inputs into silk production into direct and indirect forms. Under existing practice, direct energy input accounts for a significant majority of total energy use (84%) while indirect energy from the manufacture and transport of chemicals, consumables etc accounts for 15%. Electricity, primarily from powering irrigation pumps, constitutes just over 32% of the total embodied energy.

Table 1

Bombyx silkworms have been selectively bred for millennia to exclusively forage on the leaves of mulberry *Morus alba* (Ganga 2003b). One of the reasons for the co-domestication of this specific plant and the moth might well be the relatively high (15 -28%) protein content of mulberry (Sánchez 2000). Thus mulberry leaf compounds have become the key 'forage' for the silk worm and its silk gland in order to be able to produce the nitrogen-rich proteins fibroin and sericin required in such large quantities for the animal's silk output. Clearly, the high nitrogen content of the leaves requires fertilisation.

Put into the context of the functional unit used here, this equates to 2.9 kg nitrogen per kg raw silk produced. This very high and if not counter-productive then certainly unnecessary application of nitrogen may well be attributable to excessive application of fertilisers heavily subsidised by the Indian government (Gulati and Narayanan 2000). Indeed, it has been noted amongst Indian agronomists (Singh 2000) that loss in soil fertility as a result of over-fertilisation has resulted in further over-fertilisation compounding the problem. We note here also that several farmers in our sample did not use any urea, substituting more costly ammonium sulphate. This unexpected result is likely due to bottlenecks in supply, and may partially account for observed fertiliser application patterns. The energy cost of farmyard manure and its production did not contribute greatly to the overall embodied energy of raw silk, despite being added in high quantities. This was primarily due to the closed loop production of this organic fertiliser later on in the process.

A stock-pruned mulberry garden takes just 45 days to grow back in full foliage, and can produce up to 70 tons of leaves per hectare (Yadav, 2004). Recommended values from moriculture literature (Ganga 2003b) depend on soil type and rainfall but a reasonable recommendation under irrigated conditions for the ruling mulberry hybrid variety V-1 is NPK of 350:140:140 kg/ha/year. Our data shows that cocoon farmers are applying NPK in an unbalanced ratio of 520:488:151 kg/ha/year. This is partly due to lack of information on best practice on part of the farmers and partly due to prevalent government subsidies in the agricultural sector in India.

The average electricity used in irrigation was 3130 kWh/ha/year, which compares to 1600 kWh/ha/year for the rest of agricultural India (Lall et al. 2011). These relatively high values can be attributed to farmers being able to avoid payment for electricity used in agriculture, and so have little incentive to use their pump systems economically. It may be argued that if they had to pay for the energy used, farmers would find it unprofitable to engage in agriculture – be it sericulture or otherwise (Lall et al, 2011). Subsidies for fertiliser and electricity are linked to the inefficient input use observed in this sample (Planning Commission, 2006). This results not just in excessive energy use, but causes eutrophication and may damage long-term soil productivity (Vijayan et al, 2007)

Cooking the cocoons is one of the primary energy consuming (51%) processes during the production of raw silk. The extent to which the wood has dried out, and therefore its calorific value, is an important criteria for the reelers as it dictates the cost of extractable heat from the wood and the amount needed. However, with the relative humidity of Karnataka State (95% in the monsoon season), the equilibrium moisture content of exposed wood can reach as high as 20% (Reeb 1997), decreasing the recoverable heat value. This would suggest that the burn efficiency of the wood drops significantly in the monsoon season, driving up wood consumption. Given the potential impact this will have the embodied energy it must be argued that more data and analysis is required to realistically estimate the energy inherent in reeling and re-reeling.

To alleviate the significant fuel costs and environmental burdens of wood burning stoves, Dhingra *et al*. developed a gasifier based silk reeling oven which, by converting wood into syngas (H_2 and CO). Heat conversion is up to 46% more efficient and greater control of the water bath is possible, which in turn leads to higher quality silk (Dhingra et al. 2003). This shows that appropriate technological innovation can make a substantial contribution to energy efficiency. Through implementation of existing technologies and economies of scale it is possible to drastically reduce the energy consumption during this critical process in silk manufacturing.

Fully automated reeling machines used predominantly in China use electrical elements to heat the water in a closed boiler as well as massively parallelising the reeling process. This compares with traditional hand-reeling or semi-automatic reeling machines, like those used by the reelers in this study, in which the water is heated under a open fire and in an open basin, resulting in heat and water inefficiencies. However, electricity is a very inefficient way of producing heat, while traditional boilers are based on a renewable resource. Further analysis of both technologies under a LCA framework will clarify the tradeoffs involved.

Efficient use of co-products can substantially improve silk production sustainability. Twigs from rearing beds can be fed to cattle, mulberry shoots can be used as firewood, pupae are an excellent feed in aquaculture and chicken rearing (Jintasataporn, 2012). Commercial applications of sericin would be especially advantageous as is currently not utilised by any reeling operators in our sample.

Lastly, other technologies under development such as genetically engineered silkworm which spin directly reelable fibres rather than cocoons (Vollrath and Woods 2011) and additives and processes to water to soften the cocoon at lower temperatures show great promise in further reducing energy requirements.

The energy cost during the process of fibre extrusion from the silk gland can be calculated (Holland et al. 2012) and compared with polyethylene. Formation of the fibrils (building blocks of the polymer fibres) is 10 times more energy efficient in silk than for polyethylene. This is due to the lower shear rates at which silk fibrils form in comparison to those of polyethylene. Also, polyethylene requires 100 times the energy as a result of the need to melt it before it can be spun. On the other hand silk is spun from the liquid dope at room temperature. Overall, therefore, silk is 1000 times more efficient in its energy of formation than polyethylene. Two lessons follow: Firstly, engineers looking to develop low energy technologies for fibre formation would do well to examine silk. Secondly, the silk industry needs to optimise three specific sub-processes in order to minimise energy costs: fertiliser usage, irrigation systems and unravelling. It is the unfortunate but necessary process of unravelling the cocoons as well as the practice of fertilising and irrigating mulberry that results in a higher cumulative energy demand. Our investigation is a first study of the subject and therefore lacks the breadth and width of a full study. It is thus not comprehensive enough to make conclusive comparisons. It is nevertheless informative to compare the calculated embodied energy in raw silk with other fibres, bearing in mind regional differences - for example Steinberger et al. found Indian cotton production between two and four times more energy intensive than US cotton, a difference mainly attributed to poorly regulated groundwater irrigation. (Steinberger et al. 2009).

Table 2

Conclusions

The value of sericulture for rural development potential is unquestioned, and few other agriculture activities compare in providing gainful employment in areas where agricultural land is scarce. This results in the sector being heavily supported by central and state governments. Moreover, in some states in India silk farmers form an effective pressure group, and have secured extensive subsidies for primary inputs such as fertiliser and electricity used for irrigation. Together these two inputs account for over 45% of the embodied energy in the final product in our study. The reeling industry in Karnataka does not receive the same level of subsidy farmers do, and the reelers operate on a far more independent and entrepreneurial basis, with low margins. This industry is therefore driven by economics and should be interested in more energy efficient processes (e.g. gasifier stoves) (Dhingra et al. 2003) if the return on investment can be demonstrated, capital costs are not prohibitive, and extension services are provided to increase technological awareness.

While it is outside the scope of this study to contrast the embodied energies calculated with figures with those of other silk producing regions, reports from Chinese silk producing areas (Bian 2011), indicate that Indian silk reeling is more energetically expensive. That being said, mass flow is not the only standard by which the environmental impact of textile products can be compared. It is worth bearing in mind that silk is a high-value product without true substitutes. Despite its small market share it occupies a unique place in textile markets, and commands a significant price premium. Indian prices as of Feb 2013 are 7.5 and 11 times higher per kilo for silk than for nylon and cotton, respectively (Ind. Min. Tex., 2013).

The sustainability of silk is often considered a selling point for this ancient and valuable material. Despite the sample size limitations inherent in a pilot study, our findings suggest that with regards to energy consumption, current cottage industry production of this fibre in India has some way to go before it competes with most manmade fibres on this metric. Fertilization, irrigation and wood consumption are the identified environmental hotspots. LCA can be successfully used to identify the most effective ways of improving the production taking into account the whole production cycle.

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Indian silk industry as a whole. More extensive research will be needed for a full characterization of Indian silk.

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FIGURES AND TABLES

Figure 1: Mass and energy flow diagram indicating the flow of mass in the production of raw silk. Solid lines: primary inputs; dotted: waste and co-product flows

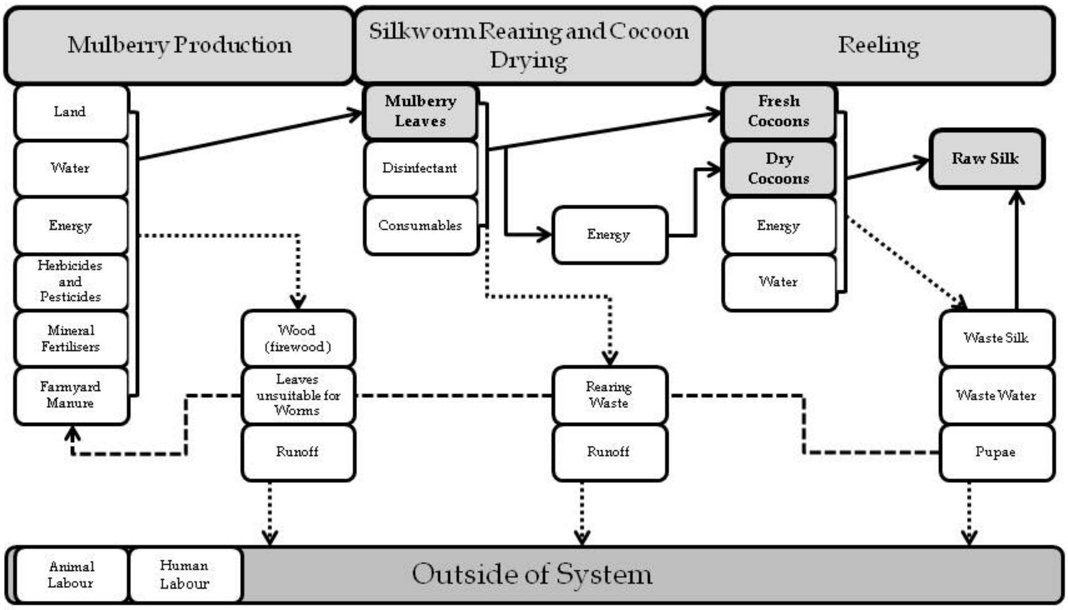

Figure 2: An energy flow diagram for the production of Raw silk, as generated by SimaPro. Mass values and contribution to energy demand are indicated at the top of grey process nodes. Line thicknesses and arrows indicate relative size and flow direction of cumulative embodied energy.

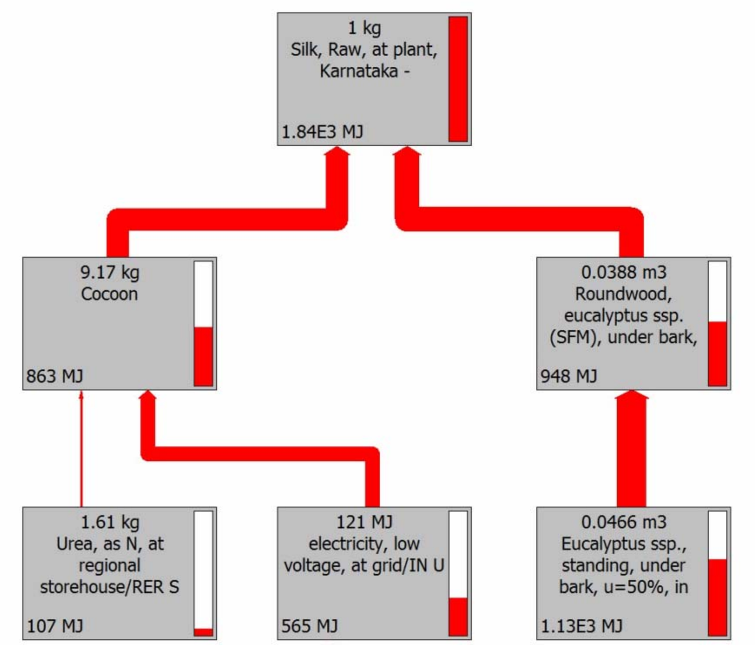

Table 1: Total Energy Use per kg raw silk produced under observed practice and calculated values for optimised production techniques, i.e. recommended fertiliser quantities and use of a gasifier oven. The energy inputs are broken down into direct and indirect energy inputs. *Note that only processes contributing above 2.5% total energy are included, with the exception of K.

		Value	% of CED
Direct Energy			
Wood	MJ	948	51.4%
Electricity	MJ	591	32.1%
Tot. Direct Energy	**MJ**	**1539**	**83.5%**
Indirect Energy (Fertiliser)			
N	MJ	169	9.2%
P	MJ	94	5.1%
K*	MJ	8.5	0.5%
Total Indirect Energy	**MJ**	**271.5**	**14.7%**
Total Remaining Processes	**MJ**	**32.5**	**1.8%**
Total	**MJ**	**1843**	**100.0%**

Table 2: Textile fibre energy use (1: Barber and Pellow, 2006; 2: Ecoinvent)

Textile	**Energy (MJ/kg)**
Raw silk (this study)	1843
Nylon	260[1]
Polypropylene	86[2]
Viscose	169[2]
Cotton Yarn	180[2]
Wool (unprocessed)	118[2]

Sericultural Extension System in China

By

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(ORAL PRESENTATION)

Based on introduction of the law of the People's Republic of China on" the Popularization of Agricultural Technology" and agricultural extension system in China, describes in detail the Chinese sericulture extension system. At present, Chinese sericulture extension system is composed of three sub-systems: technology extension, education, scientific research. The sericultural technology extension system is made of six pyramid levels by the national, provincial, city, county, township, village levels. There are 9 universities are engaged in sericulture/silk education from undergraduate to PhD postgraduate. There are 23 sericultural research institutes in China. Among them, Sericultural Research Institute, Chinese Academy of Agricultural Sciences is only one national institute. The rests are provincial or regional institutions. In addition, focuses on a new *China Sericulture Research System,* a branch of new *China Agriculture Research System (CARS)* which is established in 2008.

SUSTAINABLE PRODUCTION OF OAK TASAR CULTURE IN MANIPUR

By

[1*,]Reeta Luikham; [2]T. James Keisa, [3]T. Shantibala and [4]K. Chaoba Singh

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Manipur is situated in the North Eastern region of India, agriculture is the main products and source of employment. The objectives of alleviating rural health, poverty and to arrest migration of rural folks to cities, there is a need of diversification of agriculture sector to other important avocations. One of such avocations is sericulture, which generates employment on a large scale. Since the introduction of the oak tasar silkworm, *Antheraea proylei* during 1970, Manipur has the privilege of exploring the abundantly available oak (*Quercus*) floras as a means of earning subsidiary income through rearing of silkworm. However, the production of oak tasar in the state is still unable to surpass 4.0 metric tonnes as it is reared only once during the spring crop successfully. With the aim of enhancing the oak tasar production, an additional crop during summer and autumn seasons gives sustainable production by integrating the rearing technology, host plant as well as disease and pest management activities. *Antheraea proylei* larvae were reared in four different phases w.e.f. 15th July onwards at an interval of 15 days with the management of host plant (*Quercus serrata*) by phase wise pruning and application of bio-fertilizers, FYM and disinfection of rearing farm at low altitude (785m ASL) and high altitude (1200mASL) respectively. Among the four different phases of silkworm rearing, fourth phase brushing on 30th August had shown maximum effective rate of rearing of 25.32± 0.85 % followed by 20.67±1.65% ERR in third phase brushing on 15th August at low altitude, whereas at high altitude first phase brushed on 15th July had recorded highest 23.24±2.03% ERR followed by 17.69±4.04% ERR in second phase brushing on 30th July. The correlation between larval survival percentage, leaf yield and abiotic factors showed significant positive relation. Hence, the brushing schedules for rearing of *A. proylei* during summer/ autumn season may be conducted according to the elevation at Low altitude during last week of August to first week of September and at high altitude during last week of July to first week of August to get maximum cocoon yield. It will generate employment to the tribal people and sustains their household income and their family life can be improved.

Keywords: *Antheraea proylei*, *Quercus serrata,* pruning, reared, summer and autumn seasons, survival, climatic factors.

SERI-BIODIVERSITY OF MANIPUR, NORTHEAST INDIA: VISION FOR SUSTAINABLE LIVELIHOOD AND POVERTY ALLEVIATION

By

[1*]T. Shantibala, [2]Reeta Luikham, [3]TH. Victor, [4]R. K. Lokeshwari and [5]H. Debaraj

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India has a unique identity, being producer of all the five commercially traded varieties of natural silks, namely, mulberry, tasar, oak tasar, eri, and muga. The Indian Sub-Himalayan belt extending from Jammu and Kashmir in the North West and Manipur in the north east is the natural abode of many sericigenous insects which feeds on naturally grown plants available in this region. Northeast India, one among them, is believed to be center of radiation of wild silkmoths. Manipur being an Indo-Burma biodiversity hotspot in particular makes ideal home for a number of wild sericigenous insects, including Muga (*A. assamensis* Helfer), eri (*S. cynthia ricini* Donovan), oak tasar (*A. proylei* Jolly) and mulberry silk (*B. mori* Linn.). In Manipur, sericulture has a long tradition and has been utilizing this biodiversity since prehistoric time. The survey during 2010-2012 revealed the presence of 19 species feeding on more than 25 different host plants, out of which 14 species were distributed to 10 genera i.e. *Antheraea, Actias, Attacus, Archaeoattacus, Cricula, Bombyx, Loepa, Theophila, Samia* and *Sonthonnaxia* indicating the existence of very rich sericigenous biodiversity in the region. Manipur is considered as hot spot of seri-biodiversity which play a significant role in

sustainable rural livelihood and poverty alleviation in the state. Therefore, developing and strengthening of *in situ* and *ex situ* mechanism for seribiodiversity conservation in forest as well as outside the protected areas apart from the commercially known traded silk varieties is the need of the hour. Within Northeast India, Manipur is the second largest producer of silk and contributes about 10.71% to the total NE raw silk production and generates employment to 39,258 families on farm and non-farm activities expanding to all the nine districts of the state. Out of the total number of 2315 villages in the state, 934 villages have been covered for sericulture development activities including 376 villages under catalytic Development program of Ministry, Govt. of India. A household lady can earn a minimum of Rs. 800/- per week by producing 1kg of ghicha yarn silk without spending any money investment. The silk cultivation is an eco friendly and women friendly occupation that provide high employment, vibrancy to village economies and ideal programme for weaker section of society supporting sustainable livelihood and poverty elevation.

Keywords: Seri-biodiversity, Manipur, Sustainable livelihood and Poverty elevation

SERI TOOL SOFTWARE IN SERICULTURE

By

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ABSTRACT: The feed back gathered from different sericulture areas including the field workers of Central Silk Board and Directorate of Sericulture of many states of India and also utilizing own experience in extension and research , it was felt imperative here to develop instant software which may be readily available even for a beginner in sericulture as well as stakeholders and may run on PC as well as mobile (Andoid , windows , symbian,S40) for accurate determination of different chemical formulations and quantifications and measurements of widely used seventeen parameters which will discussed more accurately. The Seri tool software has been devised in such a way that it may be used not only in mulberry sericulture but by doing certain modifications and up dation it can be utilsed by wild silk and Vanya Silk and other agriculture sectors also. Its utility is too fold and there is further scope to incorporate the various components and post cocoon technology also, At first hand attempt has been made to concentrate on 17 parameters used in mulberry sericulture Considering the utility of this software at R&D centres , it is imperative also to up date this software by taking other parameters in different national and international languages

Keywords: Seri tool , Online , Offline , software , PC and mobile

INTRODUCTION

In Sericulture , sericulturists frequently require instant help in the formulation of different disinfectant solutions for its use in disinfection program, requirement of different packages of practices for mulberry cultivation management like quantification of mulberry cutting and sapling requirement in specified area (Acre/Hectare) , mulberry leaf requirement for desired number of dfls , mulberry disease management with proper quantification of fungicides , fertilizer management with appropriate quantity of chemical fertilizers linked with the latest market rate per Kg and mulberry pest management with proper quantification of pesticides . In silkworm rearing management, sericulturists always require instant quantification of temperature & relative humidity, rearing space and determination of weight of loose eggs . and cost of rearing houses based on annual dfls rearing capacity etc.

For making solutions, formulations and project reports, researchers , scientists and sericulture field staff generally consult their note book and literature for making formulation of the solutions which is a lengthy process and above all the calculations are not available at one place as a ready reckoner for the help . Similarly they have to be very accurate in determining the solution required for disinfecting the rearing house and chawki rearing houses more effectively as well as in the formulation of fungicides and pesticides for mulberry disease management . If there is any mistake in the calculation of quantity of disinfectants, it may not show its efficiency as well as there will be wastage of costly disinfectants which will be not economical. Similarly the capacity of tanks available at Govt. Farm and disinfectants required for washing the rearing appliances like plastic rearing tray , mount ages rearing nets vary to the size of tanks , one has to be very precise and accurate in the determination of disinfectants. Further due to various size of rearing houses at farmers level, the exact formulation of each house is required . Similarly in other applications like use of pesticide, mulberry cutting and sapling estimation , fertilizer applications , weight of silkworm eggs , silkworm larvae space and mulberry leaf requirement, estimation of renditta and cocoon price with non destructive methods without wasting of cocoons by the buyers in cocoon market and annual activity of different activities of sericulture, sericulturists always require calculator for determinations of exact quantity and it takes too much time and references.. Lot of the books , technical bulletins , VCD , pamphlets have been released by the Central Silk Board and State sericulture Departments (1,2,3) but this will be the first attempt to develop instant software for computation of different complicated formula and management practices and estimation of formulas based on the latest market rates (on line) used in sericulture in fragment of seconds accurately. Generally in books the old cost of the chemical ,disinfectants and other materials are mentioned but this software can be linked with the latest market rates .This software also takes care about the latest up gradations and advancements in sericulture technologies and may be useful to the sericulurists , students , research scholars , scientists engaged in the Sericulture Industry, The further plan is also to standardize this software in Hindi and other international and regional languages in such a way that it can run in any mobile so that at field level the sericulturist can utilize it in broad way . This may also be used as a training tool in different diploma and PG diploma courses of Central Silk Board and IGNOU sericulture certificate courses as well as State Sericulture Departments can also distribute it at different units The Central Silk Boad and other State Sericulture Department can link it with their web sites for its online application.

MATERIALS AND METHODS

The software was developed with JAVA Programming by utilizing single JAR file and GUI components . Preliminary software capacity is of 2 MB only

System Requirements for running the software

128 MB + RAM

* Windows , Linux & other x 86 operating System

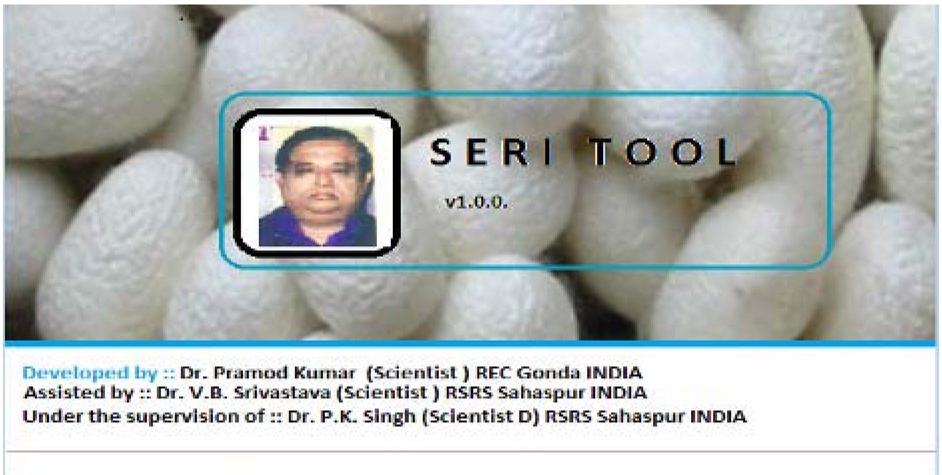
- This program works on **Windows** operating system, developed in **JAVA** back end tool. The main modules consists based on the standard schedules developed by Central Silk Board.(Ref 1,2,3)
- User-friendly data input and report generation.

How it works on the Desk Top ?

On Desktop the Icon Seri tool is clicked and after double clicking

Fig 1 : ICON

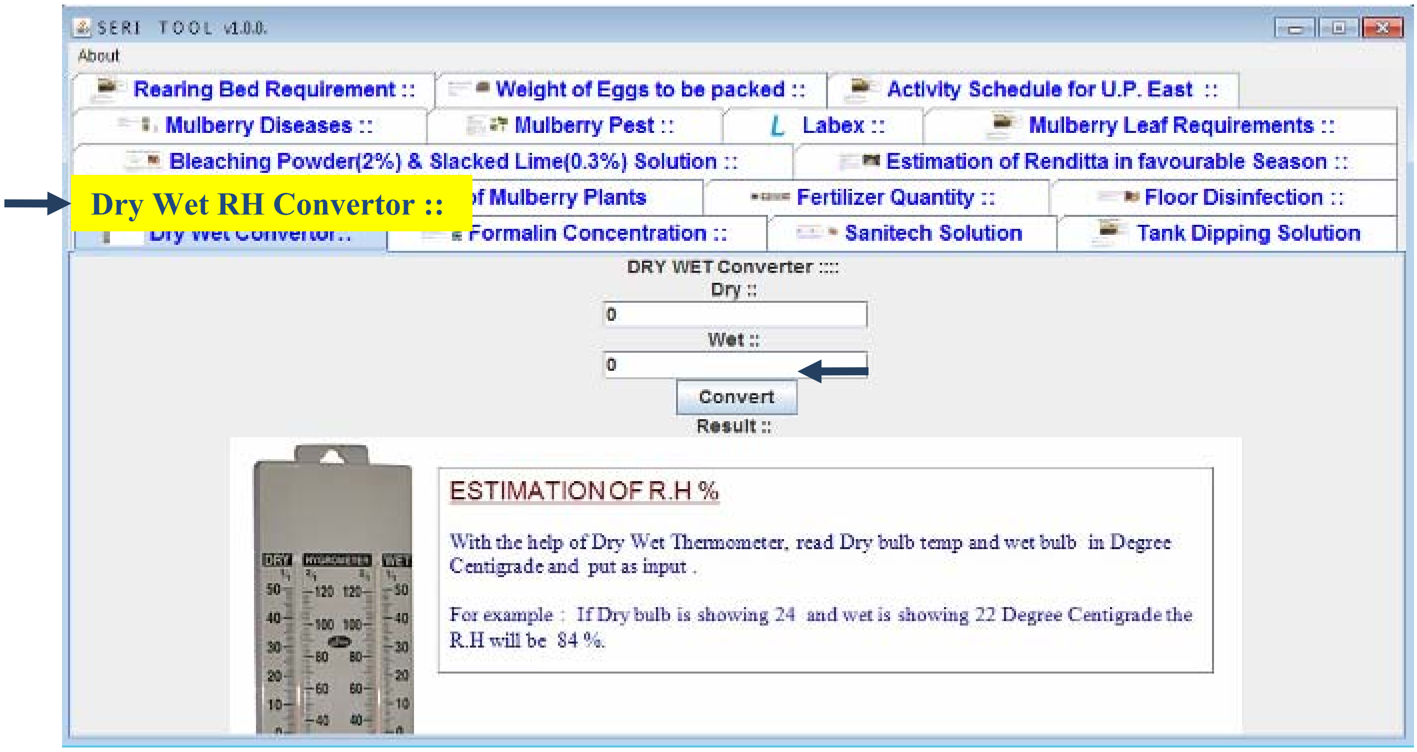
Splash Screen of About is displayed below :

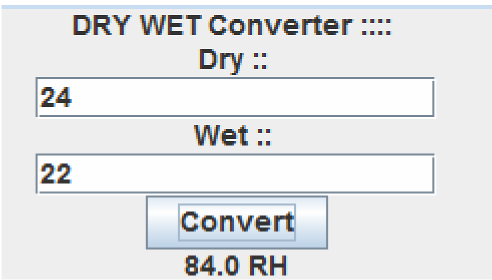


RESULTS AND DISCUSIONS

While determining the number of mulberry cuttings required for planting the specified area for the development of bush plantation or Nursery raising , this software is very much useful in determining the number of cuttings required . For determining the required quantity of fertilizer based on the soil test , this software has been formulated in such way it will give the output of the total fertilser requirement accurately . It was also felt necessary to have some instant formula so as to calculate the Relative Humidity % in CRC centre without seeing the conversion chart (Dry /wet) generally used in sericulture areas . This software serves the other purposes like determination of disinfectants, space in silkworm rearing , leaf requirement during silkworm rearing and determining cocoon price and activity schedule of different sericulture activities .

A- COMPUATION OF RELATIVE HUMIDITY %





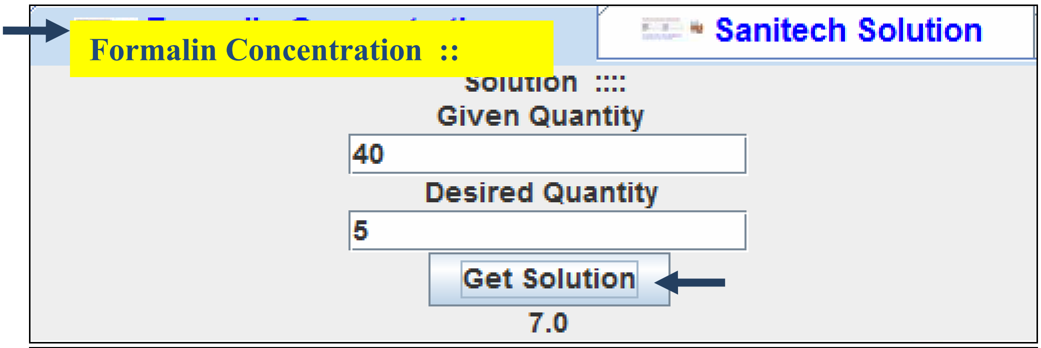
INPUT 1

INPUT 2

Fig 2 : Format for RH %

B- COMPUTATION OF FORMALIN CONCENTRATION

One has to fill the given solution strength of commercial formalin mentioned and desired solution as Input I and Input II . The software will immediately compute the water part in formalin required in one part of formalin,



Input I

Input II

Output

Fig 3 Showing the format for determination of formalin concentration .

C - PREPARATION OF SANITECH SOLUTION

With this one can compute the amount of Sanitech , Activator , Slacked lime ,and water required in given capacity of quantity required.

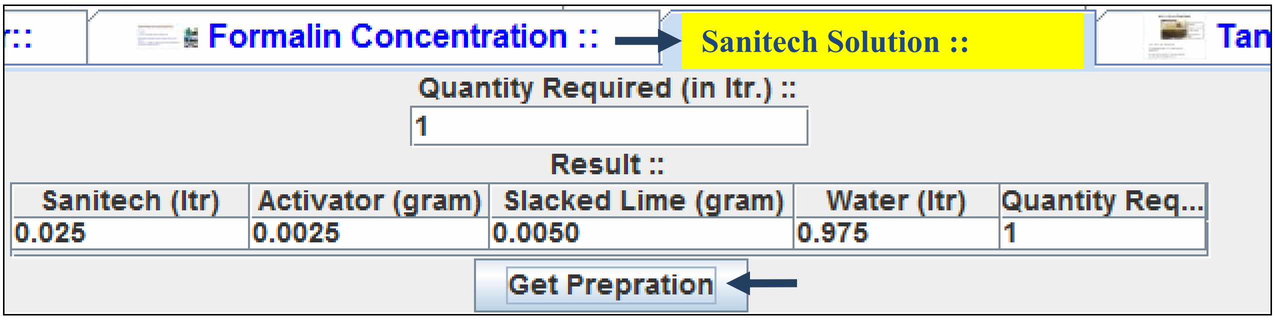


Fig 4 Showing the format of determining the Sanitech Solution

D - TANK DIPPING SOLUTION

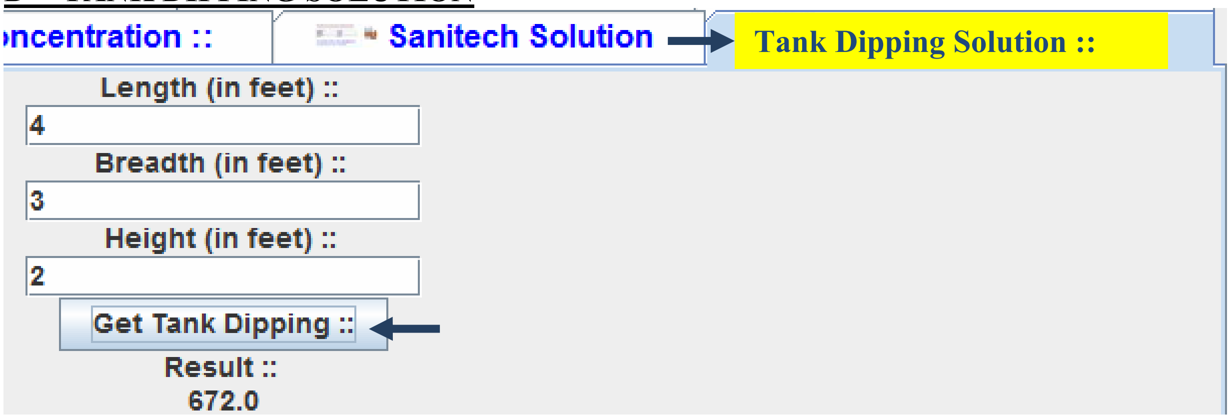


Fig. 5 : Format for Tank Dipping Solution.

E- ESTIMATION OF SHELL RATIO %

As per figure, by putting the value of shell weight(in gm) and cocoon weight (in gm) one can compute the shell ratio %

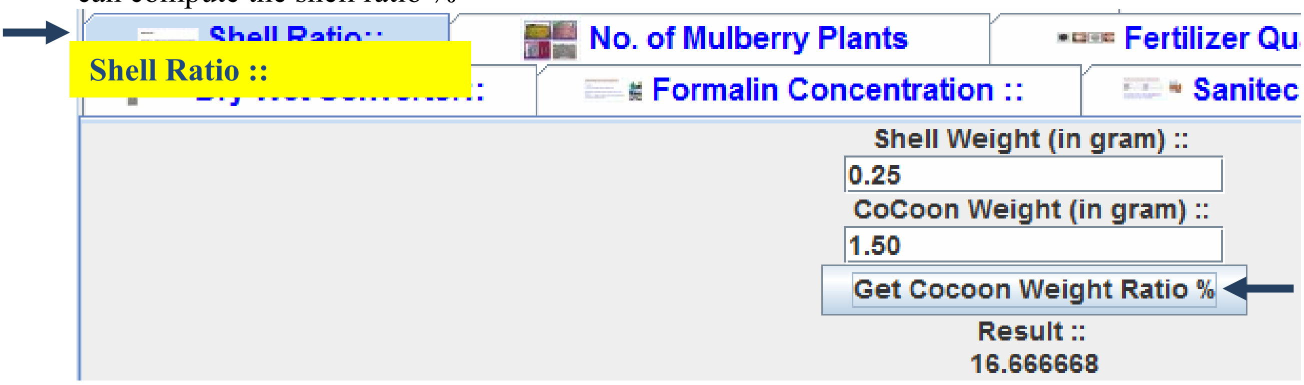


Fig 6 Format for estimation of Shell Ratio.

F- ESTIMATION OF NUMBER OF MULBERRY CUTTINGS

In order to get the no. of Mulberry Cuttings and saplings required in specific areas one has to put Area in Acre and spacing in inch as inputs. The output will be No, of plant per Acre.

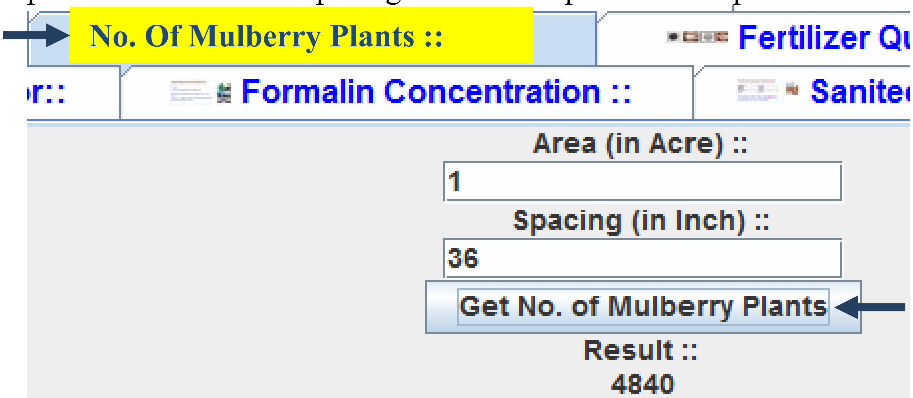


Fig 7 Format for Estimating no. of Mulberry Plants.

G- ESTIMATION OF FERTILIZER REQUIREMENT IN MULBERRY

In order to get the quantity of fertilizer required and its cost , this software is useful in computing the quantity of fertilizer in KG/Hectare by putting the N:P:K ratio in Input format. The cost of Urea Super Phosphate and Potash can also be linked through Internet to get the Current Market Rate.

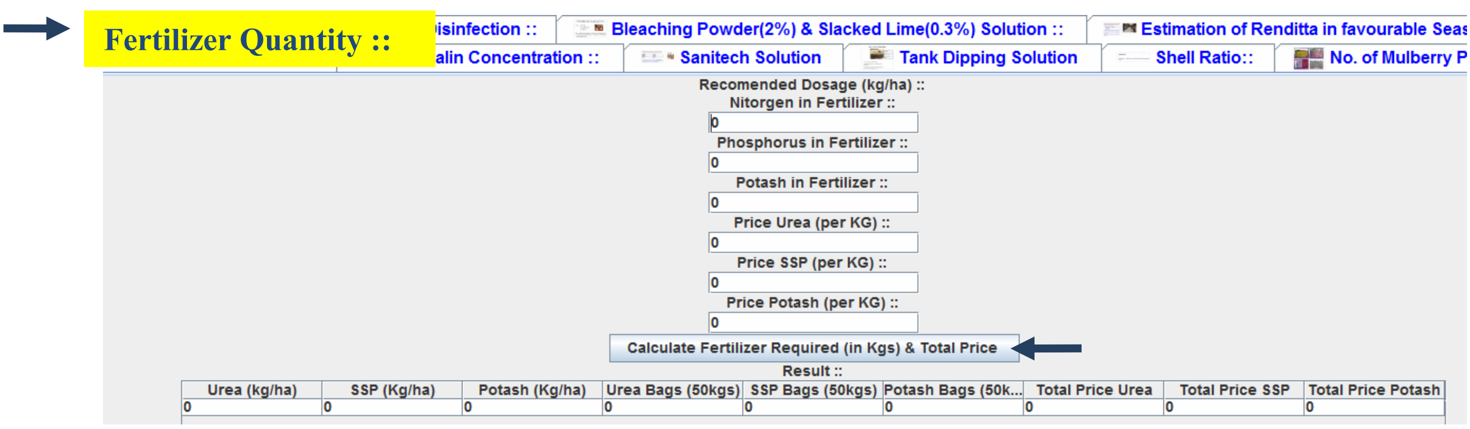


Figure 8 Format for Fertilizer dose calculation.

H- FLOOR DISINFECTION

By putting Floor length in Feet and Floor breadth in feet one can calculate the disinfectant required in KG.

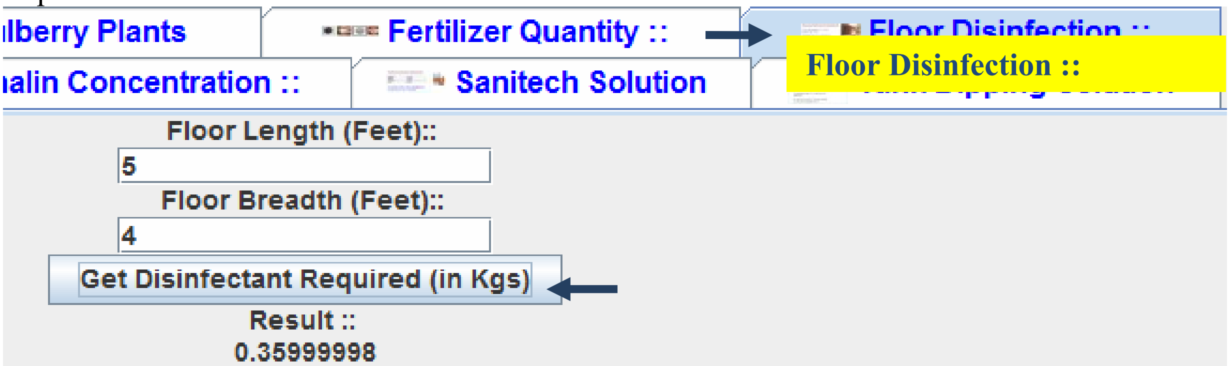


Figure 9 : Format for Floor Disinfection.

I- ESTIMATION OF BLEACHING POWDER (2%) AND SLAKED LIME (0.3%) SOLUTION

By putting the quantity of solution required in litre as input one can know Water (ltr) , Bleaching Powder (Gram) , Slaked Lime (Gram) required.

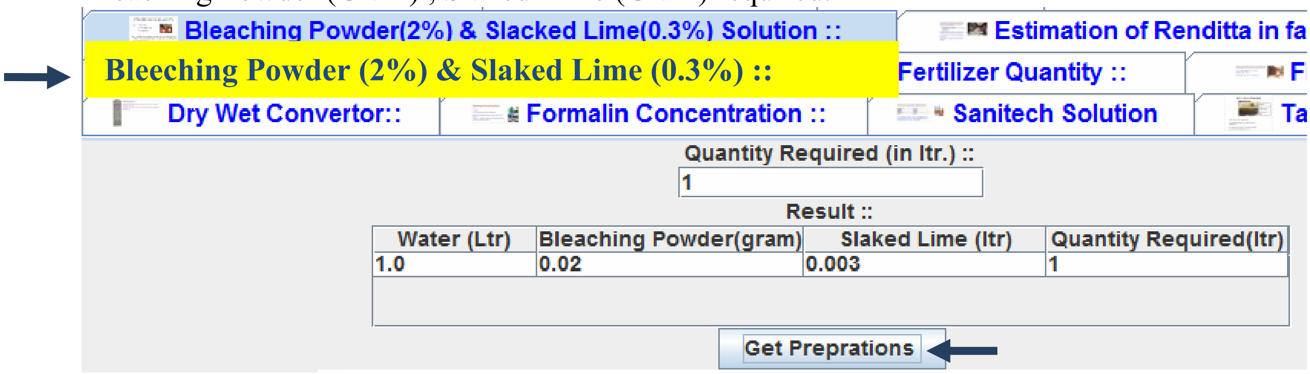


Figure 10: Format For Estimation Of Bleaching Powder (2%) And Slaked Lime (0.3%) Solution

J- ESTIMATION OF RENDITTA IN FAVOURABLE SEASON

By putting the value shell ration and defective cocoon % One can know the value of Renditta by non-destructive method. Further the market value of cocoon can be accessed by dividing the raw silk price (which can obtained through Internet via Silk Exchange) , One can access the Estimated Cocoon price.

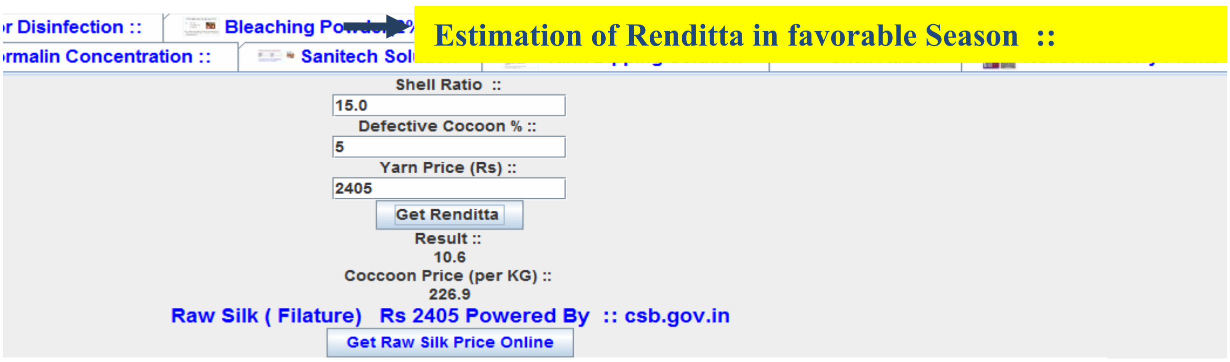


Figure 11: Format For Estimation Of Renditta In Favorable Season

K- ESTIMATION OF MULBERRY DISEASES

By putting the value of Water I n Litre One can get the requirement of 0.2% of Carbendazim for controlling leaf spot, powdery mildew, leaf rust and stem canker of mulberry.

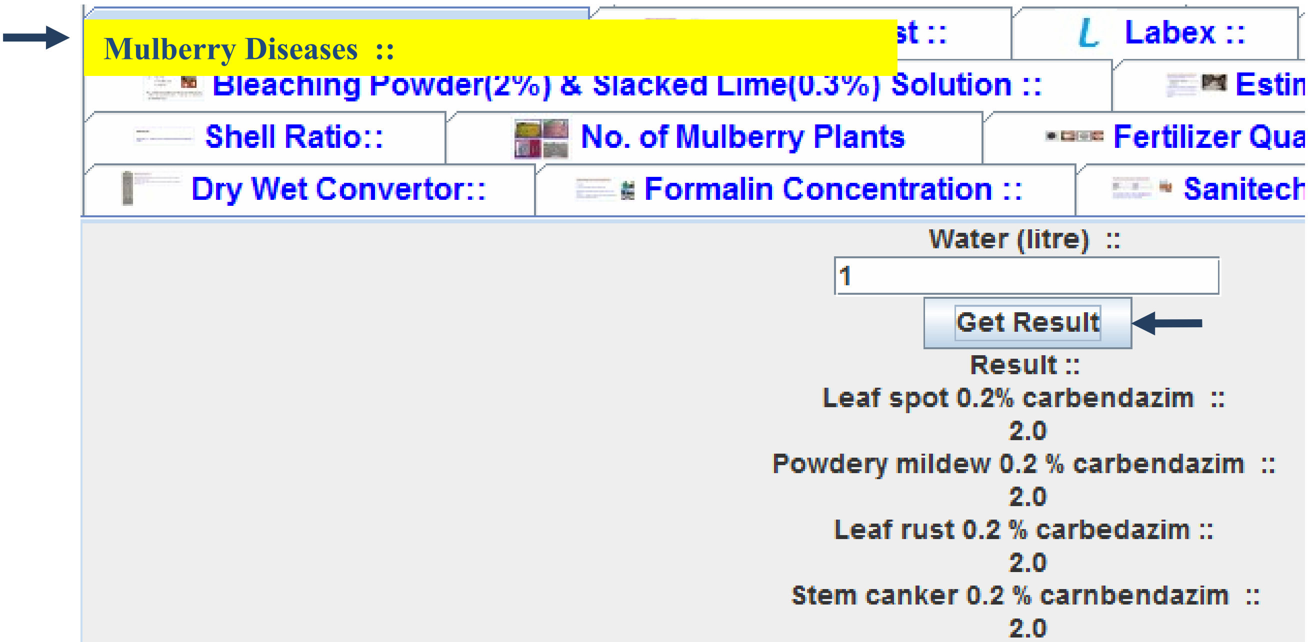


Figure 12: Format for Estimation of Mulberry Diseases.

L- MULBERRY PESTICIDES

By putting the value of volume required of Pesticide in Litre, percentage of Solution desired and Toxicant percentage available in the pesticide, One can know the commercial formulation of pesticide required as well as Water quantity required per liter.

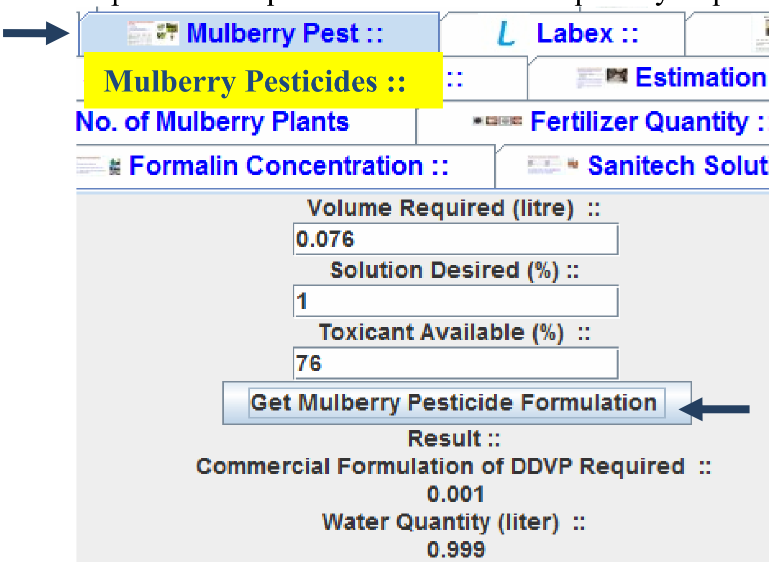


Figure 13: Format for Estimation of Commercial Mulberry pesticide solution.

M- LABEX

By putting the value of quantity required in KG of Labex , one can know the requirements of components like Bleaching powder & lime in grams.

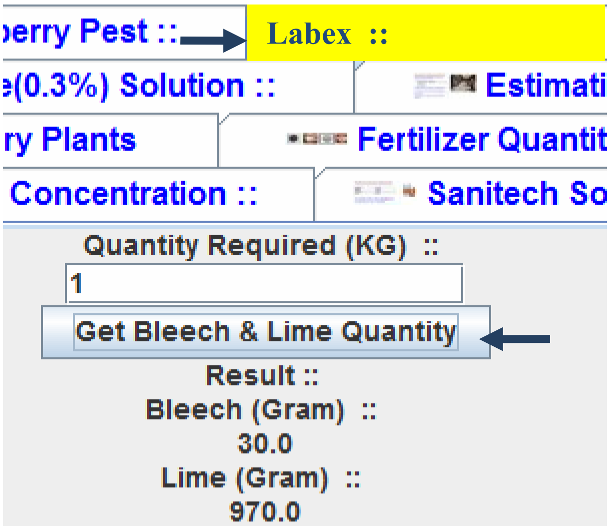


Figure 14: Format for Estimation of Labex Components.

N- MULBERRY LEAF REQUIREMENT

By selecting the stage of Silkworm Larvae and silk worm hybrid one can know the quantity of mulberry leaf required in Kg/100 DFLs.

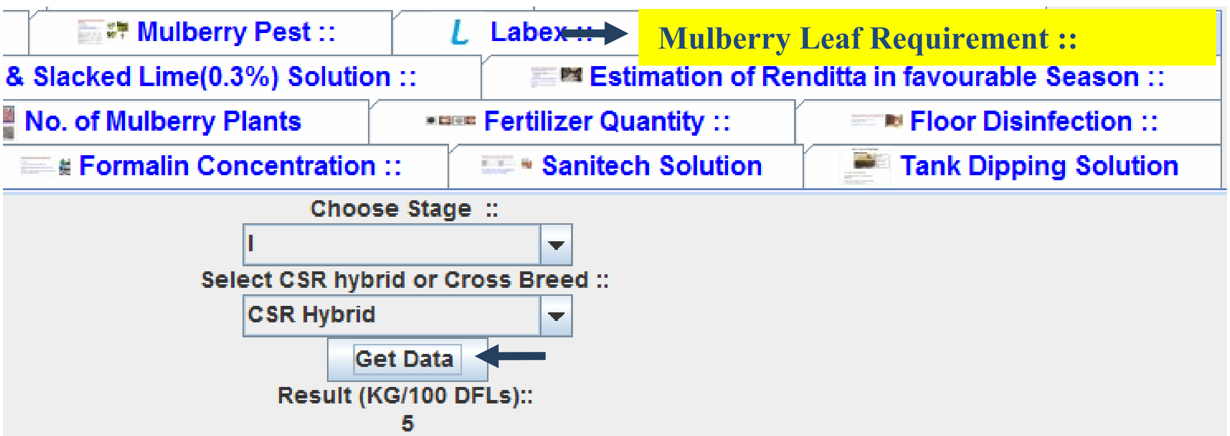


Figure 15: Format for Mulberry Lead Requirement.

O- REARING BED SIZE REQUIREMENT

By selecting the stage of Silkworm Larvae of silkworm one can know the bed requirement in start and end in square feet.

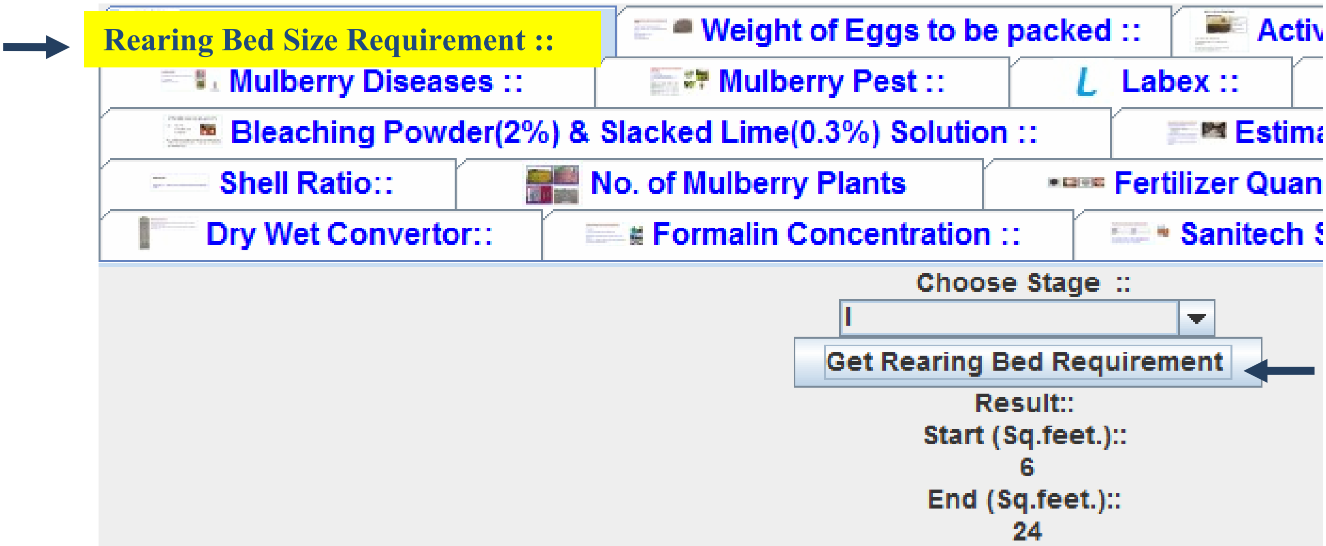


Figure 16: Format for Rearing Bed Size Requirement.

P- <u>WEIGHT OF SILKWORM WORM LOOSE EGGS TO BE PACKED</u>

By entering the no. of loose eggs per gram, one can know the weight of Eggs per gram. This will be useful in grainage .

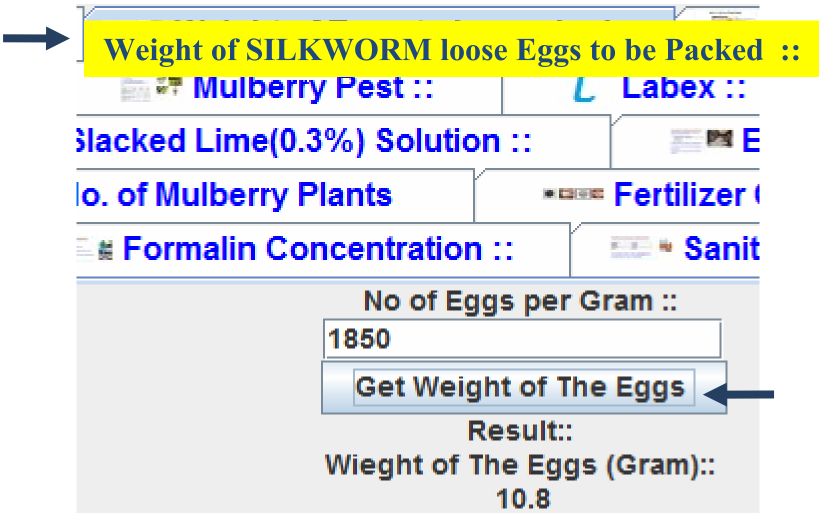


Figure 17: Format for Wight of Silkworm loose eggs to be packed.

Q- <u>DETERMINATION OF ACTIVITY SCHEDULE OF MULBERRY & SILKWORM PRACTISES</u>

By selecting the week in Annual Calendar , One can know the activity schedule of mulberry and silkworm practices to be done in Eastern U.P. condition.
For other areas of India it will be updated further.

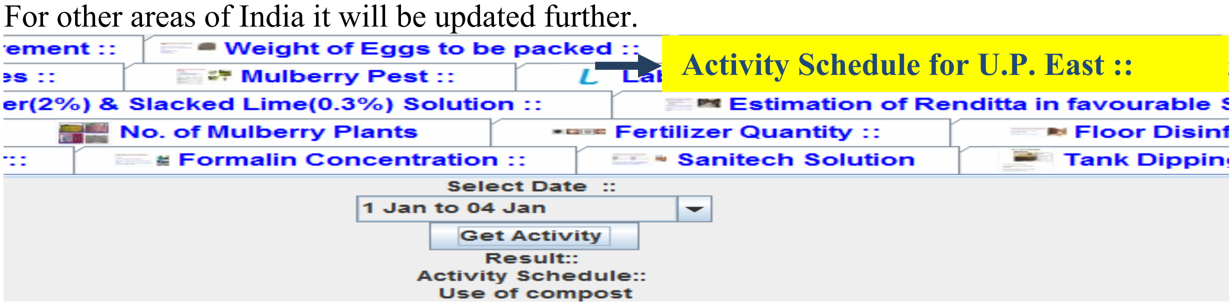


Figure 18: Format for determination of activity schedule of mulberry & silkworm practices.

R- SILKWORM REARING HOUSE

AREA UNDER MULBERRY	1 ACRE
REARING METHOD	TRAY
REARING CAPACITY /100 DFLS	1250
NO. OF CROPS PER YEAR	06
BATCH SIZE	208

REARING HOUSE REQUIREMENT

300 dfls

FUNCTIONAL UNIT	DIMENSIONS			ARE/100 DFLS	TOTAL AREA REQUIRED SQ FT
	L (FT)	W (FT)	AREA SQFT		
CHAWKI ROOM	20	10	200	66.67	139
REARING UNIT	30	25	750	250.00	521
BARAMDAH/ ANT ROOM	25	08	200	66.67	139

*_As per prevailing market rate based on Internet

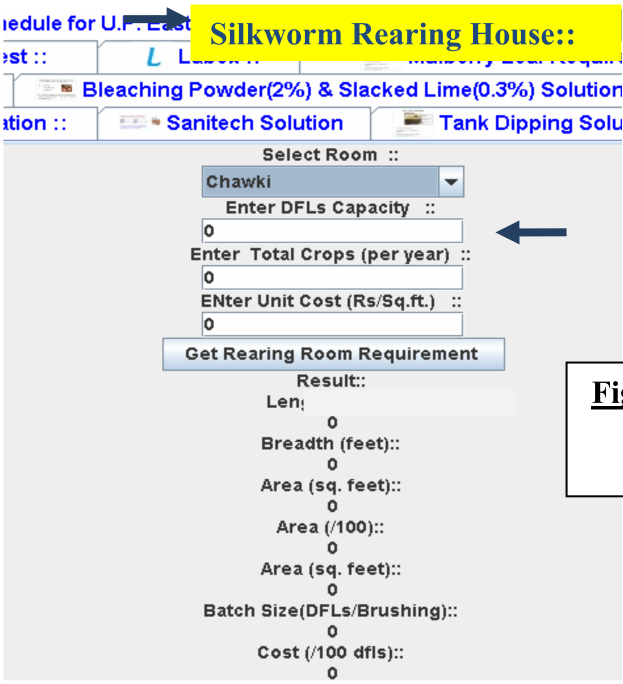


Figure 19: Format of SilkWorm Rearing House.

S- SERI TOOL SOFTWARE IN MOBLIE

India's mobile subscriber base should grow to 993 million by 2014, according to researcher Gartnern (4) , which expects the world's fastest-growing mobile market to close 2010 with more than 660 million subscribers. India is the second-largest wireless market in the world after China with its 618 million mobile subscribers at end-May, according to data from the country's telecoms regulator. Mobile connections were at 525 million at end-2009.

Considering the world wide networking and easy accessibility of Mobile user in developing countries like India , it is imperative to develop such type of software which may be compatible both in PC and mobile . In countries like India , in agricultural rural area average one mobile exist in one family similarly in sericulture areas the mobile utility is more prevalent . Hence it was essential here to develop such type of software which may be easily assessable to the farmers for easy dissemination of Technology transfer.

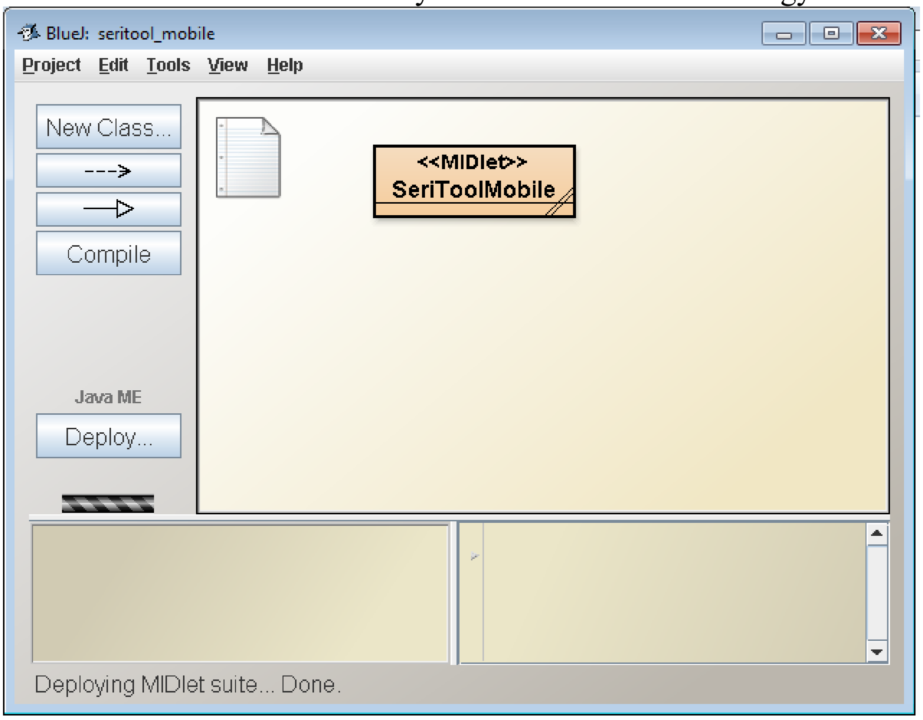


Fig 20 : Blue J Main screen utlised in the construction of Seri tool software for Moblie vesion

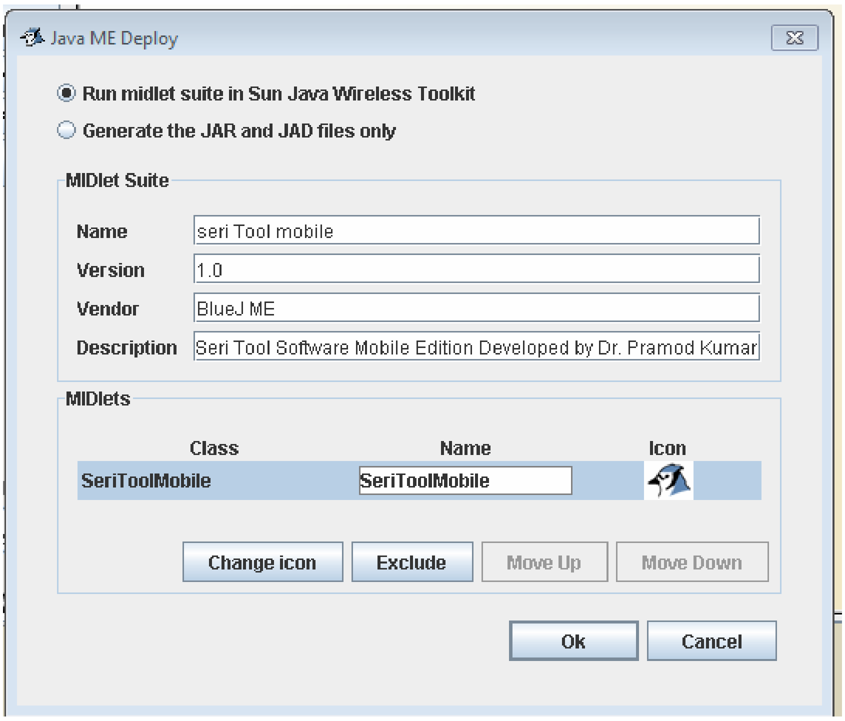


Fig :21 Mobile software running program , Emulator for testing software

Fig 22 : Output of the program in mobile

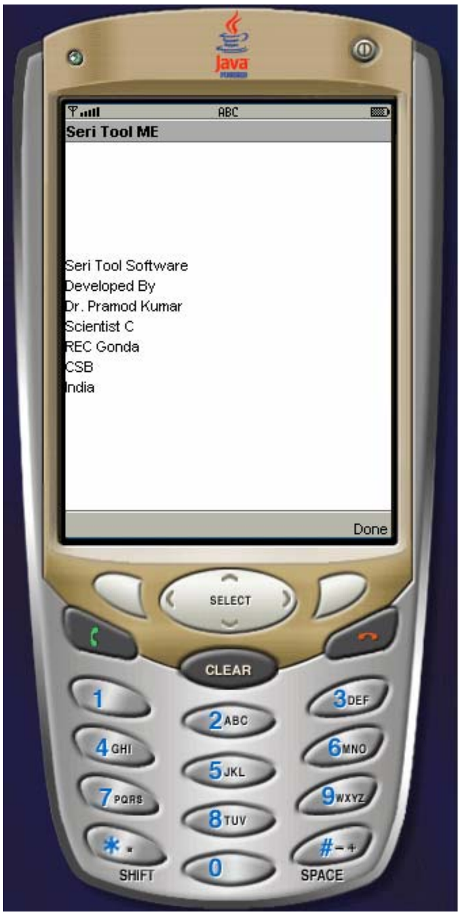


Fig 23: Main Screen of the Program

Fig 24: Main Calculation Screen

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Oommen Joy P. (2003) In Seri business a User's Guide , Central Silk Board Bangalore, India.

Rajesh Kurup & Devidutta Tripathy (2010) , Mobile users in India at 993 million in 2014: Researcher Gartner

A STUDY ON QUALITY ASPECT OF ERI CULTURE FOR THE SOCIO-ECONOMIC DEVELOPMENT OF THE BODOS IN KOKRAJHAR DISTRICT, ASSAM, INDIA

By

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Eri culture is mainly confined to the Brahmaputra valley of Assam and in some tribal inhabitant districts of Bihar, Jharkhand, West Bengal, Orissa, Andhra Pradesh, etc. The North Eastern region of India has established itself the world over for being a hub for practicing diverse sericulture activities, especially the 'Vanya' silk varieties, that include Muga (*Antheraea assamensis*), Eri (*Philosamia ricini*), Oak Tassar (*Antheraea proylei*) including harbouring a rich biodiversity of sericigenous fauna of commercial importance. Eri silkworm (*Philosamia ricini*) is polyphagous and feeds on wide range of host plants. Castor(*Ricinus communis*) and Kesseru (*Heteropanax fragrans*) are two primary food plants. Some of the important secondary food plants are Tapioca(*Manihot utilessima*); Payam (*Evodia flaxinifolia*); Barkesseru (*Alianthus excels*) and Papaya (*Carica papaya*). The art of rearing of silkworms, spinning & weaving is an integral part of the Bodo people. It is not only a traditional practice but also plays a dominant role in socio-economic development by stabilizing the economic condition of the families. Eri culture is practiced not only for silk but also for the protein rich pupae for consumption of people as a delicacy. The Eri silk has special thermal properties, which supplement the requirements of warm clothing to some extent.

Key words : Eri culture, Polyphagous, Sikworm rearing, Spinning, weaving, Socio-economic.

MUGA SEED PRODUCTION LINKAGE FOR ECONOMIC EMPOWERMENT OF WOMEN IN NORTH EAST REGION OF INDIA

By

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Muga silk the world famous golden yellow color silk is prerogative of India and pride to Assam one of the North Eastern state of the country. The lustrous simmering silk fiber is produced by *Antheraea assamensis* Helfer with 6 broods in a year is geographically isolated to the single pocket of the world that is Assam . This lepidopteron insect feeds mainly on the aromatic leaves of *Persea bombycina* and *Litsea polyantha* in wild conditions and is exposed to intermittent climatic fluctuations particularly during summer and rainy (seed crop) seasons. Therefore the seed crop production often gets affected due to pests, diseases as well as climatic vagaries. All the on farm technical activities during breeding and rearing are carried out by women. The muga silkworm during its rearing period is also facing environmental pollutants due to oil exploration and insecticide spray on tea gardens at the proximity of muga farms. As a result there is heavy larval mortality and crop loss and also shortage of silkworm eggs for further multiplication.

In order to sustain this wonderful nature's gift of golden muga silk to Assam, a detailed exploratory study has been under taken in the neighboring states to find out the feasibility and introduction of muga culture.

The adjacent states Sikkim, Mizoram and Nagaland enjoys ideal climate. The temperature ranges 20^0C to 30^0C during summer and 11^0C – 21^0C in winter The annual rainfall is 250 to 300 cm..These optimum conditions facilitate introduction of muga rearing and the pilot study reveal that the biological parameters of muga cocoons produced in the above states.(mature larval weight (12 -16 gms), pupal weight (5 -7 gms), fecundity (180-250) and survival rate (50-80%)) are better than traditional zone. The commercial traits, shell weight (0.4 to 0.8gms), shell ratio (10 -13%) and silk recovery are higher than Assam state. The winter seed crop introduced in Assam and Manipur state border shown better performance in terms of economic and other commercial traits. Thus paving a way to introduce muga culture in nontraditional states with season specific crops so as to strengthen the seed linkage program of Assam state in addition to improve the economic status of all stake holders. The details are discussed in this paper.

Keywords: Antheraea assamensis, seed crops, rearing potential and silkworm diseases.

Cricula trifenestrata: A potential Indian Vanya silk source for additional income generation and economic stability of the cashew farmers of India

By

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Cricula trifenestrata Helfer (Family: Saturniidae, Order: Lepidoptera) is a minor defoliating insect pest of cashew plantation in Kerala, a South Indian State. Of late it was also identified as one of the wild sericigenous insect producing small meshi golden yellow cocoon. It occurs from June to December. Life table studies indicates that during summer and monsoon the duration of Egg, Larval, Pupal and Adult stages were 68 and 166 days respectively. The pupae of winter population undergo diapauses for 4-5 months. The mature larvae of winter stock were observed to spin compact cocoons with shell wt of 0.25 grams. The mean values of cocoon wt : shell wt of summer and winter population showed appreciable differences between population and different sexes.

Anacardium occidentale, Schleichera oleosa, Spondias pinnata, Salix tetrasperma, Mangifera indica, Persea americana (avocado), Cinnamomum zeylanicum , Bischofia javanica are known/reported host plants of *Cricula trifenestrata* . Recently certain wild tress /plants *viz., Persea macrantha (vernacular name:* Kulirmavu *), Olea dioica (Family:Oleaceae, Common name: Rose Sandalwood), Litsea coriaceae (* Family: Lauracea *),* Indian Badam tree etc. are found to be very good hosts of *C. trifenestrata,* thus opening up the opportunity of rearing of these wild silk moths on such host plants, as these plants can be easily grown in waste lands.

International market survey revealed that, the global Price of 14 g *Cricula* silk yarn is around 6.4 Euro and a kilogram of Cricula shells fetch a minimum of 100 US Dollars. Preliminary rearing studies pointed out that 150 DFLs of cricula (1 DFL / cashew tree= 150-170 eggs) can be reared on 1 ha cashew plantation which without affecting the main cashew crop yield 22,500 cocoons .The expected income is US $ 450-500 equaling to 24000-26,500 Indian Rupees. . The post-cocoon studies conducted on cocoons of cricula indicate that they are open ended and thus fit for the production of spun silk. The golden yellow silk was extracted through Central Silk Board spinning machine. Cricula silk fabrics were produced on power loom using mulberry silk yarn as warp and Cricula silk as weft with 120 ends/inch. This is the first report from India on successful exploitation of sericigenous potential of *Cricula trifenestrata* where silk fabric and artefacts were made successful on commercial level.

The Cricula silk with its uniqueness of being organically produced, is known as an “Ahimsa silk” (Peaceful silk) since for the extraction of silk the worms are not killed. There is a huge demand for Ahimsa silk in the international market. Thus by concentrating on pre-cocoons activity, the struggling farmers can earn from Cricula culture as a source of extra income, in addition to the main income from the sale of cashew nuts and cashew apple products. If exploited scientifically in large scale, the Cricula being a pest can be pearl for cashew growers.

Keywords: *Cricula trifenestrata*, Vanya silk, India, Cashew, silk clothes and artefacts, commercialization, economics.

Women In Sericulture

By

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Sericulture is a labor intensive cottage industry that provides gainful employment to the rural populations. Approximately 60% of different activities like mulberry cultivation, silkworm rearing, reeling, twisting, weaving and printing involve women, while in certain other areas like marketing and purchasing the involvement of women has to be strengthened and encouraged. All the sericulture activities require proper attention fitting the instinctive qualities of women and as silkworm rearing is an indoor activity, well suited for the rural women facilitating them to nourish silkworms effectively. The advancement of rural women both financially and socially leading towards self-reliance is a necessary component for development. In sericulture, though 60% of the sericulture activities are being conducted by women recognizing them as an important component in rural development in general and sericulture in particular has not received due priority. Serious efforts are required for upgrading the knowledge of women on various aspects of sericulture. Effective expansion of sericulture without recognizing the participation, involvement and contribution of women would not yield the desired result. Although adequate thrust has been given since recent past, the accrued benefits and opportunities for leadership bypassed women leading to underutilization of their potential. The up-gradation of their knowledge on certain important sericulture activities especially the scientific technologies for better productivity, production and quality of silk is the **NEED OF THE HOUR.**

The concept of women's advancement in sericulture

- Traditions and customs of the society in Indian rural context do not encourage the majority of the rural women to work outdoors.
- Sericulture proves to be a boon wherein women can carry all the work within the house after attending to their own regular household chore.
- In sericulture women folk contribute for more than 60% of the total work involved.
- The income thus generated by them has been found to be properly utilized for the economic and social development of the family as a whole
- Majority of the ongoing training/exposure programs are centered in off-farm locations thus restricting the effective involvement of women due to the limitations of prevailing socio-economic framework.
- Economic status of sericultural families in general and women in particular would be improved through the higher cocoon yield and productivity.

  Karnataka State Sericulture Research and Development Institute, Bangalore, Karnataka State ,INDIA implemented the project funded by Department of

Science and Technology, Government of India aimed at dissemination of sericulture technological know-how for the benefit of tribal women populations towards improvement of cocoon yield productivity through rural women who constitute main work force of various activities of sericulture. Such extension oriented ON-FARM training programmes, demonstrations of need based technologies, group discussions, formation of self-Help-Groups contribute self – reliance, poverty alleviation and empowerment, community mobilization among tribal women populations. On-Farm sericulture activities conducted in a Tribal cluster-Tulasidoddi, Kanakapura Taluk, Bangalore Rural District, Karnataka State, India are discussed in the present paper.

Keywords: Women, Sericulture, self-reliance, poverty alleviation, empowerment, community mobilization, Tribal women.

PRODUCT RANGE DIVERSIFICATION IN SERICULTURE FOR VALUE ADDITION

By

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Sericulture is a labor intensive export oriented cottage industry and has proved to be an excellent example for alleviating rural unemployment and poverty in India. The current scenario of decreasing silk production due to various factors like fluctuating climatic conditions, thrust on agricultural land, high cost of inputs, and discouraging cocoon price has created scope for a challenging, vital, need based situation for potential economic area-Product diversification for value addition in sericulture for commercial utilization contributes for rural employment and income generation and strengthens sericulturists. As a unique, challenging venture in our Karnataka State Sericulture Research and Development Institute, Bangalore, Karnataka State, India attempted to explore the diversified mulberry wood articles , mulberry fruit based edible products and cocoon handicraft products of nutritive, medicinal, utility and aesthetic values. The following are the product range for commercial utilization, popularization and to create a potential market are discussed in detail

Mulberry wood articles-Spoons, Forks, Table decorative articles, Toys, Kitchen articles, Chopsticks etc.

2.Mulberry edible products-Mulberry leaf Spicy Pakodas, Jam, Pickle, Gulkanda,Halwa,Gulumba,Churan,Chutney,Biscuits,Cakes. Seri- crafts with cocoons-Garlands, Greeting cards,Dolls,Flowers,Flower Baskets, Dolls, Gift articles, Decorative items etc.

Keywords: Value Addition in Sericulture, Product diversification, handicrafts, wood articles, edible products.

Building Producers' Institutions across the Tasar Silk Value Chain- Impact on Socio-economic Conditions of Tribals

By

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(POSTER)

ABSTRACT: Tasar culture has potential to create livelihoods for the weaker sections of the society in poverty ridden, Left Wing Extremism affected states in Central and North India through income and employment augmentation. However, to bring in socio-economic change, there is a need to build backward and forward linkages amongst various activity groups across the tasar silk value chain and by encouraging tribal participation in these unreachable areas. The developmental initiative by the Central Silk Board (CSB) partnered with the Ministry of Rural Development, Govt. of India and an NGO, PRADAN in the States of Bihar and Jharkhand included mobilization of activity groups, building Producers' Institutions and nurturing Community Based Organizations to take care of the core activities with active role in decision making. Role clarity of various organizations involved, profile of the beneficiaries and Producers' Institutions build to establish linkages across the activity chain, impact on production, productivity, social and economic conditions of tribals, tasar value chain and the sub-sector are detailed. Interventions helped to check seasonal migration, enhancing food security, releasing the mortgaged fertile lands besides asset creation; ensuring education and health are studied across the sample. It also paved way for better GO-NGO collaboration in the tasar sector for further upscaling and leveraging the presence of multi-stakeholders.

Keywords: ***Livelihoods, socio-economic change, tasar silk value chain, Community Based Organizations, Producers' Institutions, GO-NGO collaboration***

Introduction:

India spends over 2% of Gross Domestic Product towards anti-poverty and social reforms. However, about 42% of the country's rural population still lives below the poverty line and 80% of these rural poor belong to the marginalized caste and communities. Many of the developmental initiatives launched to bring in socio-economic changes in rural and tribal areas are yet to achieve the desired results due to low levels of participation by the tribals. In Central and North India, Tasar culture is the major income and employment generating livelihood activity for tribals, which also protects environment. Various technologies have been developed by the research Institutes of the Central Silk Board (CSB), Ministry of Textiles, Govt. of India. Though CSB and Departments of Sericulture in these States have initiated many developmental programmes for promotion of tasarculture, dissemination of the recommended technologies remained sluggish due to various reasons including acceptance levels of tribals and reach of the extension workers to the activity clusters, thereby hampering the envisaged production targets.

This warranted the need to increase participation of the stakeholders and involving the professional Non-Governmental Organizations (NGOs) found to be one of the practical solution in view of covering remote locations, large population and diverse cropping pattern in tasar development. This also helped to reduce the economic burden of government agencies and also to tap the strengths of Community Based Organizations (CBOs) and NGOs in group formation and motivating the activity groups towards efficient use of resources, conservation of soil, water and bio-diversity, capacity building, linking various activity groups, extension support, establishing credit linkages, marketing, growth with equity and sustainable growth.

While NGOs enjoy certain functional advantages, being community based, more accountable and capable of providing services at a lesser cost, CSB has roped in NGOs in sericulture developmental activities in various projects viz., National Sericulture Project, UNDP assisted sub-programme and special SGSY Projects. NGO-GO collaboration has become inevitable, mainly in the States/ areas where the Department of Sericulture/ Central Silk Board could not implement the schemes for want of extension network or manpower. Role of the facilitating NGOs is to elicit people’s participation in Self Help Groups (SHGs) and building them into sustainable CBOs would help in achieving the set objectives of any development initiative besides role clarity and active participation of all the organizations concerned.

The Project: One such collaborative initiative has been the Special Projects under special Swarnajayanti Gram Swarojgar Yojana (SGSY), with the financial assistance from the Ministry of Rural Development, Govt. of India in the States of Bihar and Jharkhand executed by the Central Silk Board and implemented by a Non-Governmental Organization, Professional Assistance for Development Action (PRADAN). The initiatives with an objective to benefit the disadvantaged communities by utilizing degraded waste lands without exerting pressure on fertile soils resulted in substantial income generation through tasar production cycle, which is complementary to growing of other crops. Besides, tasar culture requires low investment from producers and there is a huge gap between supply of Tasar silk and demand for it. Main objective of the projects was to make a multidimensional impact on the lives of over 11000 poor tribal families, aiming at poverty reduction and environmental protection through nurturing grassroots level Community Based Organizations.

The Impact: Effective mobilization of activity groups, increase in their equity, women participation lead to reduction in dependency on government institutions, improved bargaining power, increased economic returns and social status. Capacity building and skill development was the important project component. Active participation of tribals helped them to exert voice and attach accountability with the providers of technology, extension and financial services. While adoption of proven technologies helped them to improve production and productivity levels, working together and with the agents of change to identify problems and devise solutions in order to save, build assets, adopt new livelihoods for themselves and their families resulted in impressive additional annual net returns in the range of Rs. 15000/- to Rs. 25000/-. Increasing the green cover through raising tasar host plants in degraded lands and conservation of natural host flora in fringe forest areas helped in environmental protection. Due to value addition in the production clusters through effective linkages amongst various activity groups led to substantial economic gains. Capacity and skill development initiatives also helped tribals to gain practical knowledge with higher efficiency and thereby building a pool of Service Providers in various activities, who are finding employment in other tasar producing states.

Many social benefits viz., women empowerment and their involvement in decision making, check in migration of families to urban areas, enhanced food security, release of the mortgaged land, asset creation like building pucca house, purchase of jewellery, livestock and vehicles, repayment of loans, release from clutches of money-lenders, increase in savings, ensuring good education, health and marriage of their children were derived with this intervention. This also helped in creation of self-sustained and replicable production clusters and also to build better GO-NGO collaboration for implementing future developmental initiatives.

Materials & Methods:

Project Stakeholders & Their Linkages: Stakeholders of the initiatives were selected as per the norms listed under the SGSY, from the below poverty line (BPL) families of rural poor mostly belonging to scheduled tribes, Schedule Castes and other weaker sections of the society, traditionally involved in tasar culture. Special emphasis was laid on encouraging women to take active role in the project especially in the silk production activities like reeling, spinning etc. Landless and unemployed tribal youth were motivated to take some entrepreneurial activities like tasar silkworm egg production in the tribal areas to cater the local needs. Required backward and forward linkages from plantation to silk reeling were built to achieve maximum value addition within the production clusters. Enabling support required to take up plantation of tasar host plants in private degraded waste lands, soil and water conservation measures, silkworm seed production, capacity building of stakeholders, credit mobilization from financial institutions was provided besides establishment of common facilities to store the critical inputs, processing activities viz., reeling and spinning was provided under the projects.

Implementation Modalities: Tribal families were mobilized in to activity groups based on the reconnaissance survey and opportunity cost analysis. Group approach led to formation of 203 SHGs covering activities like raising of tasar host plants in private degraded waste lands, tasar silkworm rearing, silkworm seed production and tasar cocoon reeling and spinning. 1387 tribal women were mobilized in 34 groups to take care of processing of primary produce in the villages itself (**Table-1**). Members of various activity groups participated at village level planning, execution and monitoring of all the project activities. Once the activity was planned, indent for required fund was placed with the representative of Field Implementing Agency, who approved subject to planning done by the groups. Later the funds were directly released to the group accounts, so as to implement the activity concerned. This not only lead to active participation of the tribals in decision making, it also brought in more of their contribution helping to increase the group savings from the project assistance, which facilitated to avail credit from financial institutions at lower levels of interest due to availability of higher margin money.

Table-1: Beneficiary profile under special SGSY Projects in Bihar and Jharkhand

Sl. No.	Particulars	Bihar	Jharkhand	Total
1	No. of Swarozgaris involved	3051	8136	11187
2	No. of SC/ ST Swarozgaries	2270	7184	9454
3	% of SC/ST to total coverage	74.4	88.3	84.5
4	No.of SHGs assisted	47	156	203

Producers' Organizations viz., Tasar Vikas Samity (TVS), Mutual Benefit Trust (MBT), MASUTA Producer Company and Eco-Tasar Pvt. Ltd., were formed at different levels.

Tasar Vikas Samiti: A Tasar Vikas Samiti comprises of 25-30 members and in many TVSs there are more than one grainage. There are about 3-4 seed crop rearers per grainage. One Tasar Vikas Samiti ensures sufficient seed (Dfl) for all the commercial rearers, locally. It also takes advantage of bulk buying of inputs and aggregate selling of the product (cocoon).

Mutual Benefit Trust: Mutual Benefit Trust is collective of Women Group of 25 Reelers and 5 Spinners in the cocoon production clusters for conversion and enhancing income of tribal women. MBTs are provided with infrastructure for stifling and storage of cocoons and machines for conversion of cocoons to silk with provisions for working capital, operating cost and consumables. These MBTs are supported with crèche for the children of tribal women reelers and spinners.

MASUTA Producers' Company: MASUTA buys cocoons from the TVSs and undertakes reeling and spinning of these cocoons through women's groups organized as Mutual Benefit Trust.

Eco-Tasar: Eco-Tasar is a private limited company with MASUTA as a major shareholder. The company has been formed to deal exclusively with the fabric market. The company provides market to the yarn produced at MASUTA.

The Study: The study included two parts. One is collection of primary data on beneficiary coverage, their activity vis-à-vis returns, impact on the value chain compared to traditional set up and the socio-economic impact which was carried out with the help of a consultant. The study included all the major activities across the tasar value chain viz., private graineurs, seed rearers, commercial rearers, reelers and spinners. Some of the social indicators like change in earnings, period of migration of the participating families, level of food security amongst the families, assets, status of loan/ mortgage, savings etc, opportunity cost for the vocation, impact on women, change in package of practices, technology and management systems in the value chain of Tasar, availability of critical inputs like quality silkworm seed, availability of market and prices for the cocoons yarn and change in the scheme / program designs and policies of the government agencies were some of the parameters included in the study.

While the beneficiary coverage and income from the activity was compiled from the primary data collected by the representatives of the field implementing agency during the project period, data on various social indicators was collected through household survey. Focused Group Discussions and Semi-structured Interviews were also part of the study with the groups of stake holders, traders and personnel involved in project implementation and monitoring. Some of the non-participating families were also covered to find out the impact of the project initiatives vis-à-vis traditional practices.

Sample Size: A 5% sample has been drawn from each of the sub groups of participating families engaged at various levels of the value chain as indicated at **Table-2**. The households have been selected based upon the simple random sampling method from the list of various groups of stakeholders provided. A representative sample has been drawn from the states and subsequently from the selected districts and blocks.

Similarly four Tasar Vikas Samitis of tasar rearers (two in each state) and Mutual Benefit Trusts of reelers and spinners (two in each state) were covered for Focused Group Discussion. Also, four Local traders (two in each state), two District level traders (one in each state) and two State level traders (one in each state) were covered under Semi-structured interviews.

Table-2: Sample size selected for the impact study of the various project initiatives

Category	**Sample Size**	**Control**	**Bihar**	**Jharkhand**
Graineurs	13	6	4 + 2	9 + 4
Seed Rearers	46	9	11 + 2	35 + 7
Commercial Rearers	330	66 (include 22 traditional rearers)	93 + 20	237 + 46
Reelers/ Spinners	106	23	23 + 6	83 + 17
Grand Total	**495**	**104**	**161**	**438**

The first figure under Bihar and Jharkhand represents the target families covered under the study while the second figure represents the control families covered.

Results & Discussion:

Technical innovations adopted at different levels of the value chain include, raising tasar host plantation in the privately owned wastelands, pioneering in establishment of tasar basic seed production centre at village level through involvement of literate unemployed tribal youth, introduction and fine tuning of the spinning machine developed by CSB and development of a reeling machine by MASUTA, introduction of new designs in weaving. Similarly, number of organizational innovations in the value chain viz., organization of rearers and graineurs at the village level in to Tasar Vikas Samiti (TVS), aggregation of TVS at District level in to a Co-operative for the sustenance of the activities, set-up of private DFL producers who can maintain quality levels and cater to the entire requirement in the project area, provision of micro-credit to make primary producers independent from moneylenders, development of yarn producer organizations at village level, development of a market for yarn (women in tasar production areas getting a market price selling it to weavers elsewhere) and development of national and international market for Tasar silk were evolved under the projects.

Impact on Production: Implementation of these projects helped in establishing 419 kisan nurseries, 656 nucleus and 952 basic seed rearers, 390 private graineurs, 5793 commercial rearers besides creation of 32 tasar silkworm rearers' and 34 reelers' and spinners' collectives. About 68.42 crore seedlings of arjun and asan were raised by the plantation farmer groups to augment block plantation in 1575 ha. of degraded wastelands belonging to tribal communities. The tribal groups could take up many of the activities which were hitherto under government domain due to capacity building, viz., rearing of 5.39 lakh nucleus seed to produce 277 lakh nucleus seed cocoons and production of over 6.0 lakh basic seed out of total supply of 11.36 lakh dfls. Besides, the groups generated 354 lakh seed cocoons to be processed for production of 57.41 lakh commercial seed to cater the total requirement of the project areas, which resulted in production of 23.68 crores of reeling cocoons. Almost 20% of the reeling cocoons were processed to produce 34.83 of MT tasar raw silk and 32.191 MT of spun silk, within the project helping in value addition in the production clusters itself.

Impact on Productivity: Beside large scale and sustainable production in the project area, due to adoption of the recommended technologies and best practices, even the productivity levels under various segments were found to be over and above the standard norms set for the sector. This was achieved due to effective forward and backward linkages established amongst various activities by PRADAN, reducing the dependency on outside agencies for supply of various critical inputs viz., basic seed and commercial seed. Impact on various productivity parameters is furnished at **Table-3**.

Table-3: Productivity parameters achieved under special SGSY Projects in Bihar and Jharkhand

Particulars	**Norms**	**Productivity under the project**		
		Bihar	**Jharkhand**	**Total**
Nucleus seed cocoon/dfl	50	56.8	49.6	51.4
Basic seed cocoons/ dfl	32	31.3	31.1	31.2
Cocoons used to produce one dfl of Commercial seed	4	3.7	3.1	3.3
Reeling cocoons/dfl	50	51.7	53.6	52.8

Impact on Socio-Economic Conditions of Participating Families: Due to adoption of best practices and recommended technologies, production and productivity increased resulting in enhanced additional income from various activities in the tasar sector. This additional income, active participation in decision making and access to the main stream helped social transformation of tribals which is evident from the following:

Private Graineurs: Over 90% graineurs started the activity in the last 10 years, with earnings in the range of Rs. 10,000/- and Rs. 30,000/- (over 63%), 4% earning more than Rs. 40, 000/- and about same percent earning less than Rs. 15000/-, from the activity covering just over one month period. It is also observed that about 74% of graineurs participated in commercial rearing and 30% in seed rearing. Only 15% graineurs did not participate in any other activity, other than the seed preparation. For most of the graineurs (i.e., about 67%), the vocation has resulted into asset creation.

In terms of debt, 93% of the graineurs who were under debt before, have completely repaid their loan while 7% have repaid partial loan. About 30% of the graineurs had taken loan against land. All the families have freed their mortgaged land. The source of credit has changed from moneylenders towards SHGs and not taking loan at all. There is, however, a decrease in percentage of graineurs taking loan from the Banks. All the graineurs were found to have stopped migrating for work. Earlier, only 33% of the families did not migrate. The remaining migrated for varied periods- 1-3 moths (41%), 4-6 months (19%) and 7-9 months (7%). All the families are now food secure with 74% families reporting surplus. In the earlier situation, about 74% families were food secure for up to 9 months.

Seed Rearers: About 90% of the participating families started rearing of cocoons within the last 10 years. The average additional income from the activity varied between Rs. 4,300/- and Rs. 10,000/-, for the rearing period of just over a month. 23% of the families are only into seed rearing, about 12% also carry out grainage activity and 69% are also into commercial rearing.

Commercial Rearers: Traditional rearers earned average additional income in the range of Rs. 800/- to 11,000/- from the rearing activity. Over 93% families started commercial rearing in the past 10 years and about 94% participating families had a net additional income around Rs. 20,000/- during the last two crop seasons and 6% reported to have more than Rs. 20,000/- net additional income, for the activity period of 1.5 to 2 months. While about 80% rearers are only into commercial rearing, 6% families are into grainage activity, 10% in seed rearing and 2% in reeling and spinning activities. Average opportunity cost is observed to be around Rs. 3000/- for the participating families in the commercial crop rearing.

Major utilization of income has been in food, asset creation, health and loan repayment. In terms of assets, families have majorly invested in livestock/ animal and vehicle (bicycle). For the utilization of future earnings, the focus is more towards savings, assets and education. Out of the 84% families under debt before initiation of the projects, 72% families have completely repaid loans. Out of the 37% families which had mortgaged land for taking loan, 77% families have freed their land. The source of credit has shifted from money-lenders to SHG. There is a slight increase in families who do not need to take credit any more.

A majority of families (i.e., 84%) now do not migrate as compared to 46% earlier. Against 59% families having food security of less than 6 months, there are only 31% families remaining in that category now. About 50% families are now food secure or have surplus food as against 21% families earlier. In terms of workload on women, about 65% women said that the workload has increased. However, 98% of the women surveyed said that they wanted to continue with the vocation primarily because it provides economic stability and they can work from home.

Reelers and Spinners: Both the groups have started working in the respective vocation in the last 7 years. A majority of participating women earn a net income between Rs. 1000/- to Rs.

2000/- in a month, for involving 3-6 hours a day. 84% of reelers are only engaged in reeling while the same figure for spinners in 50%. The opportunity cost in case of the two vocations is not considered high amongst the participating families as women shift to agriculture during the peak season and also they attend this in addition to their daily core activities. As the earning from the vocation in both the cases is regular, the income is generally utilized for regular household needs like food, health and education. There have been small investments into assets by a small proportion of families in both the categories. In term of utilization of future earnings, the focus is more towards education and savings.

About 93% reelers and 75% spinners were under debt in the before situation. 70-75% families have completely repaid their loans. About 80% and 72% families have freed their mortgaged land against 63% and 70% families mortgaging land for taking loan, in case of reelers and spinners, respectively. In case of reelers there is a marginal decrease in taking loan from money lender while there is substantial decrease in the same in case of spinners. Also, in case of spinners, 24% families now do not need to take any loan as compared to before situation when every family had a credit need.

Almost all the families participating in reeling and spinning have ceased to migrate as compared to 49% and 60% families migrating in the past, respectively. The workload on women in cases of reelers and spinners has increased for 53% and 30% of the participating women, respectively. However, all of them showed interest in continuing the vocation as it provides regular income while working locally.

Impact on Value Chain and Sub-Sector: As a result of these initiatives, the entire value chain has been strengthened with increased production and self sustaining institutions. The projects have provided a sustainable and replicable model which can help other developmental agencies to take cue from the same and replicate it in their regions. The entire value chain has been strengthened through backward and forward linkages and self sustaining institutions at each node of the chain. The initiative, through trials and tests, standardized processes, technology and models for future adoption and scaling up such initiatives. With increasing stake of the primary producers there is a direct impact on the conservation of the host plants. Village level Resource Persons generated under the projects are being utilized by other agencies/ tasar producing states for building capacities of stakeholders at their end. The program has ensured production and availability of commercial seed at the local level. Besides, addressing this major bottleneck in the value chain, the commercial seed produced in the program area is now catering to its need in other tasar parts of the country as well.

Additionally, the seed produced at the local level has developed its own standard of quality. The reeling and spinning centres developed under the program has ensured market for cocoons produced in the program area as well as in other states. The technological intervention in improving the reeling machines is expected to further augment the incomes at the primary producers' level and provide an improved version to the sub-sector. Establishment of Eco-Tasar has provided market for the yarn produced at the MBTs besides helping the primary producers to increase their stake in the value chain. The program has produced resource persons for Tasar production which are being utilized by other agencies for building capacities of stakeholders at their end.

The Socio-Economic impact of the project was well recognized and awarded at National level with Times of India Social Impact Award conferred on the Central Silk Board for the year 2012 under 'Livelihoods' category, indicates the model adopted is self-reliant, sustainable and replicable.

Conclusion & Recommendation:

These initiatives with active tribal participation remained a replicable model of best practices and value chain integration from seed to pre-cocoon and to interventions in post cocoon sectors. Empowerment and capacity building of the tribals helped in addressing many challenge viz., basic and commercial seed production, raising block plantations in degraded waste lands and developing Producers' Collectives for yarn production. Besides, the projects lead to creation of self sustainable institutions across the value chain with well defined role clarity and modalities of functioning leading to their sustenance without external support.

Tribal participation has not only leaded to success of the program but also impacted livelihoods of the participating families in various activities of tasar sector. Substantial number of families participated in more than one vocation thereby increasing their incomes from the value chain. The weavers, though, not direct beneficiaries of the program, benefit through the additional source of work orders, besides reducing the working capital requirements due to the yarn provided by Eco-Tasar.

Income derived by participating families had several direct and indirect impacts on their social status and well being. Additional income earned from the project activities has not only taken care of basic needs like food, house repairs etc., it helped them to repay loans and free mortgaged land. This was followed by investments into creating assets, savings, marriage and education. Utilization of income, as discussed before, has a direct relation to the amount of income and the felt need of the family. In case of this initiative, it is established beyond doubt that there has been a substantial increase in food security and an appreciable decrease in migration, which is bound to bring in more youth in to income generating activities, locally. In addition to this, there has also been asset creation at the household level. Besides, helping tribals to come out of their debts from money lenders, projects have increased their creditability and improved access to cheaper and fairer credit sources. The program also had a positive impact on the value chain and the sub-sector, due to effective backward and forward linkages. In terms of impact of the program on the sub-sector, it has fine tuned the technologies, developed improved prototypes and capacities of human resources in tribal areas resulting in replicable model for up-scaling in other tasar producing states.

In view of the impact made by these initiatives through active tribal participation facilitated by a professional NGO with technical and financial support from Government Organizations, this successful GO-NGO collaboration model needs to be replicated in other regions of the country for tribal upliftment.

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Carbon trading through afforestation programmes with host plants of tasar silkworm (*Antheraea mylitta* Drury) in private waste lands: A Value Add for Tribals

By

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(POSTER)

ABSTRACT: Afforestation programmes, which are part of Clean Development Mechanism (CDM) projects bridge critical gaps that remain in understanding social, economic, and environmental incentives and impacts at the interface between people, forests, and carbon sequestration. Afforestation through host plants of tasar silkworm viz., Arjun (*Terminalia arjuna*) and Asan (*T. tomentosa*) on degraded, unutilized private waste lands can add a component of livelihood creation and income generation to the local people for their sustenance. This was tested successfully on a large scale under some developmental initiatives of the Central Silk Board, Govt. of India with help of NGOs, would be a more practical and profitable proposition in view of tasar silkworm rearing for over five decades on these systematic plantations. As Indian definition for CDM projects include tree crown cover of 15%, land area value of 0.05 ha. and tree height value of 2 meters, which fits most for tasar host plants and also highest carbon sequestration rates (0.1 - 0.25 MT/ha) associated with the trees than those from herbaceous crops through their marked increases in the level of soil carbon, they also have unexplored potential to generate carbon credits.

This initiative can also address social inclusion and empowerment of tribals, activities such as agro-forestry extension, environmental education, micro-credit, marketing assistance, active stakeholder participation and group approach. Keeping in view the transaction costs in carbon trading and augmentation of tasar host plants, taking up plantations in large areas are typically necessary. Brief account of the development initiative, project benefits, possible exploration in the field of CDM and strategies for future expansion at national level are detailed.

Keywords: ***Afforestation, Clean Development Mechanism, tasar silkworm rearing, livelihood creation, carbon credits***

Introduction:

Climate change is one of the most challenging environmental, economic and social issues facing the world today. Industrialization and deforestation lead to increased pollution, as result of emission of green house gases (GHGs) there by bringing in change in the overall trend in climatic patterns. GHGs are naturally occurring gases that trap heat in the Earth's lower atmosphere, keeping the planet warm and helping to support life, which have been increasing largely due to human activity, in particular the burning of fossil fuels and deforestation. Global carbon dioxide emissions continue to mount, with average annual increase 1.3 per cent or nearly 300 million tonnes a year over the past decade. At the start of this decade, while the carbon emissions were in the range of 300 to 500 million MTs/ year in the developing countries, it has crossed 1600 mark in the developed countries. Though GHGs can be reduced by reducing consumption of fossil fuels, it is not practically feasible in view of increasing urbanization and industrialization.

India shares the global concern of climate change by becoming a Party to the Vienna Convention (1991) and the Montreal Protocol (1992) for the Protection of the Ozone Layer and on substances that deplete the Ozone Layer besides signing the United Nations Framework Convention on Climate Change (UNFCCC) in 1993. Kyoto Protocol imposes binding targets to reduce combined GHG emission by 2012, 5.2 % below their 1990's level. This can be achieved through direct regulations viz., incentives and/or obligations to reduce net emissions of greenhouse gases or through indirect measures. Following three mechanisms were provided under Kyoto Protocol to enable countries or operators in developed countries to acquire greenhouse gas reduction credits or carbon emission reduction (CERs) units. Carbon Emission Reduction (CER) is defined as a reduction of 1 tonne of carbon dioxide emission into the atmosphere and one CER earned is directly proportional to volume of CO2 equivalent emission reduced.

1. **Joint Implementation** (JI): Under this a developed country with relatively high costs of domestic greenhouse reduction would set up a project in another developed country.

2. **Clean Development Mechanism** (CDM): Under which a developed country can 'sponsor' a greenhouse gas reduction project in a developing country where the cost of greenhouse gas reduction project activities is usually much lower, but the atmospheric effect is globally equivalent. The developed country would be given credits for meeting its emission reduction targets, while the developing country would receive the capital investment and clean technology or beneficial change in land use.

3. **International Emissions Trading** (IET): The developing countries can trade in the international carbon credit market to cover their shortfall in allowances, under this. Countries with surplus credits can sell them to countries with quantified emission limitation and reduction commitments under the Kyoto Protocol.

The developing countries have no immediate restrictions under the UNFCCC to reduce green house gases, but, they can raise revenue helping developing countries through some of the above indirect measures. Hence the most practical option by adopting measures that enhances carbon sequestration, a process whereby trees and soil capture carbon. CDM projects with over three years of operational experience have low global administration cost of below 1% and generated revenue of over $ 1.5 billion through sale of Carbon Emission Reduction (CER) units at US$ 15 per unit. As on date, 1769 projects are registered and total 4200 CDM Projects are in pipeline through which over 290 crore CERs are expected until the end of 2012, of which India has over 400 projects to its credit. While CDM projects are small and mostly energy industries, it is estimated that those are in pipeline in 2006 were estimated to result in US$ 25 billion in capital investment, renewable energy and energy efficiency projects registered in 2006 were expected to result in US$ 5.7 billion in capital investment. Governments of developed countries, Portfolio Managers of Carbon Funds like World Bank PCF, corporates especially European companies under the EU-ETS Scheme and Brokers/Speculators are the potential buyers of these CERs. Transactions include equity investment in projects and receiving CERs in return (bilateral), Purchasing CERs through Forward sale through sales agreement (weak unilateral) and Purchasing CER through on the spot market trade (unilateral).

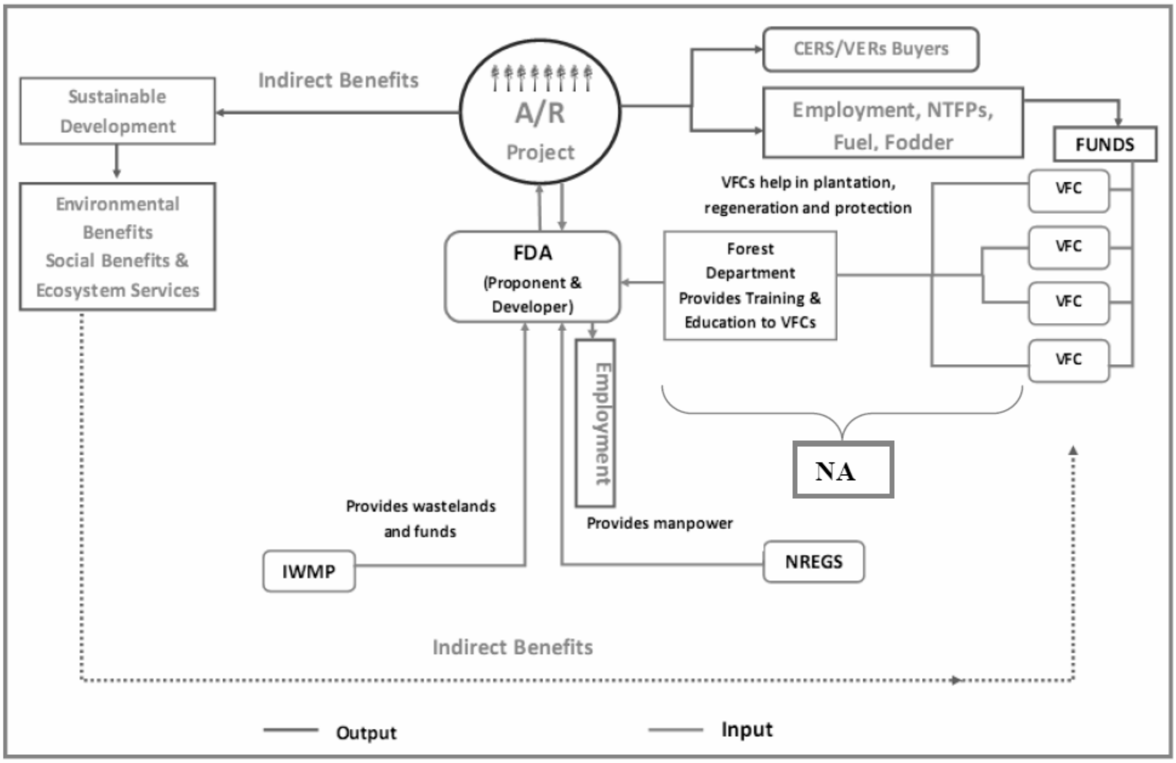
CDM Executive Board is the Regulating Body which issues CERs supported by validating and verifying Body and other National Authorities. CDM Projects include small scale (less than 15 MW) and large scale (more than 15MW) energy projects and afforestation and reforestation projects. Under the alternate option of CDM Projects through afforestation and reforestation programmes, no much action has been initiated yet (S. Thomas et.al., 2010). While afforestation Projects can be carried out on lands that has not been forested for a period of at least 50 years, reforestation projects can be carried out on land that was forested but that has been converted to non-forested land. According to Indian definition for these projects include tree crown cover of 15%, land area value of 0.05 ha and tree height value of 2 meters, are the main criteria.

Creating and protecting agro-forests and other natural ecosystems can provide a host of services that reduce human vulnerability to natural hazards including benefits of carbon sequestration. Protected areas and the natural habitats within them, can protect watersheds and regulate water flow, prevent soil erosion, influence rainfall regime, local climate and conserve genetic resources. Agricultural land in developing nations has expanded primarily at the expense of over 30% of the forest areas. Agricultural emissions of both carbon dioxide and methane are increasing because of conversion of forests and woody savannas to agricultural uses, deliberate burning of crop stubble and pastures to control pests or promote fertility, and paddy cultivation. Encouraging farmers to take up agro-forestry and farm forestry on their own lands has several advantages. Some of them are as below.

1. It saves marginal lands from further degradation and maintains or increases productivity through nutrient recycling and soil protection there by increases the value of output.
2. Through supply of raw materials (such as leaf compost) to agriculture directly and indirectly, and by producing food and forage for human and animal consumption, it complements and supplements agricultural production.
3. It diversifies the range of outputs from a given area which increases self-sufficiency and reduces the risk to income from adverse climatic, biological or market impacts on particular crops.
4. It spreads the need for labour inputs more evenly, thus reducing the effects of sharp peaks and troughs in activity characteristic of tropical agriculture.
5. The technology is simple, labour intensive, and requires little technical support.
6. It promotes value-added activities in rural India, as several communities have traditionally been involved in supplementing their incomes through processing agro-forestry products.
7. The program of agro-forestry does not invite hostility from the rural rich, which is inherent in land reforms and other distributive programs.
8. As rural women are involved in such agro-forestry activities, it leads to their empowerment through income generation and capacity building.

But above initiatives have not attracted people's participation, as they treat them only as government's programmes and utilizing the private degraded waste lands for the purpose with a change in outlook, might be a practical solution to this. Chandra (1994) suggested that a practical way to achieve rural development in India, with solving the problems of deforestation, poverty and unemployment simultaneously, is to channel investment into forest based cottage industries, which have both high employment potential and income generation capacity, which includes tasar sericulture using planted trees of *Terminalia arjuna*. Kumar and Reddy, 2000 studied the successful inclusion of *Terminalia arjuna* under compensatory afforestation plantations under Telugu Ganga Project in Andhra Pradesh.

Vegetation in the forests or block plantations raised under various developmental programmes have the potential to earn substantially more from carbon trading, which could be a source for afforestation programmes. As result of Bali climate summit, traders in the emerging European carbon market are buying the carbon credits (one-ton reduction in carbon) at about $35. Though afforestation has potential for earning revenues through carbon trading, forest-based carbon market would be complicated keeping in view of the various Forest Acts in force. The per capita availability of forestland in India is one of the lowest in the world, 0.08 hectares, against an average of 0.5 hectares for developing countries and 0.64 hectares for the world. The right of deforestation in the country has been considerably reduced during the last few years. The average annual rate of deforestation fell from about 1.3 million hectares in the 1970s to 339,000 hectares in 1980s and to about 129,000 hectares during 1990-95. However, considering that important objective of the National Forest Policy, 1988 is to increase the forest/tree cover to 33 per cent from the present level of 19.27 per cent, even the reduced level of deforestation is a negative achievements, though of a lesser intensity. Following figure indicates the model to use available resources for climate change afforestation projects.



Out of the 14 afforestation projects in India, the Designated national Authority (DNA) of India has approved ten CDM projects so far (NCDMA India 2010). Of the ongoing projects the land area covered is in the range of 106 to 3060 ha. and among the projects in pipeline the land are is in the range of 27 to few thousand ha., comprising degraded private and government lands. These afforestation projects have potential generate income from timber production, NTFP including tasar cocoons, carbon credits and other co-benefits like employment generation, biodiversity enhancement, soil quality improvement, enhancement of ground water resources.

Sericulture Industry & Clean Development Mechanism: Two Silk industries viz., M/s Garden Silk Mills Ltd., Surat, Gujarat and the Palsana Industrial cluster, Gujarat have been involved in small scale (13.5 MW) natural gas based package cogeneration system for power generation and steam generation using the exhaust waste heat, CDM projects in India with crediting period of ten years and estimated credits of 5,86,124 units.

Further, The Energy Research Institute developed a gasifier suitable for silk reeling industry under Swiss Development Corporation funded SERI-2000 project, which is now commercially marketed by two manufactures. The main goal of the project was to improve the productivity and profitability and reduce environmental impact of post-cocoon processing in the silk industry. Biomass gasifiers developed for the silk industry allow fuel savings of about 70%, representing 822 tons of fuel wood per year. This reduces CO2 emissions of the silk factory and decreases the pressure on the local forests. In addition these systems also reduced the water consumption of silk reelers. However, the above effort could not commercially sustain due to various practical reasons.

Tasar host plant cultivation as an option for CDM: However, the alternate option of CDM Projects through afforestation programmes, can well be utilized in sericulture sector. Agro-forestry like raising tasar host plants not only has the potential to store carbon, it also addresses the need for alternative livelihoods amongst tribal populations who currently benefit from deforestation. India being the second largest producer of tasar silk after China, it has a prominent role to play in Indian economy. It is practiced by over 1 lakh 25 thousand tribal families in Jharkhand, Orissa, Chhattisgarh, West Bengal, Andhra Pradesh, Uttar Pradesh, Maharastra, Madhya Pradesh and Bihar. Tropical tasar silkworm *Antheraea mylitta* Drury is polyphagus and rearing is carried on nature grown forest plantation belonging to genus Terminalia, *viz., T.arjuna, T.tomentosa* (*arjuna* and *asan*) and also *Shorea robusta (sal)*. Production of tasar cocoons largely depends on the availability of food plants in the forest. In India, though tasar flora is available in about 111.68 lakh ha., it is mainly dominated by Sal, while tasar rearer prefer arjuna and asan leaving about only 11900 ha. for tasar silkworm rearing.

Farmers generally do not raise their own plantation and solely depend upon nearby forest patches. Of late, indiscriminate felling of tasar food plants from village forest for fuel purpose has posed great hindrance for extension of tasar cocoon production, besides objections raised by local forest department officials. Though, under Inter State Tasar Project (ISTP) over 7500 ha. of land was brought under Arjun./ Asan plantation in different traditional and non-traditional states, but much of the plantations have not been properly maintained after the project, due to lack of accountability on part of tasar rearers. It is therefore, necessary that economic plantation should be raised in private lands, as land resources are better managed and utilized under private ownership to avoid conflict, which may arise with respect to ownership and income sharing. In case of private wastelands / fallow lands, the major challenge before the intervention is to create a vision of long term livelihood opportunity for the land owner through the utilization of waste/fallow lands. Since tasar silkworm rearing is a family avocation, hence the landowners would always value host tree plantation raised in their private lands as an asset and the family will tend to invest efforts and resources to maintain the plantations in better ways. Moreover, the income from this asset would always be fully retained by the landowners.

Details of extent of tasar host plants in forests and tribal families conducting rearing are appended at **Table-1**, below. This along with additional area brought under tasar host flora mostly comprising the preferred food plants viz., is not available for optimal capacities of tasar silkworm rearing due to lack of accountability. It is therefore, necessary that economic plantation with arjuna and asan should be raised in private lands for tasar silkworm rearing, as it is economically viable compared to other agricultural and commercial crops in tribal areas.

Table-1: Tasar food plants and rearers in different states.

State	Available forest area (lakh ha.)	Area under tasar food plants (lakh ha.) *	No. of tribal families in tasar rearing (in lakh)	Plantation available for exploitation (Ha.)
Jharkhand/ Bihar	34.9 (27.73/7.17)	9.18	0.600	1270 70
M.P./ Chattisgarh	146.32 (62.72/ 83.6)	50.48	0.200	5600 2300
Orissa	67.46	20.24	0.320	400
West Bengal	11.48	3.55	0.050	120
Andhra Pradesh	65.18	13.02	0.030	910
Maharashtra	66.96	10.04	0.020	1200
Uttar Pradesh	35.10	5.21	0.015	30
Total	**427.40**	**111.68**	**1.235**	**11900**

Source: State of Forest Report, 2003. ****CSB estimates***

Raising the tasar host plants in the private wastelands improve the accessibility for silkworm rearing, landowners valuing host tree plantation raised in their own lands as an asset and the family will tend to invest efforts and resources to maintain the plantations in a better way, as the tasar culture has been a tradition and a way of life for many a tribal families. It also avoids problems of income sharing as in case of common/ forest lands.

Materials & Methods:

Central Silk Board (CSB), Ministry of Textiles, Govt. of India, the Apex body has supported the concept of raising block plantations of tasar host plants under various initiatives. But it was limited to village common lands, revenue and forest lands, resulting in non-sustenance of the activity after the project period. To overcome this, it has taken up many collaborative initiatives with support of other developmental agencies under the Swarnajayanti Gram Swarojgar Yojana (SGSY) Special Projects, Tribal Development Fund Projects etc., in the States of Bihar and Jharkhand involving a professional Non-Governmental Organization, Professional Assistance for Development Action (PRADAN) to promote economic plantations of tasar host plants in private wastelands of tribals on a large scale by integrating all the activities across the tasar silk value chain. The stakeholders were from the below poverty line (BPL) families of rural poor mostly belonging to scheduled tribes, Schedule Castes and other weaker sections of the society who are traditionally involved in tasar culture.

The idea of promoting arjuna plantation to create sustainable livelihoods by using hitherto idle assets like wastelands of tribals had relevance in the southern part of Bihar (now Jharkhand) as the average landholding of even poor households was 1.7 hectares and 40% of the landholding was either fallow or uncultivable. A cluster-based approach was followed to attain scale of economy in a compact area (comprising of 1-2 panchayats) with an overall area of plantation of around 100-150 ha. involving 100-200 families, this ensured equitable sharing of benefits by the participants and participation of the majority.

Selection and motivation of tribal groups: Concept of plantation and its benefits were shared with small groups of poor tribals preferably in hamlets owning a contiguous patch of lands (at least 5 ha. of land) suitable for tasar host plant cultivation. Exposure visits were organized to economic plantation promoted under other schemes in which rearers have already started commercial cocoon production. Interaction between the tasar rearers and the group was facilitated to understand the economic returns and the various factors like managing and protecting plantations at least for 4 years before it fetches returns and labour contribution they need to make.

Selection of plantation site: A compact geographical area covering 1-2 panchayats having a minimum of 35% of the private land holdings coming under the category of fallow / wastelands was identified. The wastelands / fallow lands without continuous stone layers with in 3 feet depth and soils interspersed with loose bolder or soil with loose morrum layers up to 4 feet depth were selected. Special land husbandry measures were taken up to check run-off of water and soil erosion, where slope was more than 25%. Fallow / wastelands belonging to poor people looking for livelihood activity was only selected.

Opportunity cost analysis: A hamlet-based meeting was organized to assess the economic benefits of the idle lands such as from cattle grazing, or from fuel wood gathering from the bushes growing on the land. Investment and returns from the same land were discussed if Tasar plantations are raised on it, besides economics of other competitive agriculture crops like minor pulses or millets, which can be grown on the land.

Formation of Tasar Vikas Samity: Tasar Vikas Samity (TVS) is an informal village level group responsible for raising and maintenance of plantations. TVS's role begins with selecting the nursery farmer. It then plans, implements and monitors the entire range of activities including pits and trenches, land husbandry, transplantation, etc. The TVS meets once in 15 days to plan and budget for various activities. It has its own bank account. TVS maintains its accounts and maintain stock book for material transactions, which are audited. By forming TVS, increased tribal participation was sought at every stage of plantation activities starting from site selection, planning, budgeting, nursery raising and transplantation to regular intercultural operations and protection of plantations against grazing. All the financial and material transactions with individuals in the villages are carried out through the respective TVSs. If the owners of the land, earmarked for plantation, comprise of majority of the SHG members, then the SHG in the village has played the role of TVS.

At the start of the work, the TVSs are facilitated to prepare a detail work plan and budget based on their abilities to contribute labour and material. The work plan and the budget of the TVSs are submitted to PRADAN office through the functionary of PRADAN operating in the area. Once the work starts in the village, PRADAN functionary assesses the progress of the work and monitors the expenditure details and recommends release of the next indent directly to the bank account of the TVS.

Land Husbandry and Plantation Maintenance: Tasar host plantations are raised in the unbunded / unterraced uplands or medium uplands that remain mostly fallow or sporadically cultivated. These lands in undulating topographical terrain facilitate rapid water run off to cause soil erosion. Considering this, land husbandry measures viz., staggered trench, 30' x 40' model and field bunding, water harvesting structures etc., were planned to check water run off and prevent soil erosion to enhance moisture retention capacity of the land.

Intercropping: To sustain the interest of the tribal rearers during the gestation period, they were encouraged to take up intercropping leguminous crops that fix nitrogen in their roots and add the same to the soil. As the farmers start attaching value to the short-term returns from intercropping, hence, their own interest in protection of the plantations from grazing animals improves significantly. Moreover, cattle are generally not released in the cropped land. Ploughing across the slope at the time of intercropping turns the soil of the entire field and checks water run-off, which promotes vigorous growth of the plants. Leguminous plants like moong (*Vigna mungo*) and urad (*Vigna radiata*) were utilized for intercropping. Rapid growth of tasar host plants is thus triggered by increased soil loosening, higher percolation of rainwater and biologically added nitrogen.

Results & Discussion:

Block plantations of tasar host plants viz., arjun and asan were raised in the project area by the members of TVSs and maintained for three years as per recommended package of practices. While, the block-wise and district-wise area covered under the projects is indicated at **Table-2**.

Table-2: Tasar host plants raised under Special SGSY Projects

Sl. No.	State	Districts	Blocks	Plantations raised (Ha.)
1	Bihar	Banka	Bounsi, Chandan & Katoria	511.8
2	Jharkhand	Godda	Godda, Sundarpahari & Poraiyahat	360.0
		Dumka	Jarmundi, Saraiyahaat, Sikaripara, Kathikund & Dumka Sadar	527.00
		West Singhbhum	Jagannathapur, Kumardungi, Manjgaon & Jhinkpani	171.0
Total		4 districts	15 Blocks	1569.8

Besides raising economic plantations of arjun and asan, the Projects helped in rejuvenation of over 10000 ha. of natural forests with tasar host plants with annual income potential of over Rs. 10.0 crores. With successful implementation of special SGSY Projects, over 4000 ha. tasar host plantation was raised in private waste lands under other developmental projects in addition to planning of about 20000 ha., under various developmental schemes with support of CSB during the XII Plan period.

Performance Indicators of Raising Tasar Host Plants: Survival percentage of over 95% after one year and over 90% after two years with average height of plants of more than 8 ft. after 2nd hoeing in 3rd year and at least 80% of the plants will mature in 4th year ready for tasar silkworm rearing were fixed as checklist for extending the assistance under the Projects.

Sequence of activities under the Special SGSY Projects was adopted by incorporating all the technological inputs from the Central Tasar Research & Training Institute (CTR&TI), Ranchi in raising of kisan nursery and establishment of block plantations and their maintenance. Besides, SHGs were encouraged to produce vermicomposts which was utilized in maintaining the plantations besides application of inorganic fertilizers to upkeep the soil health.

Impact of the initiative: All the block plantations and chawkie gardens raised under the Projects have become ready for rearing tasar silkworms by fourth year. Further, the crop duration was considerably reduced because of quality foliage resulting in better growth of tasar silkworms. Suitability of leaf quality and increased uptake of dfls (disease free layings) per unit area was evident with increase in cocoon productivity of 60 per dfl from 35 per dfl under natural forest plantation. In some of the clusters, cocoon yields were as high as 100-110 cocoons/ dfl. The increase in cocoon yield was due to better management practices of tasar silkworm rearing on plantations raised in private lands as they were in the vicinity of villages. Further, the crop duration was considerably reduced from 75 days in forest plantation to 60 days in these economic plantations due to quality foliage resulting in better growth of tasar silkworms (**Table-3**). This has further resulted in increase in net income levels of different stakeholders have increased from Rs. 4 to 5,000/- to Rs. 18 to 20,000/-.

Table-3: Impact of economic plantations of tasar host plants raised under the Special SGSY Projects

Particulars	Forest plantation	Economic plantation
Cocoon Productivity (per dfl)	35	60
Crop duration (Days)	75	60
Net income/ crop/ rearer (Rs.)	4 to 5000	18 to 20000

Besides the above, the projects have helped in organizing 12600 rearer families, 251 village level grainage entrepreneurs and 1165 tribal women in tasar yarn processing. Projects also lead to production of 63.38 lakh tasar silkworm dfls and 22.73 crore tasar cocoons worth of over Rs. 30.94 crores, during the project period. This output and net income levels are bound to continue or increase for at least another five decades besides many other socio-economic and environmental benefits.

Future Opportunities for carbon trading through raising host plants of tasar silkworm: Studies by Paul et. al. (2002) emphasized on the quantifying changes in soil C, which may be an important consideration under large-scale afforestation or reforestation, to which the present initiative also fit in. This attains importance with respect to tasar host plants, which biomass would be consumed only once in a year, but compensated by the silkworm litter as the rearing is carried out on the trees.

Management of soil health is the priority for these tasar rearers as these plantations would help them to rear tasar silkworms with annual returns of over Rs. 20,000/- per ha. for over fifty years with minimum maintenance, better management practices due to the vicinity of the plantations to the villages etc., which would bring in sustenance of the activity besides expansion. These plantations also have unexplored potential to generate carbon credits based on the Clean Development Mechanism (CDM). This attains importance as the developed countries and economies in transition can acquire carbon credits generated through such projects to abate part of their greenhouse-gas emission-reduction commitments ratified in the Kyoto Protocol (Wilfred and Kwon, 2000). It is established that highest carbon sequestration rates (0.1 - 0.25 MT/ha) are associated with the trees than those from herbaceous crops and consequently can cause marked increases in the level of soil carbon.

Vegetation in the forests or block plantations raised under various developmental programmes have the potential to earn substantially more from carbon trading, which could be a source for afforestation programmes, to which the present initiative fits in very well. As result of Bali climate summit, traders in the emerging European carbon market are buying the carbon credits (one-ton reduction in carbon) at about $35. In view of the demand for tasar silk, need for block plantations in private waste lands, availability of huge tracts of degraded lands and very many developmental schemes, makes this very viable proposition.

Issues to be addressed: Though there is vast potential to utilize the plantations of tasar host plants in private lands of tribals, some of the major issues to be addressed in these projects are demarcation of the project boundaries, permanence (temporary credits), quantification of Carbon Emission Reductions (CERs), validation and verification and environmental and social sustainability. F. Haupt & H. Lüpke (2007) have elaborated on the both the constraints and opportunities for afforestation projects under CDM. Due to these issues, while only one project is registered from China under this category, two projects have been submitted from India to the CDM Executive Board.

Of the above demonstration of land Eligibility becomes a very important criterion and under afforestation projects, the proposed land should be of non-forest category for 50 years before the project start and land use change from non-forest to forest defined through tree crown cover, tree height and land area. Further, the complex methodology involved, difficulty in proving land eligibility and establishing baseline, expensive and limited data and maps, limited expertise available in this field etc., are the some of the areas need to be looked into for bringing in additional and recurring income avenues to these poor tribals besides other social and economic benefits like migration to urban areas, checking pollution through enhanced green cover, soil erosion etc. Keeping in view the above benefits, the mentioned issues needs attention of policy makers and environmental activists to bring in active tribal participation in raising tasar host plants in systematic by involving professional NGOs for better facilitation and to bring in social inclusion and empowerment of tribals.

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Producer Company – An Innovative Concept for Tasar Yarn Production

By

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(POSTER)

ABSTRACT: Tasar sericulture, which is mostly a forest based tribal activity, its yarn production adds maximum value across the activity chain. Tasar yarn production had no independent identity due to its unorganized nature and was under the control of middlemen till recent times. Though, cooperatives in some of the states were established for yarn conversion the same could not sustain due to various managerial difficulties and lack of participatory approach. Central Silk Board through its various development initiatives and women friendly gadgets attempted to bring in business sense among tribal women to take up this activity as a micro-enterprise in production clusters. Central Silk Board in association with Professional Assistance for Development Action (PRADAN), an NGO enlarged the network of women tasar reelers and spinners in the States of Bihar and Jharkhand under the Special Swarnajayanti Gram Swarojgar Yojana (SGSY) Projects through group and cluster approach. Various steps viz., selection of tribal women, their capacity building, mobilizing them in to Mutual Benefit Trusts (MBT) along with development of backward and forward linkages are discussed. Innovative interventions viz., upgradation of existing tasar yarn production technologies and validation through tribal participation, promotion of business sense and entrepreneurial capability among yarn producers, promotion of Producers Company, establishing linkages with economic services, promotion and sale of tasar yarn, partnering with other agencies for achieving the quality standards and further value addition etc., leading to socio-economic development and empowerment of tribal women are discussed. Issues related with the functioning of the Producer Company and its sustenance is also discussed besides suggesting support systems required and the future strategies.

Keywords: ***Central Silk Board, Mutual Benefit Trust, Producer Company***

Introduction:
In spite of India being the second largest producer of tasar silk after China, tasar silk production trends are very much fluctuating till recent times. Tasar sericulture includes continuous chain of several production activities comprising the tasar cocoon producers and the yarn producers. While rearing of silkworms and collection of cocoons is mostly practiced by socially and economically marginalized tribal communities, tasar yarn production, a low-income subsidiary activity of poor women in their free time within the house had no independent identity.

Present system of yarn production & Marketing: Post-cocoon technology for *vanya* silk production in India has been very primitive till recent times. About 90% of tasar raw silk was produced on "Natwa" *i.e.,* manually with the help of a bamboo made Natwa, rubbing the silk filaments on thigh, which is laborious, undignified for a woman and unhealthy producing hardly 80 gms per day per reeler. In addition, many kinds of hand spun yarns are produced *viz.,* Ghicha, Katia, Jhuri, Balkal etc. Use of palm, thigh, and primitive tools in the production of tasar yarn has proven to be unhealthy and ineffective in enhancing productivity, ensure reasonable income to the producers and maintaining high quality standards of the produce. There is very low investment in innovation and up-gradation of yarn production technologies and marketing of yarn by either the private sector or the government to establish tasar yarn as an independent product in the tasar sector, except for the recent interventions in taking up comparative performance of all available reeling and spinning machine for field trials involving tribals besides cooking technology. In addition to the various constraints, some of the specific problems faced in the processing and marketing sector of tasar culture are detailed below.

1. *Vanya* silks are considered as a low priority area in many of the states without sufficient budget provisions to avail the benefit of the Central Schemes.

2. Non-adoption of technologies due to financial constraints, lack of knowledge to understand & propagate the technologies and motivation at the field level.

3. Due to traditional systems of production process and unorganized nature of cocoon and yarn marketing, both the yarn-producers and weavers are often exploited by the middlemen.

4. Though, cooperatives in some of the states were established like any other sector they have often become vehicles for government programmes, operating with substantial government funds and personnel led to political interference.

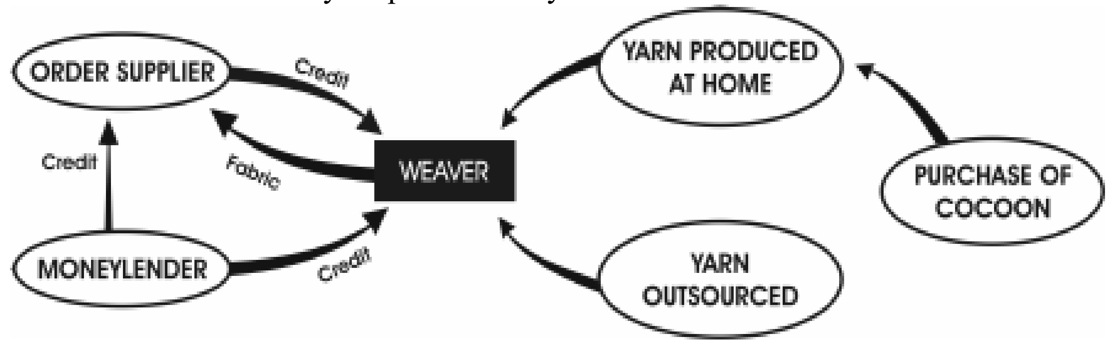
5. Producers of cocoons and yarn do not get remunerative prices for their produce in absence of uniform system/pattern for fixing quality linked price.

6. Though some of the government marketing agencies improved the bargaining power of cocoon producers, same could not sustain and incurred heavy financial losses.

7. Absence of inter-state transport/ trading of cocoons in some of the States hindering free market operations.

8. Absence of independent agencies for production forecasting and its reporting for tasar raw silk fuels the speculation of its prices, difficult to plan for its processing.

Traditional tasar yarn production activity has no independent identity, is a low-income subsidiary activity of poor women, mainly wives of weavers in their free time within the house. Traditional, inefficient production process, technology and exploitation by the traders and moneylenders crippled the activity. Tasar yarn production chain in traditional weaving clusters is mainly of two types. Firstly, the well off yarn traders purchase and stock cocoons for the whole year and get the cocoons reeled from the traditional women reelers in the vicinity of reeling clusters against the specific order from the weavers or fabric manufacturers. This arrangement sustains as these poor women has no alternate income opportunity. Secondly, the weavers buy cocoons for the whole year taking credit from local moneylenders at a very high rate of interest. Female members of the weavers' family convert the cocoons and the weavers after weaving the fabric sell it to the fabric traders, who are mostly the moneylenders, who pass on the meager amount to weaver after deducting principle and interest on loan. As this is not an organized system, both the yarn producers and weavers are financially exploited in a closed system operated by the moneylenders, traders, and order suppliers. The traditional tasar yarn production system could be described as below:



Development Initiatives by Central Silk Board: Central Silk Board, the Apex Body for Sericulture development in the country with help of some reputed NGOs brought in a shift from traditional practices to small user-friendly machines for conversion of yarn from tasar cocoons by women through various development initiatives *viz.,* United Nations Development Programme (UNDP) assisted Project and Catalytic Development Programme (CDP) schemes of CSB. The concept of individual reelers and spinners has proved to be profitable for poor women in the production clusters. However, lack of purchase and holding capacity /infrastructure of raw material, know-how on technical issues, facilitation in procurement of raw material and sale of tasar yarn, availability of spares, institutional support etc., resulted in non-sustenance of the activity at individual level after conclusion of respective development initiatives.

In view of the above, Central Silk Board in association with Professional Assistance for Development Action (PRADAN), an NGO enlarged the network of tasar reelers and spinners in the States of Bihar and Jharkhand under the Special Swarnajayanti Gram Swarojgar Yojana (SGSY) Projects with the assistance from the Ministry of Rural Development (MORD), Govt. of India through group and cluster approach. Under this development initiative, PRADAN and CSB has taken up various activities such as upgradation of existing tasar yarn production technologies, selection of interested women among the Self Help Groups for reeling and spinning activities, skill enhancement and capacity development, promotion of business sense and entrepreneurial capability among yarn producers, organization of the producer groups in to Mutual Benefit Trusts (MBT) or just Primary, village based Activity Group, establishing linkages with economic services, aggregation, sorting, grading, packaging, promotion and sale of tasar yarn through the federation of these MBTs / Activity Groups formalised as Producers Company, a new concept in tasar yarn production in the country paving a new way for socio-economic development of the women from economically challenged families located in inaccessible and remote villages.

Concept of Producer Company: 'Producer Company' is fundamentally designed to serve producers of primary products, whether these be agricultural and related, or handicrafts and other artisan's goods under 'Companies (Amendment) Bill, 2000' as an additional Part (Part IXA) to the Companies Act, (Act 1 of 1956). This is considered to be an enterprise for the economic and social betterment of its owners (producers) through self-help, mutual aid and voluntary association, and performs only such services as are primarily intended to benefit its owners. Objectives of the Producer Company include production, pooling, procurement, grading, marketing of primary produce; processing produce to add value; supply of inputs, machinery and equipment; education in relation to the other objects; technical and consulting services, training, research and development; activities related to production and financial support and credit facilities to Members, and other activities that are ancillary or incidental.

Materials and Methods: Tasar yarn production was selected as a livelihood opportunity to promote among women as it offers a steady income stream throughout the year, suitable to women and there is a huge gap between demand and supply of tropical tasar yarn in India. Areas of intervention are:

- Upgradation of existing tasar yarn production technologies
- Promotion of business sense and entrepreneurial capability among yarn producers
- Establishing linkages with economic services
- Promotion and sale of tasar reeled yarn in the open market
- Promotion of new fabric designs and sale of fabrics, made out of the yarns produced
- Promotion of producers' business organizations

Tasar yarn producers promoted under Special SGSY Projects are neither confined to the weaving clusters nor linked to weaving. The tribal women in the tasar cocoon production clusters are selected and organized into Self Help Group (SHGs), which are nurtured to evolve as a cohesive, democratically functioning group. Initially SHG members start investing in small business of their choice taking credit from the groups' corpus and if required additional credit from nearest bank, which would be supported with skill development in technical aspects of the reeling/ spinning. In tasar yarn production issues such as availability of cocoons, volume of working capital required and sale of tasar yarn that is produced in scattered and remote villages, compels the producers to be collective to sustain for long time.

Considering these aspects, each village level, yarn producers' group (25-30 women from 2-4 SHGs of same village or adjacent villages) are promoted to increase individual production efficiency, profitability and quality of life, to take care of the production risks. These village level yarn producers groups are registered as a Mutual Benefit Trust (MBT) *i.e.,* a form of private trust. MBT has advantages of simplicity in compliances, new form, have good image as a formation (unlike cooperatives), and lastly as it is a private trust the promoter, being a settler, can protect the interest of members and the spirit of the formation as long as necessary. Besides, small primary level organisations with members from geographical proximity helps to develop ownership - facilitate access to information, monitoring of credit to members, decision-making processes, etc.

Similarly the secondary level organisation of the yarn producers, is registered as a Producer Company, functions like a Cooperative but is governed and regulated like a private limited company of the producers (individual, formal or informal group/groups) only, to ensure marketing of produces and fair trade with the member organizations thus it will act as an interface between the market (both input and output) and its members to handle the enterprise risks. The Producer Company spread over wide geographical area has advantages in compliances, promotions, influencing the system, negotiation in sale and purchase in bulk, pooling of resources etc. Besides it has various elements to protect the interests of the producers with scope for performance (patronage) based ownership in the organisation by linking voting rights and number of votes to the well defined, quantitative contribution in the business eliminating the inclusion of fake producers and vested interests.

With the above frame work in place, a Producer Company named **MASUTA Producers' Company Limited** was registered during December 2005 with its Registered and Head office is situated at Deoghar, Jharkhand. At present it has branches at Bhagalpur and in Delhi; in addition, it also has units comprising of number of Mutual Benefit Trusts (MBTs) at Godda, Dumka, Koderma, Hazaribagh of Jharkhand; Banka of Bihar and Raigarh of Chhattisgarh with about 1000 very active (and another 1500 in the pipeline) tasar yarn producers from Jharkhand, Chhattisgarh and Bihar with production capacity of about 20.0 MT of tasar yarn, annually. The Company works towards increasing and sustaining the earning of the producers by ensuring institutional support and fair trade of their produces in the market, supplementing livelihood promotion effort with rural poor women.

Organizational Structure: MASUTA has clear-cut management and governance structure. The Generalbody comprising of representative member from each MBT/Primary Group is the most powerful in the Governance structure, followed by Board of Directors, comprising of elected producer members and experts, co-opted in the Board. The Management comprising of hired paid staff spearheaded by the Managing Director, appointed by the Board of Director. The Managing Director is supported by other employees whose roles, responsibilities changes time to time depending on the need of the organization.

Recently, MASUTA has separated the business of cocoon with the formation of Cocoon Bank and are planning to establish a Yarn Bank to reduce the working capital need by the producers.

Objectives: The specific objective of the Company is to enhance the earning of its member-producers by supporting them in quality tasar yarn production, pooling, sorting, grading and marketing in different forms. Its other objective is to meet various needs of its members like health care etc. To achieve these objectives, the Company adopts the following strategies:

1. Development and adoption of latest yarn production technologies
2. Diversification of the products (yarns)
3. Bringing in new designs and colours that utilize its yarns the maximum
4. Aggressive promotion of the products
5. Providing health insurance coverage to the producers' and her family members

Operational Modalities of MBTs and the Company:

The operation starts with the bulk procurement of raw materials *i.e.,* tasar cocoons from the tasar silkworm rearers from the cocoon producing states. In India, tropical tasar cocoons are produced in large quantity in states like Jharkhand, Chhattisgarh, Orissa and Andhra Pradesh. It is also available in West Bengal, Bihar, Uttar Pradesh, Maharastra and Madhya Pradesh. These states produce different cocoons due to variation in eco-race and microclimate. The production of cocoons still is highly unpredictable and it fluctuates widely from year to year. Thus it is risky to depend on a single source. The Company sources its cocoons across the country (except Orissa, where it is restricted to sell cocoons to outside states) depending on the availability, quality and price of cocoons.

Price of cocoons largely depends on local production i.e., demand and supply rather the silk content in it. Various State Departments and RMB (Raw Material Bank) of CSB organize open auction of cocoons, to bring in stability in price. The Company participates in open auction and all other channels convenient to it and purchases cocoons besides purchasing cocoons directly from cocoon producers, promoted under Special SGSY Projects in Bihar and Jharkhand. The Company tries to procure maximum number of cocoons during the harvest season of cocoons, as the price at that time remains lowest. Instilling the culture of quality linked pricing of cocoons, which is the need of the hour could not be brought in practice due to unavailability of technology to assess the silk in a cocoon without destroying it.

The stifling and modern storage capacity of about one crore cocoons, created under the said Projects for Common Facility Centres (CFCs) in villages close to the clusters of such MBTs are utilized for safe keeping of cocoons, after stifling, counting and packing. Each godown has a storekeeper employed by the Company who is responsible for periodic drying, safekeeping and maintains books of the cocoon stock. The MBTs assess their annual requirement of cocoons in advance as the commercial cocoons are harvested once in a year. The Company mobilizes finance and purchases cocoons based on the quality from local producers as well as from outside states and stored in godowns. The Company also keeps stock of spare parts, certain chemicals etc required by the MBTs. Each MBT would procure cocoons required for one month from Company based on the silk content of the cocoon and keep in their work shed. The issue price of cocoons (not at the actual cost of purchase) is debited to the same Trust's ledger and adjusted with the advances deposited by the MBTs before cocoon purchase. The MBTs also purchase other materials and chemicals from the Company.

Based on the market demand seven different types of tasar yarns are produced *i.e.,* four categories of reeled and three categories of spun yarn. In order to address the major drawback of unevenness and non-uniformity in tropical Indian tasar yarn, the yarn produced by MBTs was pooled and sorted based on colour and grade and packed to one kg. units. This could serve the purpose of weavers in getting required quantity of quality graded yarn, which was almost absent in Indian tasar yarn market. In view of the hygroscopic nature of tasar yarn, the graded silk was packed in airtight polythene packets and stored under room temperature in the yarn banks / godowns. The producers deposit their yarns to the MBT fortnightly, which would be graded by the yarn graders and deposited to the Company office. The Company ensures door-step lifting (buying) of all the yarns and paid the price at a rate decided by its Board.

The operations in the Producer Company: The Company purchase yarns from its member Trusts after paying its price as described above. It pools, grades, sorts yarns, based on the colour and quality and store so as to offer it to the yarn buyers. The Company, with its partner organization Eco Tasar Silk Private Limited who purchases need based outside yarns. Then the yarns are converted into various fabrics and sold to the market in bulk or retail. Three broad categories of fabric *viz.,* grey fabric in rolls, made-ups (like stole, scarves, throws, salwar suit set) and sarees are manufactured in 1500 different colour combinations and marketed, at present. Reputed fabric designers are engaged to bring in new designs in fabric marketing division. At present there are around 300 odd designs are available in the market. Most of the buyers are concentrated in Northern and Eastern India besides offshore buyers who purchase about 30% of the products. Buyers may be broadly divided in to four different *categories viz.,* Converters (Boutique owners, exporter and printers), Traders, Importers and Consumers (direct sale). Stock of yarn, cocoon and debtors increases with the growth of the Company, part of it is backed by the Share capital (cannot be raised from public, only from member trusts) and partly from initial startup capital (raised from donor agencies) and accumulated profits. Both the Company and the Trusts use computer software for keeping the accounts. It also generates all Management Information on both financial as well as non-financial aspects of the operations.

Results and Discussion:

The Producer Company has over 2500 women as tasar yarn producers belonging to OBCs, SCs and STs organized into 71 formal and informal producers groups have demonstrated the production capacity of about 20 MT of tasar yarn in a year. The producers are distributed in 63 villages mainly in Jharkhand, Bihar and one district of Chhattisgarh. State-wise details of MBTs are detailed below.

State	District	No. of Blocks	No. of Villages	No. of MBTs
Jharkhand	Koderma	3	9	14
	Hazaribagh	2	11	14
	Godda	1	8	8
	Dumka	3	7	7
Chhattisgarh	Raigarh	2	12	12
Bihar	Banka	2	16	16

The Producer Company could sell over 90% of tasar yarn directly in the market and converted balance to fabric *viz.,* made-ups, grey fabrics and sarees through its partner organization, Eco tasar. The business turn over (excluding inter-office transactions) of the company recorded an annual growth rate of 40%.

Operational issues:

1. **Promotion of yarn producers**: Graduation of a house-wife, SHG member to an entrepreneur and then an effective leader of a company owned by them require long term and continuous effort and resources. Thus `Membership Promotion' and `Business Operation' needs to be separated and they require different types of manpower orientation and financial resources.
2. **Effective Governance**: The capability of the producer Directors and interest of expert directors are extremely important to make a balance in the governance.
3. **Technology**: Many of the technologies available are not suitable for organized activity and so many scopes are there to develop / bring in new technologies. Yarn quality estimation, silk estimation in cocoon, cooking technology, cocoon sorting etc are some of the examples.

4. **Manpower**: There is no institute where Tasar Post-cocoon technology is being taught, as a result availability of quality man-power - technologists / managers / marketing personal is a great challenge.
5. **Recognisation of the Producers:** The yarn producers who now-a-days plays very important role in the entire tasar sub-sector need recognisation / identity by the mainstreams.
6. **Over-hauling / replacement of machines:** The producers being from very poor families are not able to over-haul their machine or replace the older machines. Their company also do not have special fund created for such purpose. Thus many producers are just continuing with the old machines, affecting the quality of yarns produced.

Future Plans of the Company:

1. Immediate future plan is to strengthen both Yarn Bank and Cocoon Bank.
2. Increase the productivity as well as quality of yarns produced by the producers.
3. Up-grading the in-active producers into more active producers
4. Concentrate on the financial strength of MASUTA
5. Leadership and business orientation to the Members, its skill upgradation
6. Slow and step by step expansion.
7. Bring in new technology
8. Developing proper package for yarns with labeling and branding besides conducting events like buyer-sellers meet in major weaving clusters to create awareness and demand of Company's products.

Suggested strategy:

1. To create an independent livelihood activity status to yarn conversion through technology intervention with higher production, productivity and quality.
2. To create infrastructure for cocoon & yarn procurement and storage in view of availability of cocoons once a year through creating infrastructure and provision of working capital, to facilitate continued activity throughout the year.
3. To increase the capacities and improve functional/ operational efficiency of RMB and the marketing organizations at state level in terms of capital deployment, storage structures and manpower to mobilize cocoons from the rearers. Make the cocoon available at a reasonable and fair price to the yarn producers.
4. To improve the capacities of producers' groups in managing the Cocoon Banks through storage, in view of deployment of large scale capital results into huge interest burden on producers and its blockage in slow moving stock, in spite of availability of graded raw silk in bulk. Need for a mechanism to maintain a certain volume of stock (at least a 25% to 40% of its inflow at any time) to cater to the market, by yarn producers. This can be achieved by-

    - Infusion of soft capital, mainly in the form of grant assistance,

- Dedicated management structure that would ensure efficient procurement, handling and marketing of the stock,
- Promoting Cocoon and Yarn Bank outside the Government system, mainly with the involvement of producers' groups and producer-entrepreneurs.

5. Expand the partnership and bring in wide ranges of partners, research institutions (bio-technology, Engineering etc), financial institutions, marketing institutions, Government Departments etc.
6. To plan collaborative research in Post Cocoon Technology with focus on cooking technology suitable to various eco-races, reeling of finer denier yarn and to improve its feel.
7. To plan and promote design development and design competitions amongst weavers and design students etc., to increase the demand for indian tasar by building its own brand identity.
8. To nurture Producers' Collectives, CBOs etc., to market tasar cocoons and yarns in competitive markets and create incomes in the hands of producers through Community Resource Persons (CRPs), where the Producers' collectives review CRPs performance and pays for their services. However, there is a need to look into the following factors that are currently affecting these bodies viz.,
   - Non-uniform cooperative Acts in tasar producing states with some states without Self-supporting Cooperative Act,
   - Arbitrary subsidization/ price fixation without level playing ground disturbs the process of free market dynamics,
   - Lack of investment to trigger growth processes,
9. Development of policy decision to attract soft interventions from possible sources.

With the present experience under the Special SGSY Projects in Bihar and Jharkhand, it is proved beyond any doubt that this concept is the only viable and sustainable alternative for tasar yarn producers in the country, with provisions on the lines of strategies suggested above.

Building of Value Chain in Indian Tropical Tasarculture through Community Motivation and Training

By

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The commercial tropical tasarculture is a forest based activity of growing tasar silk insect, *Antheraea mylitta* Drury (Lepidoptera: Saturniidae) on its host flora, besides collecting wild cocoons from insect habitat to produce Vanya silk, unique to India. The activity provides livelihood to two and half lakh tribal families in Andhra Pradesh, Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Maharashtra, Orissa, Uttar Pradesh and West Bengal states of the country. However, the over exploitation of tasar resources for commercial advantage and the deforestation, urbanization induced rapid environmental change have made the practice un-sustainable. So, there is an imperative need to motivate the tasar practicing community with appropriate training on the rational utilization of tasar biodiversity for building steady and sustainable value chain in commercial tasarculture. To recuperate the situation, the Sericulture, Forest, Rural and Tribal development departments and Non Government Organizations (NGOs) of Jharkhand state, India have involved the tasar practicing tribes for self help in tasar wild silk insect resource management to understand such upkeep is must for optimal value chain building. The field survey at Goilkera, West Singhbhum district of Jharkhand, India has revealed that the self help concept through Tasar Resham Dooth System among tasar tribes has contributed to safeguard the tasar diversity through successful production of tasar seed cocoons, seed and reeling cocoons and has made the whole tasar activity commercially viable. The support on motivation and training from the government side has succeeded in building the value chain as a source of employment and income with simultaneous tasar biodiversity conservation. Hence, this self help system has adoptable potential for building value chain in tropical tasarculture for optimal exploitation of global marketing avenues of Vanya silk and thus the socio economic advancement of tasar based tribes of the country.

Keywords: Community motivation, Self Help System, Tasarculture, Training, Value chain

MUGA SEED PRODUCTION LINKAGE FOR ECONOMIC EMPOWERMENT OF WOMEN IN NORTH EAST REGION OF INDIA

By

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Muga silk the world famous golden yellow color silk is prerogative of India and pride to Assam one of the North Eastern state of the country. The lustrous simmering silk fiber is produced by *Antheraea assamensis* Helfer with 6 broods in a year is geographically isolated to the single pocket of the world that is Assam . This lepidopteron insect feeds mainly on the aromatic leaves of *Persea bombycina* and *Litsea polyantha* in wild conditions and is exposed to intermittent climatic fluctuations particularly during summer and rainy (seed crop)

seasons. Therefore the seed crop production often gets affected due to pests, diseases as well as climatic vagaries. All the on farm technical activities during breeding and rearing are carried out by women. The muga silkworm during its rearing period is also facing environmental pollutants due to oil exploration and insecticide spray on tea gardens at the proximity of muga farms. As a result there is heavy larval mortality and crop loss and also shortage of silkworm eggs for further multiplication.

In order to sustain this wonderful nature's gift of golden muga silk to Assam, a detailed exploratory study has been under taken in the neighboring states to find out the feasibility and introduction of muga culture.

The adjacent states Sikkim, Mizoram and Nagaland enjoys ideal climate. The temperature ranges 20^0C to 30^0C during summer and 11^0C – 21^0C in winter The annual rainfall is 250 to 300 cm..These optimum conditions facilitate introduction of muga rearing and the pilot study reveal that the biological parameters of muga cocoons produced in the above states.(mature larval weight (12 -16 gms), pupal weight (5 -7 gms), fecundity (180-250) and survival rate (50-80%)) are better than traditional zone. The commercial traits, shell weight (0.4 to 0.8gms), shell ratio (10 -13%) and silk recovery are higher than Assam state. The winter seed crop introduced in Assam and Manipur state border shown better performance in terms of economic and other commercial traits. Thus paving a way to introduce muga culture in nontraditional states with season specific crops so as to strengthen the seed linkage program of Assam state in addition to improve the economic status of all stake holders. The details are discussed in this paper.

Keywords: Antheraea assamensis, seed crops, rearing potential and silkworm diseases.