WILD SILKS OF INDIA
vanya

ANNUAL REPORT 2019-2020

Central Muga Eri Research and Training Institute

Central Silk Board, Ministry of Textiles (Govt. of India)

Lahdoigarh, Jorhat – 785700, Assam, INDIA

वार्षिक प्रतिवेदन
ANNUAL REPORT
2019-2020

केन्द्रीय मूगा एरी अनुसंधान व प्रशिक्षण संस्थान
Central Muga Eri Research and Training Institute
केन्द्रीय रेशम बोर्ड **Central Silk Board**
वस्त्र मंत्रालय, भारत सरकार **Ministry of Textiles, Govt. of India**
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Our Vision

To emerge as premier research institute for overall development of Muga, Eri & Oak Tasar silk industry

Our Mission

To achieve excellence in application oriented research for transforming the Muga, Eri and Oak Tasar industry from the subsistence level of production to a vibrant commercial base

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FOREWORD

It gives me immense pleasure to bring you the Annual Report for the year 2019-20, which summarizes the activities and achievements of the Central Muga Eri Research and Training Institute (CMER&TI) during the year. We have just past two decades of existence of the institute, serving the stakeholders and being a part of the history of Vanya sericulture growth in Northeast India. There is a deep sense of satisfaction in helping farmers and other stakeholders in enhancing the total Vanya silk production. Several technologies have been developed and successfully commercialized. I take this opportunity to remember the hard work of scientists and cooperation of other supporting staff of the institute, and also the stakeholders who adapted the new techniques. All this has helped in increasing the raw silk production from muga and eri and oak tasar silkworms. Though a significant progress has been made in research and development in the area of Vanya sericulture, there is a long way to go to address the burning issues. The changing climate makes the task much more challenging. With these points in mind the institute has initiated new projects such as breeding high yielding varieties of muga and eri silkworms, developing better host plants of vanya silkworms, studying the effect of climate change on rearing performance, understanding the diseases of vanya silkworms for better management, etc.

The silkworm division has made a significant progress in research and development. To manage flacherie disease a chemical formulation has been developed that significantly improved the cocoon yield. Cross infectivity of pebrine in muga ecosystem has been studied and found that some pests carry Nosema spores that can infect muga also. Efforts are being made for *in situ* conservation of muga germplasm. Disease forecasting and forewarning is being carried and regular messages are being sent to farmers to take precautionary measures.

The host plant division is working towards increasing the availability of both quantity and quality leaves to Vanya silkworms. Castor improvement program has been initiated to make the host plants available to eri farmers throughout the year. Phytochemical diversity of som plants from three agro-climatic zones revealed region and season specific differences in quality of leaves. Soil testing is being continued to assess the soil quality of different regions of Northeast India.

The biotechnology division is working on various projects that eventually help in improving the Vanya sericulture in Northeast India. DNA sequence based barcoding of wild silkworms collected from Nagaland has been completed. A new study on dietary impact on gut microbiota of muga silkworms has been initiated. Muga Diseases Early Warning System (MDEWS) linking with SILKS portal has been developed for early warning of flacherie disease 10 days in advance. Eri silkworm egg preservation schedule has been standardized for prolonging the egg incubation time.

The training division has been successful in achieving the target for the year in training the stakeholders including farmers, officials, students and NGO members in new technologies in muga and eri culture. The extension division (SEEM) has conducted a total of 103 Extension Communication Programmes covering a large number of farmers. Under SMV programme new rearing technologies have been demonstrated.

The nested units of CMER&TI have been working towards the achievement of their respective targets. RSRS, Imphal has been in forefront on research and extension activities pertaining to oak tasar silkworms. RSRS, Boko, has been catering to the needs of seri-farmers of lower Assam as well as of West Bengal. RECs have achieved the targets for the year, helping farmers in increasing the cocoon production.

I take this opportunity to thank the Chairman and members of Research Advisory Committee for their valuable inputs and support in initiation of new projects as well as smooth running of approved projects. I also thank the Competent Authority of Central Silk Board, Bangalore for providing support for development of the CMER&TI. I sincerely acknowledge and appreciate the support extended by the Department of Sericulture of all Northeast Indian states in implementing developmental and extension communication programmes. The support extended by the collaborating institutes and research funding agencies is highly appreciated.

Northeast India is a unique place as far as sericulture is considered, as it is home to all four kinds of sericulture, namely muga, eri, tasar and mulberry. CMER&TI is fortunate to work on three of these silks. With the recent inclusion of research and development of oak tasar silkworms into CMER&TI mandate, the responsibility has increased further. After two decades of existence, the CMER&TI is at crossroads with the requirement of the preserving traditional muga and eri culture, and also with the responsibility of development of newer technologies that are suitable for seri-farmers of the Northeast India. We are striving towards achieving this.

The year ended with the beginning of the COVID-19 pandemic and near complete lockdown restricting the movement of personnel. I would like to end this foreword with a high hope that the pandemic will not significantly affect the lives of seri-farmers and also the overall seri-economy of Northeast India.

Dr. Jalaja S Kumar, Director

प्रस्तावना

संस्थान की वर्ष २०१९-२० की वार्षिक रिपोर्ट का प्रकाशन करते हुए मुझे बहुत खुशी हो रही है। यह रिपोर्ट केन्द्रीय मूगा एरी अनुसंधान एवं प्रशिक्षण संस्थान, लाहदोईगढ, जोरहाट की गतिविधियों और उपलब्धियों का पूरे साल का सारांश है। हमारा संस्थान दो दशकों से रेशम किसानों/लाभार्थियों की सेवा करने और पूर्वोत्तर भारत में वन्य रेशम (मूगा, एरी और तसर) विकास के इतिहास का एक बड़ा हिस्सा रहा है। कुल वन्य रेशम उत्पादन को बढ़ाने में, किसानों और अन्य लाभार्थियों की मदद करने में हमें बहुत अधिक संतुष्टि मिलती है। हमने कई तकनीकों का विकास और उनका सफलतापूर्वक व्यवसायीकरण भी किया है। मैं इस अवसर पर सभी वैज्ञानिकों और संस्थान के अन्य सहायक कर्मचारियों के सहयोग की सराहना करती हूँ, और उन सभी लाभार्थियों/किसानों को भी जो नई तकनीकों को अपनाकर मूगा, एरी और तसर रेशम के उत्पादन को बढ़ाने मे मदद करते हैं। यद्यपि वन्य रेशम के क्षेत्र में अनुसंधान और विकास में एक महत्वपूर्ण प्रगति हुई है, लेकिन ज्वलंत मुद्दों को संबोधित करने के लिए अभी एक लंबा रास्ता तय करना है लेकिन बदलती जलवायु और बढ़ते प्रदूषण के कारण अनुसंधान और रेशम उत्पादन कार्य को और अधिक चुनौतीपूर्ण बनाती है। इन सभी को ध्यान मे रखते हुए, संस्थान ने अधिक उपज देने वाले मूगा, एरी और तसर रेशम कीटों की क़िस्मों के विकास, उन्नत किस्मों के मेजबान/खाद्य पौधों के विकास, रेशम कीट पालन पर जलवायु परिवर्तन के प्रभाव का अध्ययन तथा वन्य रेशम कीटों के रोगों को बेहतर प्रबंधन इत्यादि के लिए नई परियोजनाओं की शुरुआत की गयी है।

रेशमकीट प्रभाग ने अनुसंधान और विकास में एक महत्वपूर्ण प्रगति की है। फ़्लचरी (Flacherie) रोग प्रबंधन के लिए एक रासायनिक सूत्रीकरण (formulation) को विकसित किया गया है जिससे कोकून/कोसा (cocoon) उत्पादन में काफी सुधार हुआ है। मूगा पारिस्थितिकी तंत्र मे पेब्रिन संक्रमण का क्रॉस संक्रामकता (cross transmission) के से ज्ञात हुआ है कि कुछ कीट पेब्रिन बीजाणु के वाहक हैं जो मूगा रेशम कीट को भी संक्रमित कर सकते हैं। मूगा संरक्षण के लिए निर्धारित इन-सीटू (in-situ) स्थान पर मूगा रेशम को संरक्षण करने के लिए प्रयास किए जा रहे हैं। रोगों के पूर्वानुमान और पूर्वाभास को एहतियाती उपाय करने के लिए किसानों को नियमित रूप से संदेश भेजे जा रहे हैं।

मेजबान/खाद्य पौध प्रभाग द्वारा लगातार वन्य रेशम कीटों के खाद्य पौधो की गुणवत्ता और मात्रा को बढ़ाने की दिशा में काम किया जा रहा है। एरी रेशम कीट के लिए पूरे साल अंडी (castor) पत्तों की उपलब्धता के लिए परियोजना की शुरुआत की गयी है। तीन कृषि जलवायु क्षेत्रों (agro-climatic zone) मे मूगा रेशम खाद्य पौधा सोम का विभिन्न मौसम मे पादप रसायन (phytochemcial) विविधता और पत्तियों की गुणवत्ता का अध्यन्न किया गया जा रहा है। पूर्वोत्तर भारत के विभिन्न क्षेत्रों की मिट्टी की गुणवत्ता का आकलन करने के लिए मृदा परीक्षण भी जारी है।

जैव प्रौद्योगिकी प्रभाग द्वारा विभिन्न परियोजनाओं पर काम किया जा रहा है जो अंततः पूर्वोत्तर भारत में वन्य रेशम को बेहतर बनाने में मदद करता है। नागालैंड से एकत्रित जंगली रेशमकीटों के डीएनए अनुक्रम का बारकोडिंग कार्य पूरा हो गया है। मूगा रेशम कीट के पेट मे उपस्थित सूक्ष्मजीवों पर आहार प्रभाव के अध्ययन की शुरूआत की गयी है। मूगा रोग प्रारंभिक चेतावनी प्रणाली (MDEWS) को सिल्क्स पोर्टल (SILKS) के साथ लिंकित करने से १० दिन पहले फ़्लचरी रोग की प्रारंभिक चेतावनी के लिए प्रणाली को विकसित किया गया है। एरी

रेशमकीट अंडों को लंबे समय तक संरक्षण करने लिए एक पद्धति को मानकीकृत किया गया है।

इस वर्ष प्रशिक्षण प्रभाग ने मूगा और एरी रेशम की नई तकनीकों और पद्धतियों पर किसानों, अधिकारियों, छात्रों और गैर-सरकारी संगठनों के सदस्यों के लिए प्रशिक्षण कार्यक्रमों का लक्ष्य सफलतापूर्वक अर्जित किया है। विस्तार प्रभाग (एसईईएम) ने बड़ी संख्या में किसानों को शामिल करते हुए कुल १०३ विस्तार संचार कार्यक्रम इस साल पूरे किए हैं। एसएमवी (SMV) कार्यक्रम के तहत नई कीट पालन तकनीकी और प्रौद्योगिकियों का प्रदर्शन किया गया है।

केन्द्रीय मूगा एरी अनुसंधान एवं प्रशिक्षण संस्थान और इसकी संयोजित इकाइयों ने अपने-अपने लक्ष्यों की प्राप्ति के लिए सरहनीय कार्य कर रही हैं। आर एस आर एस, इम्फाल ने ओक तसर रेशम के कीड़ों से संबंधित अनुसंधान और विस्तार गतिविधियों में सबसे आगे रहा है। आर एस आर एस, बोको निचले असम क्षेत्रों के रेशम किसानों के साथ-साथ पश्चिम बंगाल के किसानों की जरूरतों और उनकी मदद करने के लिए तत्पर रहता है। आर ई सी ने मूगा और एरी कोकून उत्पादन बढ़ाने में किसानों की मदद करते हुए इस वर्ष के लिए अपने लक्ष्य हासिल किए हैं।

मैं अनुसंधान सलाहकार समिति (Research Advisory Committee) के अध्यक्ष और सभी सम्मानित सदस्यों को उनकी बहुमूल्य जानकारी और सहयोग के लिए तथा नई परियोजनाओं के शुरूआत के साथ-साथ अनुमोदित परियोजनाओं के सुचारू संचालन के लिए आभार व्यक्त करती हूँ। केन्द्रीय मूगा एरी अनुसंधान एवं प्रशिक्षण संस्थान के विकास के लिए सहायता प्रदान करने के लिए केंद्रीय रेशम बोर्ड, बैंगलोर के सक्षम प्राधिकारियों का भी धन्यवाद करती हूँ। मैं विकास और विस्तार संचार कार्यक्रमों को सभी पूर्वोत्तर भारतीय राज्यों के रेशम विभागों द्वारा सफलतापूर्वक लागू करने के लिए दिये गए समर्थन को ईमानदारी से स्वीकार करती हूँ और उनकी सराहना भी करती हूँ। सहयोगी संस्थानों और अनुसंधान निधीयन अभिकरणों द्वारा विस्तारित समर्थन की बहुत बहुत सराहना करती हूँ।

पूर्वोत्तर भारत एक अनूठी जगह है क्योंकि यह क्षेत्र रेशम का गढ़ है जहाँ चार प्रकार के रेशम मूगा, एरी, तसर और शहतूत को महत्व दिया जाता है और इनका पालन भी किया जाता है। केन्द्रीय मूगा एरी अनुसंधान एवं प्रशिक्षण संस्थान के साथ ओक तसर रेशम के अनुसंधान और विकास को भी शामिल करने के साथ, हमारी जिम्मेदारी और भी बढ़ गई है।

केन्द्रीय मूगा एरी अनुसंधान एवं प्रशिक्षण संस्थान के दो दशकों के अस्तित्व के बाद, यह पारंपरिक मूगा और एरी रेशम संस्कृति के संरक्षण की आवश्यकता के लिए चौमुखी चौराहे पर खड़ा है, साथ ही साथ पूर्वोत्तर भारत के रेशम किसानों के लिए उपयुक्त नई तकनीकों के विकास की जिम्मेदारी को भी लिए हुए है। हम इसे हासिल करने की दिशा में प्रयास कर रहे हैं।

कोविड-१९ महामारी की शुरुआत, पूर्ण तालबन्दी और कर्मियों की आवाजाही के प्रतिबंध के साथ यह वर्ष समाप्त हुआ। मैं एक बड़ी उम्मीद के साथ यह आशा करती हूँ कि इस महामारी से रेशम किसानों का जीवन तथा सम्पूर्ण रेशम अर्थव्यवस्था प्रभावित न हो।

डॉ. जलजा एस. कुमार
निदेशक

CMER&TI, LAHDOIGARH AT A GLANCE

Established by Central Silk Board (CSB), Ministry of Textiles, Govt. of India in 1999, Central Muga Eri Research & Training Institute (CMER&TI)has been the premier R&D centre catering to the needs of vanya sericulture industry in Northeast India. Situated in Northeast India, a proud producer of all types of vanya silks, CMER&TI focuses mainly on R&D activities in muga, eri and oak tasar culture. The institute is strengthening the infrastructural facilities in recent years for conducting research in the frontier areas. The main objectives of the institute are to evolve new technologies for increasing the productivity of muga, eri and oak tasar silkworms and thereby transforming these cultures from the state of traditional culture to a profit making and sustainable enterprises.

The institute is located at Lahdoigarh, 16 km east of Jorhat, Assam, well connected with road. It has extension units in the North Eastern States, West Bengal, Uttar Pradesh and Andhra Pradesh. Scientists are working in close coordination towards the development of farmer friendly technologies, their application in field, evaluation and fine tuning of the technologies and its dissemination. Research and Developmental activities of this institute are carried out undersix divisions.There is a Project Monitoring Cell (PMC) in the institute for planning and monitoring of the institutional R&D activities. The administrative activities are carried out by ten sections *viz.,* Establishment, Accounts & Bill, Stores and Purchase, Library, Vehicle, Construction, Labour, Computer, Hindi and Receipt & Dispatch.

To facilitate effective transfer of technologies developed by the institute and their validation in the fields, two Regional sericulture Research Stations (RSRS) viz., RSRS Boko, Assam, and RSRS Imphal, Manipur alongwith three Research Extension Centres (REC) have been established. The regional stations are located in major sericulture zones to carry out region and season specific research and to facilitate test verification and effective dissemination of laboratory findings to the field. The research station situation at Boko is dedicated to Muga related research while the research station at Imphal is dedicated to Oak tasar. The regional stations, along with the RECs under their control, are working towards identification of technologies suitable to regional needs and their diffusion to field. RECs for muga are located at Coochbehar (West Bengal) and Lakhimpur (Assam). RSRS Imphal is sharing the responsibility of transferring the technologies to the beneficiaries involved Oak tasar sericulture.

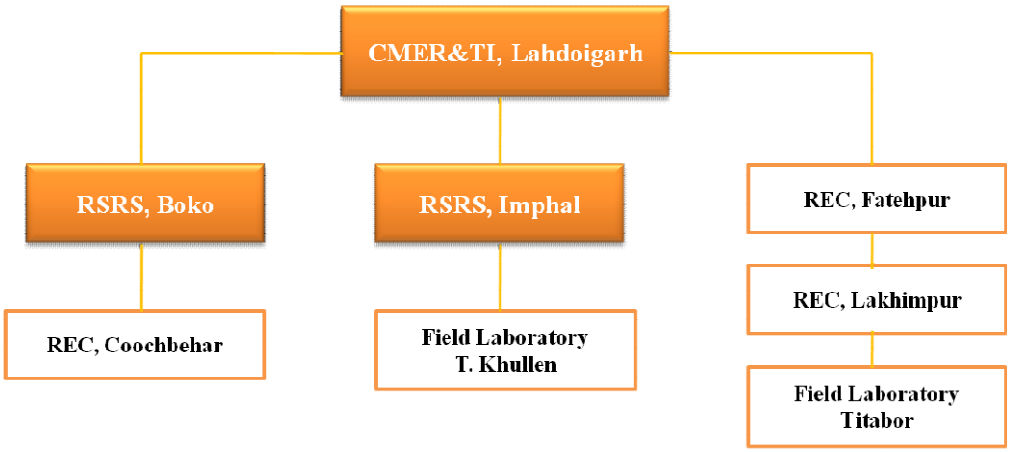
MANDATE OF THE INSTITUTE

- To act as an apex Research Institute for providing R&D support for muga, eri and oak tasar sericulture.
- To conduct basic, strategic and applied research to increase production and productivity of silkworms and their host plants.
- Improvement of food plants and silkworm eco-races and hybrids.
- To conduct socio-economic research for assessing sustainability of newly developed technologies.
- To percolate the research findings to the end users through extension and training mechanism.

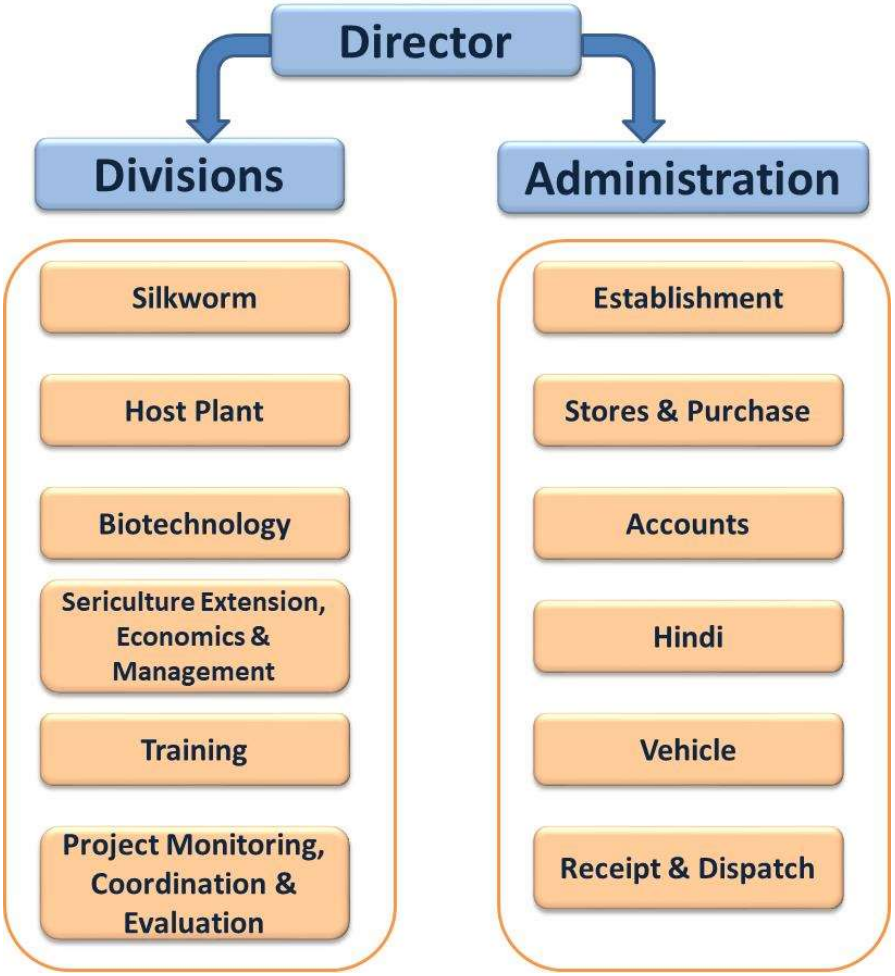
HUMAN RESOURCES

Scientists	31
Technical staff	56
Administrative Staff	24
Supporting Staff	99
Total Staff	**210**

EXTENSION NETWORK



ORGANIZATIONAL SETUP



Scientific Personnel

CMER&TI (Main institute)

1. Dr. Jalaja S Kumar	Scientist-D &Director (i/c)	w.e.f. 01.03.2020
2. Dr. Ranjana Das	Scientist-D &Director (i/c)	Till29.02.2020
3. Dr. Reeta Luikham	Scientist - D	
4. Dr. Kartik Neog	Scientist - D	Till 30.06.2019
5. Dr. T. James Keisa	Scientist - D	
6. Dr. Aftab Ahmad Shadnam	Scientist - D	
7. Dr. M. Chutia	Scientist - D	
8. Dr. D.K. Gogoi	Scientist - D	
9. Dr. Amit Kumar	Scientist – C	
10. Dr. Arun Kumar K P	Scientist – C	
11. Dr. D. K. Jigyasu	Scientist – C	
12. Dr. Kh. Subadas Singh	Scientist – C	
13. Dr. G. Subrahmanyam	Scientist – C	
14. Dr. Rajal Debnath	Scientist – C	
15. Dr. Vinodakumar S Naik	Scientist – C	Till 29.02.2020
16. Dr.Prashanth Sangannavar	Scientist – C	Till 12.07.2019
17. Dr. Vijay N.	Scientist – B	
18. Dr. Saikat Maji	Scientist – B	Till 15.11.2019
19. Dr. Manjunath R N	Scientist – B	
20. Dr. Mahesh D S	Scientist – B	

RSRS, Boko

1. Sri. SAS Rahman	Scientist –D	
2. Sri. B. Choudhury	Scientist –D	
3. Dr. M. Deka	Scientist – C	
4. Dr. H. Barman	Scientist – C	

RSRS, Imphal

1. Dr. N.Ibotombi Singh	Scientist –D	Till 29.02.2020
2. Dr. Y.Debaraj	Scientist –D	
3. Dr. L.Somen	Scientist – D	
4. Dr. S.Subharani Devi	Scientist – C	

REC, Lakhimpur

1. Dr. D. Mech	Scientist –D	

REC, Coochbehar

1. Dr. N. Biswas	Scientist –D	30.06.2019
2. Dr. O.P. Patidar	Scientist – B	

REC, Fatehpur

Dr. S. Pal	Scientist –D	

DELEGATED AND NON-DELEGATED UNITS OF CMER&TI

Delegated Units

- Central Muga Eri Research & Training Institute, Lahdoigarh, Assam (Main Institute)
- Regional Sericulture Research Station, Boko, Kamrup, Assam
- Regional Sericulture Research Station, Imphal, Manipur

Non-Delegated Units

- Research Extension Centre, Coochbehar, West Bengal
- Research Extension Centre, Lakhimpur, Assam
- Research Extension Centre, Fatehpur, Uttar Pradesh

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RESEARCH ADVISORY COMMITTEE

Chairman

Prof. Kamal Malla Bujarbaruah

Vice Chancellor, Assam Agricultural University, Jorhat – 785013, Assam

Members

Prof. Pradip Kumar Neog
Director, Extension Education Institute (NE Region),
Assam Agricultural University, Jorhat - 785013, Assam

Prof. Pratap J. Handique
Dept. of Biotechnology, Gauhati University, Guwahati - 781014, Assam

Dr. A.K. Barooah
Director, Tocklai Tea Research Institute, Jorhat - 785008, Assam

Dr. R.S.C. Jayaraj, IFS,
Director, Rain Forest Research Institute, Jorhat - 785010, Assam

Director (Technical)
Central Silk Board, CSB, Bangalore - 560068, Karnataka

Dr.JogeshDeori
Director of Sericulture, BTC, Adabari,
P.O. Choraikola, Govt. of Assam, Kokrajhar - 783376, Assam

Director of Sericulture
Govt. of Assam, Khanapara, Guwahati - 781004, Assam

Director of Sericulture,
Govt. of Nagaland, Kohima - 797004, Nagaland

Director of Sericulture,
Govt. of Manipur, Project Management Complex,
Sangaipat, Imphal East, Imphal - 7950048, Manipur

Director of Sericulture
Govt. of Mizoram, Aizawl - 796001, Mizoram

Director of Sericulture,
Dept. of Forest, Forest Secretariat, Govt. of Sikkim,
Deorali, Gangtok - 737102, Sikkim

Commissioner of Textiles & Handicrafts,
Govt. of Arunachal Pradesh, Itanagar - 791110, Arunachal Pradesh

Directorate of Sericulture & Weaving,
Govt. of Meghalaya, Shillong - 793001, Meghalaya

Scientist – D & Head
Muga Silkworm Seed Organization,
Central Silk Board, Guwahati - 781038, Assam

Mrs. Sushila Saikia
Muga Farmer, Borpathar, Golaghat, Assam.

Sri Narendra Borah,
Eri Farmer, Kaliabar, Nagaon, Assam

Member Convener

Director, CMER&TI, Lahdoigarh, Jorhat - 785700, Assam

HIGHLIGHTS OF ACHIEVEMENTS (2019-20)

Major achievements in R&D

During 2019-20, 35 research projects were carried out, of which 3 projects are DBT funded, 3 projects are DST funded, 1 project is NERTPS funded and remaining are CSB funded. Thirteen projects were concluded, 10 were newly initiated and remaining 12 projects are being continued from previous year. All the research projects are under different categorization *viz*., Environmental challenges and global warming, Drudgery reduction and women friendly technologies, Input cost reduction, Eco-friendly & organic farming etc. Moreover, 1 regular programme is conducted at the institute as well as at farmers' level. A brief highlight of the research works is presented below:

Silkworm Division

- A chemical formulation has been developed to control bacterial flacherie disease in Muga silkworm. Field efficacy analyses revealed that the technology can improve ERR by 15-18% over control in summer muga crops.
- Bacterial antagonists have been isolated and characterized against plant pathogen *Alternaria ricini* infecting Castor in North-eastern India.
- Pebrine spores were isolated from different lepidopteran species coexisting in muga ecosystem. Pathogenicity between two saturniid lepidopteran insects confirmed cross infectivity.
- Population dynamics of *E. furcellata* and *S. collaris* was studied and observed that predator bugs were found mainly in summer season, showing positive correlation with abiotic factors.
- Solar LED light traps of different wavelengths have been developed and installed in muga rearing fields. Blue light trapped maximum number of insect pests followed by green and white light.
- Attempts have been made for the *in situ* conservation of muga silkworms in Assam and BTC. Population build-up of muga silkworms has been recorded in conservation sites.
- Disease forewarning and forecasting messages have been sent to seri stakeholders/farmers for developmental progress of Muga and Eri culture in the NE region
- The biodesulfurization potential of the bacterium *Gordonia amicalis* has significantly improved in presence of biosurfactant producing *Bacillus subtilis* wherein the released 2-HBP was found to be 0.2 mM.
- Implementation of improved technologies among 150 beneficiaries enhanced income generation over benchmark by 41.75%
- Regular monitoring of diseases and pests infestation in silkworm and host plants for both muga and eri.
- Effectivity of different pesticides commonly used in tea garden viz., Ennova, Atom and Instanthas been studied and confirmed their hazardous effect to muga silkworm growth, fecundity and fertility and larval mortality.

Host plant division

- During the year 16,920 seedlings of Muga and Eri host plants were supplied to different stakeholders under different programmes. Four acres of superior Kesseru accessions (HF-005 & HF-008) was also raised at farmers' fields.
- Assessment of phyto-chemical diversity of Som under three different agro-climate zones of Meghalya and Assam revealed the region and season specific differences in the phyto-chemical quantities, stress magnitude and intrinsic protection potential of Som. It was established that the magnitude of soil intrinsic nutritional capacity in som fields varies in different agro-climatic zones, which has the direct bearing on the muga culture.
- Castor improvement programme was initiated during the year. Geographical coordinates of 08

wild/cultivated perennial castor accessions growing in North East were collected for their utilization in the pre-breeding programme. Collection of wild perennial castor accessions from the field has brought in variability to the gene pool for its further exploitation to improve this major Eri Host Plant.

- Impact assessment of petroleum crude oil activities on muga culture in Assam was carried out, which has facilitated in devising the suitable mitigation measures to revive the muga culture in contaminated areas.
- 405 soil samples were collected and analyzed covering Assam, Nagaland, Manipur, Meghalaya, Mizoram and Arunachal Pradesh. Total 2000 Soil Health Cards (SHCs) were developed and distributed to farmers in 06 North East states. 1461 soil health cards of Assam & Nagaland state were digitalized and uploaded on SHC portal and the same can be accessed by UMANG portal as well.

Biotechnology division

- Mitochondrial cytochrome oxidase subunit I (col-5P) based barcoding for biodiversity assessment in Nagaland under DBT project led to enrichment of nucleotide databases with the following set of non-mulberry silkmoth genes MT385724: MT385735
- *Loepa oberthuri* barcode submitted in Genbank nucleotide (Accession: MT385732) is the first report from this silkmoth in NCBI GenBank. Additionally, generation and documentation of barcode for *Archaeoattacus malayanus* silkmoth (MT385726) often misclassified as *edwardsii* was done. Barcode data from Nagaland samples for this silkmoth species was a pending task as reported by (Nassig and Neuman et al., 2010)
- Assessment of rearing potentialities in Nagaland region showed tapioca and payam as better suitable food plant than kesseru while castor remains the most preferred for eri silkworm rearing (SR% 10.13, 9.60, 9.20, 6.83 respectively). Combination of tapioca and castor and vice-versa yielded SR% above 10 during Autumn season.
- Under DBT funded project, studies on the dietary impact on gut microbiota of muga silkworm, led to enrichment based purification of 140 microbial strains (bacteria, fungi) from different host plant fed sources which will be utilized for further host-microbe interaction studies.
- Muga Disease Early Warning System (MDEWS) linking with SILKS portal MDEWS has been developed integrating forecasting model developed for an early warning of percent Flacherie disease incidence of Muga Silkworm both 5days and 10 days in advance before harvesting (Website link:- https://apps.nesdr.gov.in/MDEWS)
- MDEWS has been developed initially to collect data and validate the model by the authorized users. More emphasis has been given on linking to SILKS geoportal to have wider use by the farmers as well as different stakeholders of the sericulture industry in future.
- Eri silkworm egg preservation schedule has been developed in collaboration with SSTL, Kodathi to preserve the egg upto 20 days with two days incubation with around 55% hatching.

Training Division

- A Total of 1981 nos. of farmers, officials, students, NGO members were trained/up-skilled covered in seven different components like Farmers' Skill Training, Exposure visit, Technology Orientation Programme, Training under Post cocoon sector, Training under Sericulture Resource Centre, Training under STEP and Training funded under - NON CBT.
- Among them, 84% seri-farmers, 6% students from schools, colleges, NGOs and 10% of officials of CSB & State Sericulture Department, Assam and Uttar Pradesh who were undergone training on recent modern

technologies developed in Muga and Eri sectors.

SEEM division

- A total of 103 of Extension Communication Programmes were conducted in North Eastern states of India covering 6,679 numbers of sericulture farmers.
- Three Vanya Reham Krishimela,17 field day,14 farmers day, 29 Awareness programme, 27 group discussion,11 technology demonstration and 2 workshop programmes were organized by the Institute along with extension units at different states, districts and villages of North East.
- Under the SMV programme of Muga, during Katia crop 2019 a total of 94,300 gms of Muga dfls were brushed and 5,10,4395 nos of commercial cocoons were produced. Further, 1,020.88 kgs of raw silks were produced during this commercial crop.
- In Eri sector, under SMV programme during spring crop, a total of 12600 gm of Eri dfls were reared by 400 farmers and produced 1,045 kgs of raw silk during spring crop and during Autumn crop 1,2075 gm of Eri dfls were reared 400 farmers brushed and produced 1015 kg raw silk.

PMCE division

The Project Monitoring Co-ordination & Evaluation (PMCE) of this institute under the supervision of Director executes the overall planning and monitoring of the institutional R&D activities along with timely correspondence with CSB Headquarters, State and Union ministries. During 2019-20, PMCE has conducted 02 Research Advisory Committee meetings, 04 Research Council Meeting, 04 Local Advisory Committee meeting of Muga Raw Material Bank. Further, the division has appraised the physical and financial progress of all R&D activities during the Technical Audit and Institute's Review meeting chaired by Member Secretary, CSB.

Publications of institute

During 2019-20, CMER&TI published 17 research papers in National and international peer reviewed journals, 5 conference/workshop papers, 10 technical leaflets/bulletin, 2 News Letters, 2 Hindi Newsletter, 1 book, 2 Magazines and the Annual Report of the institute for 2019-20.

Other Activities

- Guest Lectures from different institutes / organizations *viz*. Assam Agricultural University, Jorhat, Assam; Rain Forest Research Institute, Jorhat, Assam; RSRS, Jorhat; NSSO, Bengaluru; Deakin University, Australia was organized in the institute where 172 scientists / scholars participated.
- National Science Day has been organized under the Advanced Level Institutional Biotech Hub on at the institute. In connection with it, a scientific talk and a quiz competition has been organized among school students and accordingly cash awards has been presented in the valedictory function.
- Swachha Bharat Abhiyan, Swachha Hi Sewa, Swachhata Pakhwada' World Environment Day, International Yoga Day, World Science Day, World Soil Day, International Women's Day *etc*. were celebrated by the institute.
- Four scientists of the institute participated in invited Radio Talks on "Muga silkworm host plants and rearing" and "Enhancement of income of farmers by muga silkworm rearing" during the year.

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उपलब्धियों के मुख्य अंश (२०१९-२०)

अनुसंधान एवं विकास में प्रमुख उपलब्धियां

वर्ष २०१९-२० के दौरान २० अनुसंधान परियोजनाएं चल रही हैं जिनमें से ३ परियोजनाएं डीबीटी (**DBT**) वित्त पोषित हैं, ३ परियोजनाएं डीएसटी (**DST**) वित्त पोषित हैं, १ परियोजना एनईआरटीपीएस (**NERTPS**) वित्त पोषित है और शेष सीएसबी (**CSB**) वित्त पोषित हैं। तीन प्रोजेक्ट इस वर्ष समाप्त हुए, ३ नए शुरू किए गए और शेष २१ परियोजनाएं पिछले वर्ष से जारी हैं। सभी शोध परियोजनाएँ विभिन्न वर्गीकरण एवं प्रभाग के अंतर्गत आती हैं जैसे कि पर्यावरण संबंधी चुनौतियाँ और ग्लोबल वार्मिंग, कठिन परिश्रम में कमी और महिलाओं के अनुकूल प्रौद्योगिकी, निवेश लागत में कमी, पर्यावरण के अनुकूल और जैविक खेती आदि। इसके अलावा, किसानों का स्तर बढ़ाने के लिए एक नियमित कार्यक्रम भी आयोजित किया जाता है। शोध कार्यों का एक संक्षिप्त विवरण नीचे प्रस्तुत किया गया है:

रेशमकीट प्रभाग

- मूगा रेशमकीट में फ़्लचरी (Flacherie) रोग प्रबंधन के लिए एक रासायनिक सूत्रीकरण (formulation) को विकसित किया गया है फील्ड प्रभावकारिता विश्लेषण से पता चला है कि गर्मियों की मूगा फसलों पर इसके उपयोग से ईआरआर (ERR) में १५-१८% तक सुधार हो सकता है।
- उत्तर-पूर्वी भारत में अंरडी पौधे को संक्रमित करने वाले अल्टेर्नेरिया रिसिनी के प्रभाव को कम करने के लिए बैक्टीरियल एंटागोनिस्ट को आइसोलेट और विवरण करके देखा गया है।
- पेब्रिन स्पोरेस को अलग-अलग लेपिडोप्टेरान कीटों से पृथक कर के मूगा रेशमकीट में क्रॉस संक्रामकता किया गया और दो सैटर्नियड लेपिडोप्टेरान कीटों के बीच पेब्रिन रोगजनन के क्रॉस संक्रामकता की पुष्टि भी की गयी।
- मूगा रेशमकीट के दो नुक़सान पहुंचाने वाले कीड़ों, *ई. फरसेलाटा* और *एस. कोलैरिस* के जनसंख्या गतिशीलता का अध्ययन किया और पाया कि ये शिकारी कीड़े गर्मी के मौसम में मुख्य रूप से मूगा पारिस्थितिकी तंत्र मे पाए जाते हैं जिसका सकारात्मक संबंध अजैव कारकों से भी मिलता है।
- विभिन्न तरंग दैर्ध्य के सौर एलईडी प्रकाश लाइट को मूगा पारिस्थितिकी तंत्र मे मिलने वाले कीड़ों को पकड़ने के लिए लगाया गया और इनको मूगा पालन क्षेत्रों में स्थापित किया गया। जिसमे पाया गया कि नीले प्रकाश सबसे ज्यादा कीड़ों/कीटों को आकर्षित करता है इसके बाद हरे रंग और सफेद रंग प्रकाश मे कीड़े आकर्षित करते हैं।
- मूगा संरक्षण करने के लिए निर्धारित इन-सीटू (**in-situ**) स्थान पर मूगा रेशम कीट को संरक्षण करने के लिए असम और बीटीसी में प्रयास किया गया जिसमे मूगा रेशम के कीड़ों का जनसंख्या मे बढ़ोत्तरी दर्ज किया गया है।
- मूगा और एरी रेशम संस्कृति के विकासात्मक प्रगति के लिए किसानों को रोगों के पूर्वानुमान और पूर्वाभास संदेशों को भेजे गए हैं।
- बयो-सर्फेकटेंट की उपस्थिती में *गोरडोनिया अमीकैलीस* जीवाणु द्वारा बायो-डीसल्फेराइजेसन की क्षमता में वृद्धि हुई है जिसमें बेसिलस सब्टिलिस द्वारा ०.२ मिमी साइज का **2-HBP** आसानी मे मुक्त करता है।
- बेहतर तकनीकों को शामिल कर के१५० लाभार्थियों के आय सृजन मे बेंचमार्क से ४१.७५% अधिक आय बढ़ गया है।
- मूगा और एरी रेशम कीट और इनके मेजबान पौधों में रोगों और कीटों की नियमित निगरानी की जा रही है।
- चाय उद्यान/बागानो मे इस्तेमाल किए जाने वाले विभिन्न कीटनाशकों जैसे एनोवा, एटम और इन्स्टान्थस के मूगा रेशम कीट पर प्रभाव का अध्ययन किया गया और पाया गया कि इन कीटनाशकों की वजह से रेशम कीट विकास, उपजाऊपन, प्रजनन क्षमता और लार्वा मृत्यु दर मे खतरनाक प्रभाव की पुष्टि हुई है।

मेजबान/खाद्य पादप प्रभाग

- इस वर्ष के दौरान मूगा और एरी रेशम कीट के मेजबान/होस्ट के १६९२०पौधों को विभिन्न कार्यक्रमों के तहत विभिन्न लाभार्थियों/हितधारकों को आपूर्ति किया गया। किसानों ने चार एकड़ से अधिक खेतों में बेहतर किस्म (HF-005 & HF-008) के केसरू पौधे को लगाया है।
- तीन विभिन्न कृषि-जलवायु विविधता वाले क्षेत्रों के तहत मेघालय और असम मे अलग अलग मौसम मे सोम पौधे की फाइटो-केमिकल मात्रा, तनाव परिमाण और सोम की आंतरिक सुरक्षा के लिए संभावित का परीक्षण किया गया। यह स्थापित किया गया है कि सोम पौधे क्षेत्र में मिट्टी की आंतरिक पोषण क्षमता का परिमाण विभिन्न कृषि जलवायु क्षेत्रों में भिन्न होता है, जिसका सीधा असर मूगा रेशम उत्पादन पर पड़ता है।
- वर्ष के दौरान अरंडी पौधे मे सुधार का कार्यक्रम शुरू किया गया था। विभिन्न भौगोलिक निर्देशांक मे उगने वाले ०८ जंगली/खेती की गई बारहमासी अरंडी को एकत्र किए गए थे। इस प्रमुख एरी खाद्य पौधे को बेहतर बनाने के लिए इन क्षेत्रों से एकत्रित जंगली बारहमासी अरंडी पौधों को प्री-ब्रीडिंग के लिए उपयोग मे लिया जा रहा है।
- असम में मूगा रेशम के उत्पादन पर पेट्रोलियम कच्चे तेल के उत्पादन की गतिविधियों का प्रभावपूर्ण मूल्यांकन किया गया, जिससे इन दूषित क्षेत्रों में मूगा रेशम संस्कृति को सुरक्षित करने और पुनर्जीवित करने के लिए उपयुक्त उपायों को तैयार करने में सुविधा हुई है।
- इस वर्ष ४०५ मिट्टी के नमूने असम, नागालैंड, मणिपुर, मेघालय, मिजोरम और अरुणाचल प्रदेश से एकत्र किए गए। कुल २००० मृदा स्वास्थ्य कार्ड (**SHCs)** इन ६ पूर्वोत्तर राज्यों के किसानों के लिए विकसित और वितरित किए गए। असम और नागालैंड राज्य के १४६१ मृदा स्वास्थ्य कार्डों को डिजिटल किया गया और मृदा स्वास्थ्य कार्ड पोर्टल पर अपलोड भी किया गया और जिसको **UMANG** पोर्टल द्वारा भी एक्सेस किया जा सकता है।

जैव प्रौद्योगिकी प्रभाग

- डीबीटी परियोजना के अंतर्गत माइटोकोन्ड्रियल साइटोक्रोम ऑक्सीकारक सबयूनिट **I** (**coI-5P)** आधारित बारकोडिंग पूरा कर लिया गया है जिसमे नागालैंड से एकत्र किया हुआ गैर शहतूत रेशम कीट पतंग का जीन परिग्रहण संख्या MT385724: MT385735 को न्यूक्लियोटाइड डेटाबेस जैव विविधता मे समृद्ध किया गया है।
- *Loepa oberthuri* के बारकोड को जीनबैंक न्यूक्लियोटाइड (परिग्रहण संख्या: MT385732**)** मे भेजा गया है पहली बार इस गैर शहतूत रेशम कीट पतंग को एन सी बी आई जीनबैंक मे शामिल और रिपोर्ट किया गया है। इसके अतिरिक्त *Archaeoattacus Chitanus* रेशम कीट पतंग का बारकोड (MT385726) प्रस्तुत और रिपोर्ट किया गया जिसका प्रलेखन अधिकतर गलत तरीके से एडवर्ड्स (edwardsii) के रूप में किया गया था। जैसा कि रिपोर्ट किया जाता है कि नागालैंड से एकत्र किया गया इस रेशम कीट पतंग का बारकोड डेटा एक लंबे समय से लंबित है (Nassig and Neuman et al., 2010)।
- नागालैंड क्षेत्र में एरी रेशम कीट पालन यह दर्शाता है कि टैपिओका एवं पायाम पौधे एरी रेशम कीट के लिए केसेरू की तुलना में बेहतर उपयुक्त भोजन पौधे के रूप पाया गया है जबकि अरंडी एरी रेशम के लिए अभी भी पसंदीदा भोजन बना हुआ है जिसका सिल्क अनुपात क्रमशः एसआर (%) १०.१३, ९.६०, ९.२०, ६.८३ है। पतझड़ ऋतु के दौरान टैपिओका और अरंडी के संयोजन मे कीट पालन करने से सिल्क अनुपात १० से ज्यादा मिलता है।
- डीबीटी वित्त पोषित परियोजना तहत, मूगा रेशमकीट को अलग मेजबान पौध खिला कर इसके पेट माइक्रोबायोटा पर आहार के प्रभाव का अध्ययन किया गया जिसमे१४० माइक्रोबियल स्टेन (बैक्टीरिया, कवक) का संवर्धन किया गया जो आने वाले समय मे मेजबान पौधे और सूक्ष्म जीव के अध्ययन के लिए उपयोग मे लाया जाएगा।
- मूगा रोग प्रारंभिक चेतावनी प्रणाली (**MDEWS)** को सिल्क्स पोर्टल (**SILKS)** के साथ लिंक करने से 10 दिन पहले फ़्लचरी रोग की प्रारंभिक चेतावनी के लिए प्रणाली विकसित किया गया है। जिसका लिंक **https: //apps.nesdr.gov.in/MDEWS** है।

- ❖ शुरुआत मे मूगा रोग प्रारंभिक चेतावनी प्रणाली का इस्तेमाल आंकड़ों इक्कठ्ठा करने और अधिकृत उपयोगकर्ताओं द्वारा मॉडल को मान्य करने के लिए विकसित किया गया। किसानों और विभिन्न हितधारकों के लिए मूगा रोग प्रारंभिक चेतावनी प्रणाली को सिल्क्स पोर्टल के साथ जोड़ कर के भविष्य में सेरीकल्चर उद्योग को और व्यापक उपयोग करने अधिक जोर दिया गया है।
- ❖ एरी रेशमकीट अंडों के संरक्षण के लिए एसएसटीएल कोड़थी के सहयोग से एक परिरक्षण अनुसूची को विकसित किया गया है जिसमे अंडों को २० दिनों तक संरक्षित कर के ५५% अंडों से कीट प्राप्त कर सकते हैं।

प्रशिक्षण प्रभाग

- ❖ इस वर्ष कुल १९८१ किसानों, अधिकारियों, छात्रों, गैर-सरकारी संगठनों के सदस्यों को प्रशिक्षित किया गया, जिसमे किसान कौशल प्रशिक्षण, एक्सपोजर विजिट, टेक्नोलॉजी ओरिएंटेशन प्रोग्राम, पोस्ट कोकून सेक्टर के तहत प्रशिक्षण, सेरीकल्चर रिसोर्स सेंटर के तहत प्रशिक्षण, एसटीईपी और गैर सीबीटी प्रशिक्षण के तहत अलग-अलग घटकों में प्रशिक्षण किया गया।
- ❖ इस प्रशिक्षण मे ८४% किसानों को, ६% स्कूलों और कॉलेजों के छात्रों और गैर सरकारी संगठनों को और १०% केंद्रीय रेशम बोर्ड के अधिकारियों को तथा उत्तर प्रदेश के किसानों को मूगा एव एरी क्षेत्रों में विकसित आधुनिक प्रौद्योगिकियों पर प्रशिक्षण दिया गया।

SEEM प्रभाग

- ❖ भारत के उत्तर पूर्वी राज्यों में कुल १०३ विस्तार संचार कार्यक्रम किए गए जिसमें ६६७९ रेशम किसानों को शामिल किया गया था।
- ❖ इस वर्ष तीन वन्य रेशम कृषिमेला, १७ क्षेत्र दिवस, १४ किसान दिवस, २९ जागरूकता कार्यक्रम, २७ समूह चर्चा, ११ प्रौद्योगिकी प्रदर्शन और २ कार्यशाला कार्यक्रमों का आयोजन विभिन्न राज्यों, जिलों और पूर्वोत्तर के गांवों में विस्तार की इकाइयों के अलावा संस्थान द्वारा आयोजित किया गया था।
- ❖ मूगा रेशम मॉडल गाँव के अंतर्गत कार्यक्रम के तहत दौरान कोटिया फसल सीजन (अक्टूबर-नवम्बर) २०१९ मे ९४३०० ग्राम मूगा रेशम कीट के अंडों (डीएफएलएस) का पालन किया गया जिसमे १०४३९५ वाणिज्यिक ककून का उत्पादन किया गया। इसके अलावा, इस वाणिज्यिक फसल के दौरान १०२०.८८ किलोग्राम कच्चे रेशम का उत्पादन किया गया था।
- ❖ वसंत फसल के दौरान, एरी रेशम मॉडल गाँव के अंतर्गत कार्यक्रम के तहत १२६०० ग्राम एरी रेशम कीट के अंडों (डीएफएलएस) का ४०० किसानों द्वारा पालन किया गया जिसमे १०४५ किलोग्राम उत्पादन हुआ और शरद ऋतु फसल मे ४०० किसानों द्वारा १२०७५ ग्राम एरी कच्चे रेशम तथ १०१५ किलो कच्चे रेशम का उत्पादन किया गया था।

परियोजना निगरानी समन्वय और मूल्यांकन प्रभाग

निदेशक की देखरेख में इस संस्थान की परियोजना निगरानी समन्वय और मूल्यांकन (पीएमसीई) ने सीएसबी मुख्यालय, सभी राज्य और केंद्रीय मंत्रालयों के साथ समय पर पत्राचार के साथ-साथ संस्थागत आरएंडडी गतिविधियों की समग्र योजना और निगरानी को निष्पादित करता है। वर्ष २०१९-२० के दौरान, परियोजना निगरानी समन्वय और मूल्यांकन ने ०२ अनुसंधान सलाहकार समिति की बैठकें, ०४ अनुसंधान परिषद की बैठकें, एवं ०४ स्थानीय सलाहकार समिति की बैठकों का आयोजन किया। इसके अलावा प्रभाग ने सदस्य सचिव, सीएसबी की अध्यक्षता में तकनीकी लेखा परीक्षा और संस्थान की समीक्षा बैठक के दौरान सभी आर एंड डी गतिविधियों की भौतिक और वित्तीय प्रगति का मूल्यांकन किया है।

संस्थान के प्रकाशन

वर्ष २०१९-२० के दौरान केन्द्रीय मूगा एरी अनुसंधान एवं प्रशिक्षण संस्थान ने राष्ट्रीय और अंतर्राष्ट्रीय स्तर पर १७ समीक्षात्मक शोध पत्र, ०५ सम्मेलन/कार्यशाला पत्र, १० तकनीकी पत्रक/बुलेटिन, २ समाचार पत्रों, २ हिंदी समाचार पत्रों, १ पुस्तक, २ पत्रिकाओ और संस्थान की वर्ष २०१९-२० की वार्षिक रिपोर्ट का प्रकाशान किया।

अन्य गतिविधियां

- इस वर्ष विभिन्न संस्थानों/संगठनों से अतिथि व्याख्यान का आयोजित किया गया जिसमे असम कृषि विश्वविद्यालय, जोरहाट, असम; वर्षा वन अनुसंधान संस्थान, जोरहाट, असम; आरएसआरएस, जोरहाट; एनएसएसओ, बेंगलुरु; डीकिन विश्वविद्यालय, ऑस्ट्रेलिया के वैज्ञानिकों द्वारा व्याख्यान दिया गया जिसमे १७२ वैज्ञानिकों/विद्वानों ने भाग लिया था।
- राष्ट्रीय विज्ञान दिवस २८ फ़रवरी २०१९ के अवसर पर "उन्नत स्तर संस्थागत बायोटेक हब" के तहत संस्थान द्वारा कार्यक्रम आयोजित किया गया था। इसमें स्कूली छात्रों के बीच एक वैज्ञानिक वार्ता और एक प्रश्नोत्तरी प्रतियोगिता का आयोजन किया गया और तदनुसार नकद पुरस्कारों का वितरण किया गया था।
- स्वच्छ भारत अभियान, स्वच्छ ही सेवा, स्वच्छता पखवाड़ा, विश्व पर्यावरण दिवस, अंतर्राष्ट्रीय योग दिवस, विश्व विज्ञान दिवस, विश्व मृदा दिवस, अंतर्राष्ट्रीय महिला दिवस आदि राष्ट्रीय एवं अंतर्राष्ट्रीय दिवसों को संस्थान द्वारा मनाया गया।

संस्थान के चार वैज्ञानिकों ने वर्ष के दौरान "मूगा रेशमकीट मेजबान पौधों और पालन" और "मूगा रेशम कीट पालन के जरिये किसानों की आय में वृद्धि" पर आमंत्रित रेडियो वार्ता में भाग लिया।

Target and achievements (Physical and Financial Progress)

SI. No	Activity	Physical Target 2019-20)	Achievement 2019-20	Expenditure incurred (2019-20) Rs in lakh
1	**A. R&D Projects**			
1.1	Projects continued through the year (No.)	6.00	9.00	25.60
1.2	Projects Concluding (No.)	18.00	13.00	50.20
1.3	New project Initiation (No.)	11.00	11.00	9.89
	Total	**35.00**	**33.00**	**85.69**
2	**Transfer of Technology**			
2.1	On station Trials	5.00	5.00	0.59
2.2	On Farm Trials	5.00	5.00	2.60
	Sub- Total	**10.00**	**10.00**	**3.19**
3	**Capacity Building & Training**			
3.1	Farmers Skill Training	20	14	12.24
3.2	Exposure visit for technology awareness	8	4	0.84
3.3	Technology Orientation Programme	8	3	1.87
3.4	Sericulture Resource Centres (SRCs)	9	11	0.44
3.5	Training under Post Cocoon Sector	2	2	1.59
3.6	Management Development Programme under STEP	2.00		
3.7	Non-CBT: Training programme funded by agencies other than CSB	16.00	6.00	
	Sub- Total	**101.00**	**46.00**	**18.53**
4	**Extension Communication Programme (ECPs)**			
4.1	Krishi Mela / Farmers meet	3.00	3.00	5.00
4.2	Field day	18.00	17.00	1.70
4.3	Farmers day	18.00	14.00	1.40
4.4	Awareness programme	33.00	29.00	2.90
4.5	Group discussion /Vichar Goshthi	39.00	29.00	0.29
4.6	Technology demonstration	14.00	11.00	0.27
4.7	Workshop/ Seminars & Conferences	3.00	2.00	2.00
	Sub- Total	**128.00**	**1.50**	**13.56**
5	**Digital Soil Health Card**	**600**	**817.00**	**19.2**
6	**Information, Education and Communication**			
6.1	Periodicals	8.00	8.00	1.20
6.2	Publications	20.00	25.00	0.00
6.3	Extension literature	10.00	10.00	0.50
6.4	Films/ Videos	10.00	0.00	0.00
6.5	Social media			
	Sub- Total			**1.70**
8	**IT Initiative**			**2.79**

10	**Maintenance of Existing infrastructure/ Asset**			**6.48**
11	**Asset Creation**			
11.1	Asset Creation / Instrument purchase			**26.67**
	Sub-Total			**26.67**
	GRAND TOTAL			**177.81**

LIST OF R&D PROJECTS

CONCLUDED PROJECTS

Sl. No	Code	Title	Duration	Principal Investigator	Co-Investigator
1	AIP 5895	Biology, population dynamics and control of Sycanus collaris Fabricius and Eocanthecona furcellata Wolff (Insecta: Heteroptera)-potential predators of Muga silkworm- CSB funding.	Mar 2018 – Feb 2020	Dr. Kh. Subadas Singh	Dr. D. K. Jigyasu
2	MOE-5873	Enhancement of rural economy through technology intervention for sustainable muga culture in Upper Brahmaputra valley of Assam (DBT funded project)	Apr 2016 – Sep 2019	Dr. R. Das	Dr. M. Chutia Sri. D. Mech
3	ARP - 5874	Development of Decision Support System for early warning of selected muga silkworm diseases & pests with geospatial technique. [In collaboration with NESAC]- (CSB funded project)	Mar 2016 – Sep 2019	Dr. D. K. Gogoi	Dr. R. Das Dr. G. Subramanyam
4	MOE 5875	Effect of plant protection formulations on the growth, development and productivity of Muga Silkworm, *Antheraea assamensis* Helfer (Saturniidae: Lepidoptera) - CSB Funding	Apr 2016 – Aug 2019	Dr. K Neog	Dr. Kh. Subadas Singh
5	APR 5877	Role of hormesis in mitigating oxidative stress and its impact on growth and yield of Muga silkworm, *Antheraea assamensis* Helfer	Sep 2016 – Aug 2019	Dr. P Sangannavar	Dr. DK Gogoi
6	ARP 5878	Development of a technology for controlling bacterial flacherie disease in Muga silkworm	Sep 2016 – Aug 2019	Dr. G. Subramanyam	Dr. R. Das Dr. M. Chutia Dr. R Debnath
7	AIT 5876	Establishment of Institutional Biotech Hub.	Feb, 2014 to Nov., 2020	Dr. M. Chutia	Dr. R. Das
8	PRP 5880	Characterization and efficacy of bacterial antagonists against *Alternaria ricini* infecting Castor in North-eastern India.	Sept. 2016 - Aug., 2019	Dr. M. Chutia	Sri. Vijay N Dr. R. Das
9	PPS 5884	Soil health cards for sericulture farmers of Assam, Meghalaya, Manipur, Mizoram, Nagaland,	Sept., 2016 - Aug., 2019	Dr. Vinodakumar Naik	Dr. D. K. Jigyasu

		Arunachal Pradesh and Sikkim.			
10	AIT 5885	Development of microbial biocatalyst by heterologous expression of *hpaC&soxABC g*ene *cluster* in biosurfactant producing bacterium for effective desulfurization of dibenzothiophene	July, 2016 - June, 2019	Dr. G. Subramanyam	
11	APR 5890	Biodiversity assessment of wild silkmoths and rearing potentialities of muga (*Antheraea assamensis* Helfer) and eri silkworm (*Samia ricini* Donovan) for sustainable development in Nagaland.	Feb, 2017 - Jan, 2020	Dr. K. Neog and Dr. R Debnath (From Jul 2019)	
12	ARE 5891	Development of LED traps for controlling major insect pests and predators in muga ecosystem – Needs for organic muga silk production	July, 2017 - June, 2019	Dr. Kh. Subadas Singh	Sri. Vijay N
13	APR-5886	Improvement of Muga Cocoon yield through technology intervention and refinement of crop schedule in Terai region of W.B.	Dec., 2016 - Nov. 2019	Dr. N. Biswas	Sri. SAS Rahman
14	APS05002EF	Popularization and utilization of Foldscope for detection of pebrine disease (Nosema assama) in muga silkworm seed production areas .	May, 2018 - April,2019	Dr. Rajal Debnath	
15	PPS 3600	Soil health card preparation for mulberry growing soils in Eastern and North-eastern India.	April, 2017 - Oct., 2019	Dr. Y. Debaraj	Dr. Ritwika Sur Chaudhuri
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ONGOING PROJECTS

Sl.No.	Code	Title	Duration	Principal Investigator	Co-Investigators
1.	ARP-5887	Isolation and characterization of lytic bacteriophages infecting bacterial pathogens of Muga silkworm *Antheraea assamensis* Helfer (DST funded project)	Apr 2017 – Mar 2019	Dr. M. Chutia	Dr. G. Subramanyam
2.	PPA 5879	Assessment of phytochemical diversity in Som (Persea bombycina Kost), the primary host plant of *Antheraea*	Sept., 2016 - Feb 2021	Dr. P Sangannavar and Dr. Amit Kumar (From	Dr. R. Das Dr. D. K. Gogoi

		*assamensis*Helfer from Northeast India.		Jul 2019)	
3.	ARP 5889	Studies on the cross transmission of pebrine spores from lepidopteran caterpillars to Muga silkworm (*Antheraea assamensis* Helfer) and its control measures.	June, 2017 - May, 2020	Dr. Kh. Subadas Singh	Dr. M. Chutia
4.	APR 5892	Formulation of Semi-synthetic diet for rearing Muga silkworm, *Antheraea assamensis* Helfer".	Oct., 2017 - Sept., 2019	Dr. T James Keisa	Dr. Kh. Subadas Singh
5.	PPF 5893	Impact assessment of petroleum crude oil on muga silkworm and their host plants in Assam.	Oct., 2017 - Jan., 2021	Dr. D. K. Jigyasu	Dr. Kh. Subadas Singh Dr. K.Neog
6	AIB 5894	*In-situ* conservation of muga and other wild silk moths in Natural Habitat (In collaboration with R.O., CSB, Guwahati and Directorates of Sericulture of Assam, BTC, Meghalaya, Arunachal Pradesh).	April, 2016 - March, 2021	Dr. P. Sangannavar	Dr. G. Subramanyam Dr. Kh. Subadas Singh
7	ARE 4726	Bio-ecology, economic injury level and management of insect pest infesting oak ecosystem.	June, 2017 - May, 2020	Dr. S. Subharani Devi	Dr. Y. Debaraj Dr. RSur Chaudhuri
8	ARP 3606	Development of a diagnostic tool for early detection of baculovirus causing Tiger band disease in *Antheraea proylei.*	Mar., 2017 - Feb., 2020	Dr. S. Subharani Devi	Dr. N.Ibotombi Singh
9	APS05001EF	Development of technology for enhancing egg laying in Vanya Silk moths by application of host plant volatiles. (collaboration with SSTL, Kodathi)	Mar., 2018 - Feb., 2021	Dr. K Neog and Dr. DK Gogoi (from Jul 2019)	Dr. P Sangannavar
10	MOE 05003 EF	Socio-economic uplifting of farmers through adoption of improved technologies and skill development in Eri culture.	Nov., 2018 - Oct., 2021	Dr. H Barman	Sri. SAS Rehman
11	PIB-05005SI	Genetic enhancement of Castor (*Ricinus communis* L.) germplasm as a source material fo development of productive perennial varieties	Oct 2019 - Sep 2022	Dr. Aftab A Shabnam	Dr. Amit Kumar Dr. V.K. Naik Dr. L Somen Singh
12	AIP-05013SI	Impact of elevated CO_2 and temperature on muga silkworm and its primary host plant	Mar 2020 - Feb 2023	Dr. Amit Kumar	Dr. Aftab A Shabnam Dr. G. Subrahmanyam

13	AIB05006SI	Breeding of muga-silkworms for improved silk quality and disease tolerance	Oct 2019 - Sep 2022	Dr. Arun Kumar K P	Dr. Mahesh D. S Dr. Manjunath R. N
14	APR05007SI	Standardization of chawki rearing practices for Eri silkworm, *Samiaricini* (Donovan)	Oct 2019 - Sep 2022	Dr. Mahesh D. S	Dr. Arun Kumar K P Dr. Manjunath R. N
15	AIT05011EF	Molecular investigation into the lignocellulolytic system of a few Wild silkmoth in North-East India	Sept. 2019 - Sept 2022		
16	MOE05004EF	Adoption of improved sustainable technologies of Muga culture for elevation of cocoon production in the tribal belt of Assam.	Aug 2019 - Jul 2022	Dr. Vijay N	Dr. D. K. Gogoi Dr. D. Mech Dr. SAS Rahaman Dr K. Sathyanarayana
Projects as Co-I in other institutes					
1	APS 3612	Development of Seed Preservation Technology for Muga Silkworm *Antheraea assamensis* Helfer (In collaboration with SSTL, Kodathi).	June, 2017 - May, 2019	Dr. D. K. Gogoi	

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ACHIEVEMENTS IN R&D PROJECTS

Silkworm Division

CONCLUDED PROJECTS

Project Code: MOE- 5873

Project Title:Enhancement of rural economy through technology intervention for sustainable muga culture in Upper Brahmaputra Valley of Assam

Project Period : April 2016 to Sep 2019

Funding Agency : DST, New Delhi
Total Budget : Rs. 35.28 lakhs
Scientists involved : Dr. Ranjana Das, PI
Dr. M. Chutia, CI
Dr. D. Mech, CI

Objectives

1. To create awareness and popularize muga cultivation among the farmers of three upper Assam District.
2. To increase income and employment generation avenues among the rural youth of weaker section through adoption of SHG approach.
3. To train 150 beneficiaries for up gradation of skills for sustainable employment generation through activities like rearing of muga silkworm, rearing of cocoon, marketing of cocoon, yarn, fabrics, utilization of pupae etc.

Summary of the findings/achievements

During the project period, 150 nos. of beneficiaries were selected from 3 upper Assam districts of Assam (50 from each district) i.e. Sivasagar, Dibrugarh and Lakhimpur for upgradation of skills for sustainable employment generation throughtechnology intervention for pre and post cocoon sector.The selected beneficiaries were trained through various awareness and demonstration programs for adoption of the improved technologies like silkworm rearing packages, bamboo mountage, Lahdoi, Silkplus, etc., for silkworm rearing practices (Fig. 1).

Eleven awareness programs were organized sensitizing a total of 701 farmers towards expansion and development of Muga culture in the major sericulture villages of Sivasagar, Dibrugarh and Lakhimpur districts. Nine Frontline Demonstration of Technology programs were organized in all the three districts for 901 Muga farmers where, all the pre and post cocoon improved technologies were demonstrated to the farmers from host plant management to cocooning of muga silkworm to meet the actual leaf yield production in muga culture. Three hands on training programmes covering 179 farmers were organized demonstrating the use of Muga silkworm technologies for the interested rural youth generation to inspire them to take up Muga culture. Six training programs were organized (2 in each district) for the 150 beneficiaries of the project on pre and post cocoon sector i.e. preparation of disease free layings (dfls), disinfection of rearing fields, method of chawki and mature stage rearing, detection of diseases of muga silkworms and their management, harvesting of cocoons, boiling of cocoons, muga reeling and twisting procedure, production procedure of GHISA from waste etc.,

A total of 5000 improved variety of Som (*P. bombycina*) seedlings were supplied to the farmers of Sivasagar, Dibrugarh and Lakhimpur districts for gap filling in their existing farms. Among the 150 beneficiaries, 12 Self Help Groups (SHG) with a minimum of 10 famers per group were created for rearing, reeling and production of disease free layings of Muga silkworms. A total of 38152 improved disease free layings were supplied to the 150 beneficiaries during the whole period for conducting muga seed and commercial crop rearing to fulfill their seed crop. Overall, these programmes sensitized 1831 Muga farmers during the project period.

150 nos. of beneficiaries which were selected from 3 districts i.e. Sivasagar, Dibrugarh and Lakhimpur of Assam for up gradation of skills

for sustainable employment generation were trained throughtechnology intervention on pre and post cocoon sector. Till the completion of December, 2018, 1 awareness program (Fig. 1), 2 nos. of technology demonstration programmes and 01 no. of hands on training program covering 180 nos.of Muga farmers were conducted. There were 12 nos. of Self Help Groups (SHG) with a minimum of 10 nos. per group was created among the 150 beneficiaries for rearing, reeling and production of disease free layings of muga silkworms. A total 16,550 nos. of improved disease free muga layings were supplied to the 84 nos. of beneficiaries. They were able to earn Rs. 34,659.00 x 3 crop = Rs.1, 03997.00 per year instead of their earlier income of 30,920.67 per farmer per year. Overall, 36% improvement on production over benchmark has been observed.

Figure 1: Awareness and demonstration program for adoption of improved technologies in sericulture.

Project Code: AIP- 5895

Project Title: Biology, population dynamics and control of *Sycanus collaris* Fab.and*E.furcellata* Wolff (Insecta: Heteroptera)-potential predators of Muga silkworm

Project Period : Mar 2018 to Feb 2020

Funding Agency : CSB, Bangalore
Total Budget : Rs. 9.40 lakhs
Scientists involved : Dr. KH. Subadas Singh, PI
Dr. DK Jigyasu CI
Dr. Mahesh DS, CI
Dr. Manabenda Deka CI
Shri Omprakash Patidar CI

Objectives

1. To study biology, seasonal occurrence and population dynamics of two important predators of Muga silkworm, *Sycanus collaris* Fab. and*Eocanthecona furcellata* Wolff .

2. Development of ecofriendly control measures against *S. collaris* Fab. and*E. furcellata* Wolff.

Summary of the findings/achievements

Field survey was conducted at different locations of upper and lower Assam to study the seasonal occurrence and population dynamic of two important predator bugs *viz.* Assassin bug(*Sycanus collaris*: Reduvidae) and Stink bug(*Eocanthecona furcellata*: Pentatomidae) in muga rearing farms. Continuous field survey was conducted throughout the year to learn the population dynamic of the bugs. Field survey was conducted different locations of upper Assam (CMER&TI rearing farms, GCC Chenijan, Lakwa, Perikata, Ponka) and lower Assam (Pailapool and Boko) (Fig. 1). From the survey, it was learnt that predator bugs *E. furcellata* and *S. collaris* made its appearance from the onset of spring viz. February to September. Peak period of its occurrence was found in the month of April and May. Methods for monitoring stink bug insects, using a sweep net or

by visual inspection of insects, are typically intensive job.Predator bugs were collected using insect trapping net, counted their numbers and cultured in the lab to study life cycle and biology of the bugs Survey was conducted mainly to understand their population dynamics, seasonal occurrence, feeding behavior and development of management practices against the bugs, *S. collaris* and *E. furcellata*.. Frequent visits were made at regular intervals to detect bug populations during rearing period and seasonal occurrence thereof. While conducting survey, different studies were taken place in the field regarding feeding behaviour of the bugs.

Feeding behavior of both predator bugs is studied, which is very tactical. Farmers were not aware about the bug predators attacking to muga silkworms. When they found dead muga silkworm falling on the ground, it was presumed that dead of muga was due to diseases, however, symptoms are different. In this regard, farmers were sensitized about the bugs; identification of the bugs, symptoms of dead muga and necessary action to control the bugs at their level. Inspection, identification and adoption of mechanical and cultural controls are important method to manage bug predators in muga ecosystem.

Figure 1: Google map showing the locations of survey and collection of bug predators

Biology and life cycle of *E. furcellata*

Stink bug (*E. furcellata*) were collected from muga rearing fields. Number of stink bugs collected from muga rearing fields was counted after every collection and reared in laboratory condition. The life cycle of *E. furcellata* completed in 70-75 days including egg incubation period. Rearing of stink bug was taken place continuously for five generations. Stink bug, *E. furcellata* is multivoltine in nature. It has five nymphal instars (five moults), adult and egg stage. Both nymphal stage and adult stage of *E. furcellata* attacked muga silkworm (Fig. 2).

Regarding the occurrence of bug predator, abiotic factors responsible for its population dynamic has been studied. It is found that predator bugs were occurred mainly in summer season, which means temperature is the main abiotic factor responsible for the population increase of bug predator (Fig. 3). Population of bug predator subsides with the onset of winter starting from November to February, which means hibernation takes place in winter season. Understanding their seasonal occurrence, Identification of the predator bugs and mechanical control is the main approach to manage bug predators at farmer's level.

Figure 2: Life cycle of stink bug, *E. furcellata*

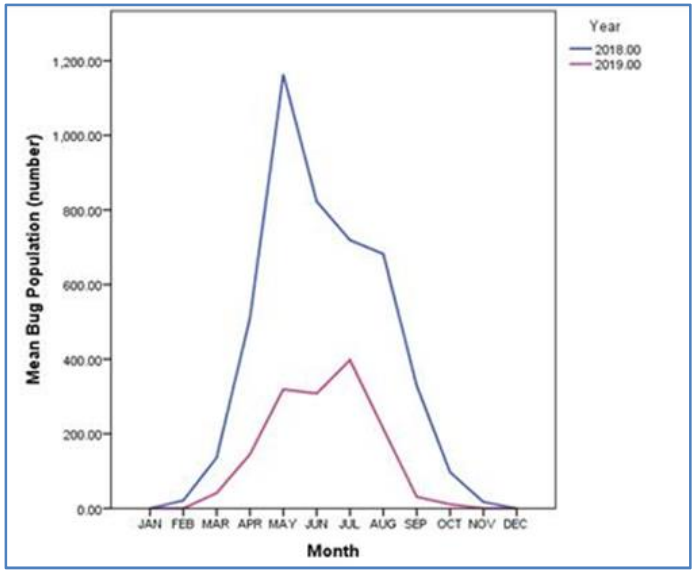


Figure 3: Comparative month wise bug emergence in 2018 and 2019

Project Code: ARP- 5878

Project Title: Development of a technology for controlling bacterial flacherie disease in Muga silkworm

Project Period : Sep 2016 to Aug 2019

Funding Agency : CSB, Bangalore
Total Budget : Rs. 41.00 lakhs
Scientists involved : Dr. G. Subrahmanyam, PI
Dr. KH. Subadas Singh, CI

Objectives

1. High throughput sequencing analysis of microbiome of flacherie infected muga silkworm.
2. Bioinformatics analysis and detection of causative bacterial pathogen responsible for flacherie disease in *Antheraea assamensis*
3. Establishing the bacterial pathogen and development of effective disease management practices

Summary of the findings/achievements

Flacherie diseased Muga silkworm insect gut microbiome was extracted. Next generation genomic sequencing was performed on the Illumina GAIIx platform. Microbiome involved in flacherie disease is established by rare fractional curves and Operational Taxonomic Units (OTUs) . Bacterial pathogens were isolated based on the cues from NGS data. Silkworm mid gut has been dissected and bacterial pathogens are cultured by plating methods. Bacterial pathogens were identified based on 16S rRNA gene sequencing analysis. These bacterial isolates were further used as test organisms for developing formulations for controlling bacterial flacherie disease. Effect of different disinfectants (Bleaching powder, Sodium hypochlorite, Lime, Formalin and a new mixture of disinfectants) on gram positive and gram negative bacterial pathogens of silkworm have been evaluated by plating studies. the formulation was tested in small scale rearing at CMER&TI institutional fields in all six Muga crop seasons and effective rate of raring (ERR) was documented. Detailed protocol for application of developed chemical formulation in muga rearing field is developed.

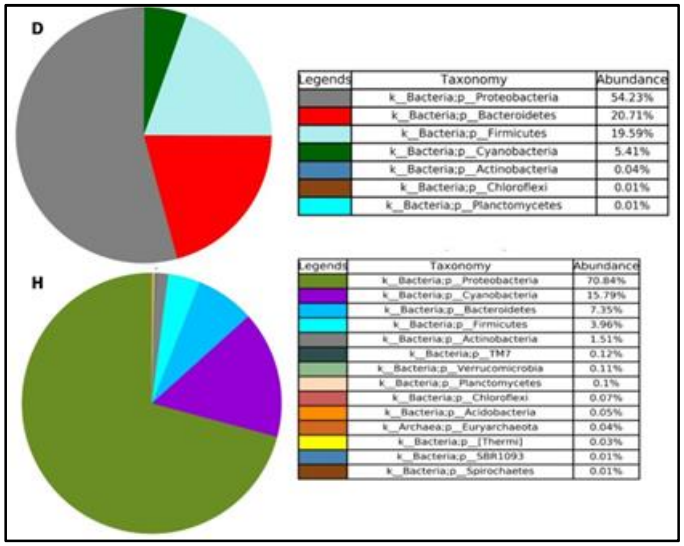


Figure 1: Taxonamic distribution of bacterial phyla in flacherie diseased (D) and healthy muga (H) silkworm larvae midgut.

Results of this project are summarized as below:

- Higher abundance of beneficiary gut microbiota such as *Alcanivorax, Oliebacter, Thalssospira, Citrobacter, Alteromonas, Enhydrobacter* were present in healthy muga silkworm midgut, while their numbers were decreased or disappeared in flacherie diseased Muga silkworms (Fig. 1).
- A new disinfectant formulation is developed and studies indicated that the newly tested disinfectant had bacteriolytic activity on two potential muga silkworm pathogens *Pseudomonas* sp., and *Bacillus* sp. been established for Flacherie disease of Muga silkworm based on Bioassay studies (Fig. 2).

Field evaluation of developed disinfectant during all the 6 muga crops showed that treatment had significantly enhanced the effective rate of rearing (ERR) approx. 15-20%.

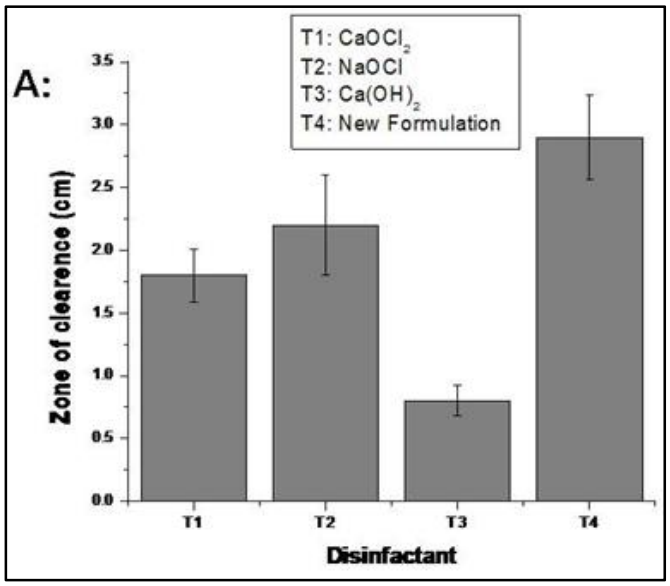


Figure2: Effect of different disinfectants on the growth of gram negative organism (A).

A new chemical disinfectant and a protocol suitable for application in Muga rearing field is developed for controlling bacterial flacherie disease. The formulation can improve ERR by 15-18% over control in summer Muga crops

Project Code: PRP- 5880

Project Title:Characterization and efficacy of bacterial antagonists against *Alternaria ricini* infecting Castor in North-eastern India

Project Period : Sep 2016 to Feb 2020

Funding Agency : CSB, Bangalore
Total Budget : Rs. 15.25 lakhs
Scientists involved : Dr. M. Chutia, PI
Dr. Jeevan B, CI
Dr. Vijay N, CI
Dr. Ranjana Das, CI

Objectives

1. To isolate and characterize bacterial antagonists from different castor growing areas against *Alternaria ricini*.
2. To evaluate the efficacy of different bacterial antagonists against *Alternaria ricini* causing leaf blight of castor.
3. Development and field evaluation of promising bio-formulation against *Alternaria* leaf spot of castor.

Summary of the findings/achievements

Altogether, thirty castor rhizosphere soil samples have been collected from different regions of Assam (India) from which more than fifty bacterial isolates were obtained by serial dilution plate technique and accordingly their gram reaction and other morphological characters have been recorded. Thereafter, the biochemical and molecular characterization of the selected (10 nos.) bacterial antagonists has been done by following the Bergey's Manual of Systematic Bacteriology and 16S rDNA homology study and analysis. The isolates were submitted to NCBI database soon after identification (by polyphasic approach) of the same and the accession numbers were obtained. The fungal pathogen was identified to be *Alternaria*

ricini strain MJL by ITS sequencing and analysis. The phylogenetic tree representing the position of the strain has been depicted. On the other hand, the 16S rDNA homology study and analysis of the bacterial antagonists depicted their identity with their closest homology of *Bacillus sp*. The identified sequences were further submitted to NCBI database and accordingly their accession number was obtained.

Antimicrobial bioassay and PGP activities

In vitro antimicrobial bioassay was conducted by dual plate culture technique. Qualitative analysis of the PGP traits of the antagonistic rhizobacterial isolates has been carried out for production of nitrate reductase, phosphatase, NH_3 and HCN. Besides, pH and salt tolerance ability of the isolates has also been assessed. Quantitative analysis has been worked out for soluble phosphate concentration, IAA, GA3 and ACC deaminase activity. The lowering of pH by the bacterial isolates has been tested for their ability to solubilize inorganic calcium phosphate in NBRIP broth. The quantitative analysis of the isolates depicted that isolate no. LRP-2 has got highest soluble phosphate concentration of 63.52 µmol/L. The pH drop has been noticed up to 5.4 in isolate no. LRP-2 that has been followed by KB-4 (5.6), KRP-6 (5.9) and LR-5 (5.9) respectively at 96 h of incubation with an initial pH of 7.0. Isolate no. KB-6 and KRP-6 are capable of producing nitrate reductase enzyme upon *in vitro* qualitative screening of the rhizobacterial isolates whereas all other isolates showed negative results against the control.

IAA production of the rhizobacterial antagonists was found to be ranging between 9.42 ± 1.22 µg/mL to 30.62 ± 1.08 µg/mL. Similarly, the GA_3 production by the antagonists was also analysed and the highest production was noted in isolate no. LRP-2 with 18.96 ± 1.11 µg/mL. In case of ACC deaminase activity almost all the isolates were capable of degrading ACC into α-ketobutyrate with the highest by UR-6 (5.43 ± 0.15 µg/mL). Qualitative screening of the bacterial antagonists against some plant growth promoting (PGP) traits like HCN, NH_3 and Siderophore production revealed that almost all the isolates were positive for the production of the former two traits. On the other hand, sidereophore production was found to be positive in LRP-2 and UR-6.

From the above results, LRP-2 and KRP-6 showed better results in comparison to the rest of the bacterial antagonists. Hence, these isolates have been selected for further pot experiments to draw a conclusive result just before applying under field conditions.

Pot experiment for plant growth promotion assay and disease severity

Pot experiment was conducted with five different treatment combinations for analysing the agronomical parameters. The treatments included T_1: Normal soil, T2: Cow dung or farm yard manure (FYM), T_3: Inoculums of strain LRP-2, T_4: Inoculums of LRP-2 and UR-6, T5: Inoculums of LRP-2 and UR-6 along with 50% of recommended (as per CMER&TI, Central Silk Board) NPK dose. Non-bloomy red (NBR-1) variety seeds of Castor with 0.5 % (v/v) NaOCl for 10 minutes and washed with sterile water. The seeds were thereafter sown into pots with sterile soil loaded in it. The agronomical parameters were recorded after 45 days of treatment application. The percent disease severity (PDS) upon application of eight different treatment combinations was recorded to be highest in the castor plants treated with T_2 and T_4 treatment combinations (13.33 %) that has been followed by treatment T_6 whereas lowest PDS was observed in treatment T_8. Similarly, percent disease incidence (PDI) was noted highest in the castor plants treated with T_2 and T_6 (100%) while the lowest PDI was recorded in treatment T_4, T_5 and T_8 respectively with 33.33%.

Similarly, another pot experiment was also conducted with eight different treatment combinations for analysing the percent disease severity and incidence with triplicates. The seeds

were thereafter sown into pots with sterile soil loaded in it. Treatment (T_1) with sterile water was taken as positive control while treatment T_2 included only pathogen. Similarly, treatment T_3 includes pathogen and fungicide (Indofil) applied on alternate days respectively, T_4: Bacterial isolate LRP-2 + pathogen applied on alternate days respectively, T_5: isolate no. LRP-2 + pathogen applied on the same day, T_6: pathogen + isolate no. LRP-2 applied on alternate days respectively, T_7: isolate no. HF -1 + pathogen applied on the same day and T_8: isolate LRP-2 + HF-1 + Pathogen applied on the same day. The results were recorded at an interval of one day for one month consecutively.

The highest shoot length upon treatment application during the pot experiments was noted in the castor plants treated with T_2 (5.93 ± 0.33 m) that has been followed by treatment T_4 (4.80 ± 0.13 m) and the least was found in the plants treated with T_1 (2.77 ± 0.16 m) treatment combinations. However, in case of the most important growth parameters (no. of leaves per plant, fresh leaf weight and leaf biomass) so far as sericulture is concerned, highest activity was observed in the plants treated with T5 treatment combinations which is 6.67 ± 0.21 nos., 50.00 ± 1.08 g and 40.00 ± 1.03 g respectively. This indicates that even though the plants treated with T_5 treatment combinations are shorter in size yet they are very much productive with highest no. of leaves per plant, fresh leaf weight and leaf biomass. On the other hand, the leaf moisture content was found to be highest in the plants treated with T_2 and T_4 treatment combinations which are 13.33 ± 1.14 g and 13.33 ± 1.02 respectively.

Project Code: MOE- 5875

Project Title:Effect of plant protection formulations on the growth, development and productivity of Muga Silkworm, *Antheraea assamensis* Helfer (Saturniidae: Lepidoptera)

Project Period	: April 2016 to June 2019
Funding Agency	: CSB, Bangalore
Total Budget	: Rs. 15.95 lakhs
Scientists involved	: Dr. Kartik Neog, PI Dr. KH. Subadas Singh, PI

Objectives

1. To study the effect of chemical pesticides / plant protection formulations on the growth and development of Muga Silkworm.
2. To study the effect of biopesticides / biocontrol agents on the growth, development and productivity of Muga Silkworm.
3. To develop suitable methodologies / procedures to reduce the effect of pesticides on muga silkworm.

Summary of the findings/achievements

It is evident from present studies that muga silk industry is facing a major challenge with small tea growers in Upper Assam which is the main commercial hub of muga silk. On the other hand, tea, muga and oil are the three major natural resources of North-East India, have the right to exist individually. The trust deficit among the farming communities of various sectors was clearly visible in the grass root level due to conflict of interest. Hence there should be better coordination among different stakeholders of Muga, Tea and Oil industries to chalk out some viable approaches to sustain these industries in general and muga industry in particular which is considered as pride of Assam. The capacity building of farmers' is required for adoption of improved package and practices of muga culture and should avoid raising muga gardens in vicinity of tea growing areas. A

complete mission mode multi-disciplinary project should be launched involving the different stakeholders of muga silk, tea and oil sectors to develop long term technological strategies to achieve the goal for inclusive development in muga silk sector.

From the present investigation, it can be concluded that, the pesticides / insecticides applied in the tea gardens neighbouring the muga rearing fields has adverse effects on the growth, development and reproductive behaviour of the silkworm.

As recorded, a very lower dose of the above chemicals cause death of the silkworm and drifting of a small quantity of the insecticides on the larval body through air current may cause a detrimental effect on the overall production of cocoon crops. It warrants need for measures for mitigating the ill effects of the insecticides through multiple strategies. Judicious use of insecticides, use of less toxic insecticides to muga silkworm, proper scheduling of the insecticide application for avoiding application during the muga rearing period may to some extent help reduction in the muga cocoon crop loss. Moreover, development of insecticides non toxic to muga silkworm, development of resistance in muga silkworm against commonly used insecticides are some of the areas for future research on the field of muga sericulture industry sector.

Effects of selected insecticides on the behaviour and physical changes in muga silkworms

Fourth instar muga silkworm larvae were treated at different dosages of four insecticides which are commonly used in tea gardens and the observations were recorded at different intervals of time (12, 24, 36 and 72 hours). The effects were observed to have significant impacts on the worms' appetite, mortality, activity, etc. pattern. The effects recorded for different doses at different intervals of time by the 3 insecticides are noted as follows:

Effects of Atom on muga silkworms

Treatment with Atom on muga silkworms resulted in loss of appetite, immediate haemolymph vomiting, sluggishness, inactivity, lethargy, colour changes and ultimately death. At high doses viz, recommended dose of 0.1%, etc., the effects were immediate causing death instantly. However at lower concentration doses, the symptoms persisted but slowly and to a lesser degree. It must be noted that of the 3 chemicals used on the samples, the impact was least in Atom.

An interesting thing to note is that at 0.02% concentration of recommended dose, after a few hours of treatment, the silkworms exhibited restoration of colour, appetite and stability. They started to feed properly after slight haemolymph vomiting initially.

Effects of Ennova on muga silkworms.

Ennova and Atom had similar kind of effects to similar degree on the silkworms. The immediate effects were detrimental at higher doses. But at lower concentrations of doses, the effects were not immediate and the intensity was much lesser. Restoration of health, appetite, colour and stability was also recorded in the case of Ennova.

Effects of Instant on muga silkworms

This chemical had the most profound impacts on the samples. The silkworms died immediately even at very low concentrations. Symptoms included instant vomiting of haemolymph, complete loss of appetite, inactivity, etc. resulting in immediate death. However, in the case Instant treatment, loss of colour change or physical changes were not observed. Mortality was highest in Instant.

LD_{50} determination

After treatments with the insecticides, the muga silkworms were kept under observation for a period of 12, 24 hours, 36 hours and 72 hours respectively. Their physical symptoms, changes, mortality, etc. were recorded for the lethal dose determination. The mortality rate of the samples determines the LD_{50} dose of the chemicals. The control samples were treated with distilled water and observed in the same time intervals as the treated samples. The observations were noted over a time period of 12, 24, 48 and 72 hours

respectively for each dose concentration and lethal dose was determined. The findings of this experiment are explained in tables and graphs depicted as follows (Table 1).

Table 1: Mortality of worms treated with ATOM at different hours after treatment

	Dose	Hours of treatment			
		12 hrs	**24 hrs**	**48 hrs**	**72 hrs**
1	Recommended Dose (RD) (0.1%)	10 (±0)	10 (±0)	10 (±0)	10 (±0)
2	½ of RD	7.33 (±1.5)	8.67 (±0.5)	9.33 (±0.5)	10 (±0)
3	1/3rd of R.D.	8.33 (±1.5)	9.33 (±0.58)	7.33 (±2.1)	8.67 (±1.53)
4	1/4th of RD	7.0 (±1)	8.0 (±1)	7.0 (±1)	7.33 (±2.1)
5	1/5th of R.D.	5.67 (±1.55)	6.0 (±1)	4.66 (±0.6)	4.33 (±0.6)

Note: Figures in parenthesis indicates Standard Deviation (S. D.).

Table 2: Mortality of worms treated with ENNOVA at different hours after treatment

	Dose	Hours of treatment			
		12 hrs	**24 hrs**	**48 hrs**	**72 hrs**
1	Recommended Dose (R.D.) (0.1%)	10 (±0)	10 (±0)	10 (±0)	10 (±0)
2	½ of R.D.	10 (±0)	9.67 (±0.58)	9.0 (±0)	8.67 (±0.58)
3	1/3rd of R.D.	10 (±0)	8.33 (±0.58)	6.67 (±2.083)	9.33 (±1.155)
4	1/4th of R.D.	8.33 (±0.58)	6.67 (±1.55)	6.33 (±0.578)	6.0 (±1.73)
5	1/5th of R.D.	3.0 (±1.0)	6.67 (±1.55)	5.33 (±0.58)	4.67 (±0.58)

Note: Figures in parenthesis indicates Standard Deviation (S.D.).

From the above table it was evident that about 50% of the muga silkworms died at 1/5th of the recommended dose that is at 0.02% concentration of the Atom insecticide.

From the above table (Table 2) it has been observed that 50% of the muga silkworm sample population was killed at 1/5th of the recommended dose which is 0.02% of the recommended dose concentration.

Table 3: Mortality of worms treated with INSTANT at different hours after treatment

Dose	Hours of treatment			
	12 hrs	**24 hrs**	**48 hrs**	**72 hrs**
Recommended Dose (0.1%)	10 (±0)	10 (±0)	10 (±0)	10 (±0)
½ of R.D.	10 (±0)	10 (±0)	10 (±0)	10 (±0)
1/3rd of R.D.	10 (±0)	10 (±0)	10 (±0)	10 (±0)
1/4th of R.D.	10 (±0)	10 (±0)	10 (±0)	10 (±0)
1/5th of R.D.	10 (±0)	10 (±0)	10 (±0)	10 (±0)
1/20 of R.D.	9.33 (±0.58)	10 (±0)	10 (±0)	10 (±0)
1/100 of R.D.	10 (±0)	5.33 (±0.58)	9.67 (±0.58)	9.0 (±1.0)
1/400 of R.D.	6.33 (±2.081)	6.67 (±1.53)	4.67 (±0.53)	6.33 (±1.16)

Note: Figures in parenthesis indicates Standard Deviation (S. D.).

From the above data (Table 3), it is understood that the toxicity level of Instant insecticide is high. At a much lower dosage i.e. at

1/400 of the recommended dose, almost half of the muga silkworm population perished.

Thus, from the table (Table 4) shown below it can be inferred that the LD_{50} doses of each of the three insecticides have been determined which is $1/5^{th}$ (0.02% concentration) of the recommended dose each for Atom and Ennova. However, it has been observed that the toxicity level of Instant is much higher than these two. The LD_{50} dose of Instant is 1/400 of the recommended dose.

Table 4: Larval body weight, cocoon weight, shell weight of 5^{th} instar larvae and fecundity of moths treated with different insecticides.

Treatments	Larval body weight (g)			Cocoon weight (g)	Shell weight (g)	Fecundity (Nos.)
	Male	Female	Average			
Atom	7.89	11.20	9.55	6.01	0.51	112.00
Ennova	8.24	11.07	9.66	4.87	0.46	96.00
Instant	8.10	11.15	9.63	5.91	0.46	82.00
Control	9.24	13.39	11.31	6.49	0.69	158.00
S.Ed.±	0.14	0.19	0.12	0.10	0.01	0.23
$CD_{0.05}$	0.29	0.37	0.24	0.20	0.02	0.45

Project Code: APR- 5877

Project Title:Role of hormesis in mitigating oxidative stress and its impact on growth and yield of muga silkworm, *Antheraea assamensis* Helfer

Project Period : Sep 2016 to Aug 2019

Funding Agency : CSB, Bangalore
Total Budget : Rs. 7.85 lakhs
Scientists involved : Dr. Prashant S, PI
Dr. D.K. Gogoi, CI

Objectives

1. Study on the impact of hormetic effect of heat shock on growth and yield of muga silkworm
2. Understanding the levels of oxidative stress and antioxidants in muga silkworm

Summary of the findings/achievements

Oxidative stress and Antioxidant

The estimation of oxidative and antioxidant were conducted during Chatua crop (Mar-Apr) 2019 and Jethua crop (May-June) 2019. Experiment conducted during the Chatua crop of 2019 were not repetitive across replication so data not considered, Jethua crop of 2019 oxidative and antioxidant levels were estimated (Table 1 and Fig 1).

Table 1: Oxidative stress and antioxidant level in muga silkworm

Treatment	LPX	CAT	SOD	GST
Control	0.09	0.98	2.60	103.00
T-1	0.58	2.24	3.38	125.00
T-2	0.66	2.72	5.80	137.00
T-3	0.74	3.68	6.60	146.00
Mean	0.52	2.41	4.60	127.75
SEM	0.148	0.573	0.977	9.405
CD @ 5%	0.443	1.719	2.930	28.198

Where: LPX-Lipid peroxidase (mmol TBARS mg/ protein), CAT-Catalase (microkat/mg protein, SOD-Superoxide dismutase (unit/mg protein), GST-Glutathione S transferase (mmol CDNB conjugate formed / min /mg protein)

The results obtained in the experiment indicate a significant induction of LPX in response to temperature stress, similar to other insects (Yang et al., 2010; Jia et al., 2011). Elevated levels of SOD, CAT and GST may be interpreted as possible protection by antioxidant and detoxifying enzymes, which could be sensitive to ROS generated under temperature stress. Organisms are equipped with an inter-dependent cascade of enzymes to alleviate oxidative stress and to repair the damaged macromolecules produced during normal metabolism or due to the exposure of

xenobiotics. In this cascade, SOD is the first enzyme to deal with oxyradicals that dismutate O_2 to H_2O_2, which gets further scavenged by CAT. Increased antioxidant defence systems of SOD, CAT and GST maybe an adaptive response of silkworm larvae to avoid oxidative stress during its exposure to temperature.

Based on this study, season specific stress, antioxidant levels, and combative effect of heat treatment on stress levels in different developmental stages was understood.

Outcome of the project

- At 37ºC with 30 minute incubation in B.O.D at head pigmentation stage of muga silkworm will give uniform hatching and higher survivability of young larvae after hatching.
- This technology (mild heat stress at egg stage) to be validated at RSRS/RECs/ MSSO & sub-units.
- Further, during 4th and 5th instar little smoke (37ºC for 30 min) will improve the good cocoon %.

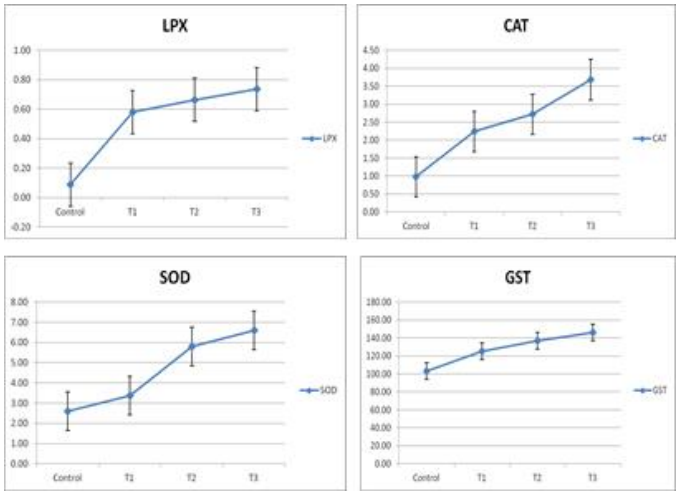


Figure 1: Effect of temperature on (a)lipidperoxidation(mmolTBARS/mgprotein), (b) catalase (nkat/mg protein), (c) superoxide dismutase activity (Unit/mg protein) and (d)glutathione-S-transferase (mmol CDNB conjugate formed /min /mg protein),in the *Antheraea assamesis* H Data are expressed as mean.

Utility of the project

- After confirmation and validation of the technology, it can be recommended to practice in grainage before distribution of seed to farmers/ stakeholders.
- For improvement of fecundity also this can be taken up at cocoon stage for 30 min at 37ºC incubation in B.O.D as most of the grainages are equipped with B.O.D equipment.

Project Code: AIT- 5885

Project Title: Development of microbial biocatalyst by heterologous expression of *hpaC&soxABC gene cluster* in biosur factant producing bacterium for effective desulfurization of dibenzothiophene (DST Fast track young scientist project

Project Period : Aug 2016 to July 2019

Funding Agency : DST, New Delhi
Total Budget : Rs. 41.00 lakhs
Scientists involved : Dr. G. Subrahmanyam, PI
Dr. KH. Subadas Singh, CI

Objectives

1. Cloning, expression and purification of hpaC and soxABC gene cluster in a biosurfactant producing bacterium
2. Characterization of the DBT desulfurization activity by recombinant strain LBBMA 155
3. Industrial applications of recombinant strain in biorefining the hydrotreated fuels

Summary of the findings/achievements

Isolation, characterization and identification of biodesulfurizing bacteria was done from oil polluted soils. Biochemical characterization for biodesulfurizing property of the BDS isolates was done first by Gibb's assay.Throughout the experiment of DBT was used as the sole S-source. Molecular detection ofdszoperon was done withdszAB gene specific PCR. Comparison made between *Gordonia sp.* and *Rhodococcus erythropolis IGTSO8*(MTCC 3552), and *Escherichia coli* W (MTCC 448) procured from

Microbial Type Culture Collection(*MTCC*),done for BDS activity. PCR amplified product hpaC coding FMN:NADH dehydrogenase was cloned in *E. coli* through *B. subtilis* / *E. coli* shuttle vector pBE-S by Ligation- TA cloning kit. Transformation of product was done in DH5α competent cells, Thermofisher, by Plating on LB kanamycin plate. Colony PCR was performed for confirmation of heterologus expression studies followed by plasmid isolation, GenElute HP Plasmid Miniprep Kit. Amplification of hpaC gene from recombinant bacterium was done with the primers mentioned above. A series of short-term laboratory soil microcosm experiments with well mixed soil samples of with Ph 6.0. Before conducting the incubation experiments.Whole genome sequencing of BDS bacterium was performed with standard procedures.

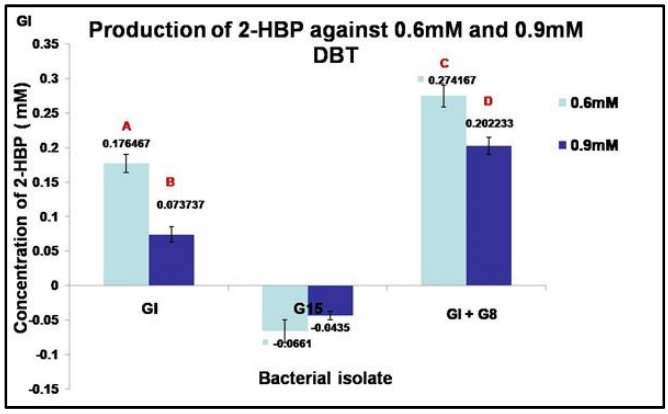


Figure 1: Biodesulfurization DBT by *Gordonia* sp I and bacterial consortia (GI + G8) at two different DBT concentrations (0.6 mM and 0.9 mM).

Molecular characterization of *Rhodococcus erythropolis* IGTS08, MTCC 3552 and *Gordonia sp*., showed presence of both dszAB gene of size 2.5 kb and dszC gene of size 1.3 kb. *Rhodococcus erythropolis* IGTS08, MTCC 3552 showed maximum 2-HBP production (0.180mM) at 0.3mM DBT concentration where as *Gordonia sp*. showed maximum 2-HBP production (0.231m) at 0.6mM DBT concentration (Fig. 1). Heterologous expression of SOX hpaC gene encoding FADH-NADH dehydrogenase was done. Bacterial consortia contained *Gordonia* sp I and biosurfactant producing *Bacillus subtilis* can effectively biodesulfurize the DBT up to 0.33 mM. Whole genome sequencing of *Gordonia* sp I was completed. Gordonia sp I was identified at species level as *Gordonia amicalis* I. The size of the genome was found to be 4.9 MB with 1,03,906 nos scaffolds N-50. Gene prediction analysis revealed that a total of 4614 no of genes are present in *Gordonia amicalis* genome. *In-situ* soil microcosm experiments suitable for industrial application of biodesulfurizing bacteria was conducted. The biodesulfurization potential of the bacterium has significantly improved (P>0.05) in presence of biosurfactant producing *Bacillus subtilis* where the released 2HBP was found to be 0.2 mM. Whole genome sequencing of *Gordonia* sp I was completed. Gordonia sp I was identified at species level as *Gordonia amicalis* I. The size of the genome was found to be 4.9 MB with 1,03,906 nos scaffolds N-50. Gene prediction analysis revealed that a total of 4614 no of genes are present in *Gordonia amicalis* genome.

Microbial consortia consisting of *Gordonia amicalis* I and biosurfactant producing *Bacillus subtilis* G8 was developed for bioremediation of dibenzothiophne (DBT).

Project Code: ARE- 5891

Project Title: Development of LED traps for controlling major insect pests and predators in muga ecosystem-Needs for organic muga silk production

Project Period	: July 2017 to June 2019
Funding Agency	: DST, New Delhi
Total Budget	: Rs. 14.79 lakhs
Scientists involved	: Dr. KH. Subadas Singh, PI Dr. Vijay N, CI

Objectives

1. To develop light traps through LED (Light emitting Diode) for controlling major insect pests and predators in muga ecosystem.

2. Field trial for validation of developed LED traps for controlling major insect pests and predators of muga ecosystem.

Summary of the findings/achievements

The LED lights of different colours having different wavelength were developed into LED light traps. LED light of six different wavelengths with transparent sheets applied with tangle foot glue (to trap insect pests) has been installed every day at night in the muga rearing field for monitoring of insect pest of muga ecosystem. Trapped insect pests were counted and pictures were taken for further identification. It has been observed that leaf miner adults were attracted towards UV light, Soalu leaf gall were attracted towards green light and Som stem gall adults were also attracted more towards green colour followed by blue and then yellow. Blue light is giving good result for gall insects and UV light is attracting mostly micro-lepidopteran insects (Fig. 1). Few flies (tachinid) were attracted towards green light. Installed more number of green color trap with solar LED. Solar light has been modified to four wavelengths. Earlier recorded from Som *E. fornicates* (Tea shoot hole borer), which is serious pest of tea, is attracted towards different wavelength.

At every one-week interval the transparent sheets are detached from the trap and the numbers of insects attracted are counted in 1-inch square area of trap separately on order wise basis and then accordingly the picture of attracted insects are taken by Telescopic Zoom Microscope. Seasonal occurrence of the insect pests trapped in LED light has been studied. The newly developed simple and cost effective LEDlight trap was observed to attract black ants, Componotus sp., Black ants, tingid bug were attracted towards white light. Trapped insects were identified and tabulated based on the occurrence on different cropping seasons.

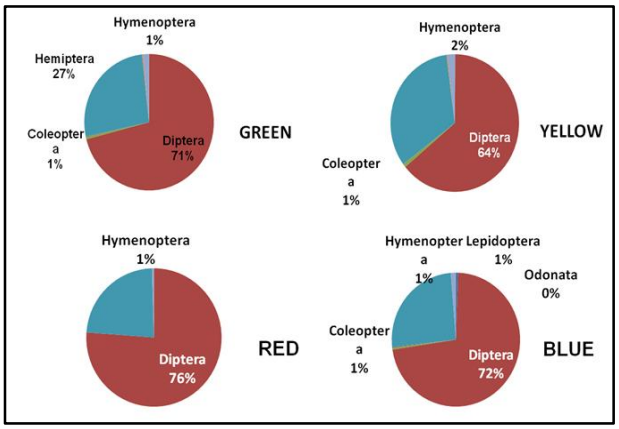


Figure 1: Proportion of different kinds of insects trapped in different colors of light

Demonstration and awareness of LED light trap device has been conducted at State sericulture farms in Golaghat district, Muga farmers at Lakhimpur, Dhakuakhana, Sivasagar, Kaliabor and Pasighat (Arunachal Pradesh). Based on the traps in different crop season, insects were categorised based on their seasonal occurrence, which will help farmers in forewarning and forecasting activities.

ONGOING R&D PROJECTS

Project Code: ARP- 5887

Project Title: Isolation and characterization of lytic bacteriophages infecting bacterial pathogens of Muga silkworm *Antheraea assamensis* Helfer

Project Period : April 2017 to Mar 2020

Funding Agency : DST, New Delhi
Total Budget : Rs. 35.28 lakhs
Scientists involved : Dr. M. Chutia, PI
Dr. Ranjana Das CI
Dr. G. Subrahmanyam, CI

Objectives

1. Isolation and characterization of bacteriophages against muga silkworm bacterial pathogens.
2. Study of the phage biology and genome organization.
3. Evaluation of the potential phages cocktail against muga silkworm pathogens.

Summary of the findings/achievements

Phage isolation from environmental samples

Soil, water, litter, manure samples from cattle, sheep etc., and sewage effluent were collected for screening for the presence of phage active against these bacteria. An inoculum (400 µL) from the actively growing 3-4 hour culture was mixed with 4 mL of LB broth, 5mL of concentrated salt solution ($MgCl_2$ + $CaCl_2$) and 1mL/1g of environmental sample respectively. The mixtures were then kept in the shaker incubator for 7-9 days. From these mixtures, filtrates were collected every day using sterile syringe and 0.22µm syringe filters. These then stored in the refrigerator at 4°C to use within the week and at -20°C for long term use. Samples were added to LB broth supplemented with 2 mM Calcium chloride and the mixture were be incubated for ~1 hr at room temperature with shaking. The supernatant were filtered using a 0.22 µm pore size syringe driven filter unit.

Actively growing bacterial culture (3-4 hours incubation) were mixed (400µL of culture/4mL of media) and pours over the 1st layer of LB Agar plates. After solidification of the overlay agar, 5-10µL spots of the filtrates collected were put on the agar accordingly. Plates were then placed for overnight incubation at 37°C.

Clear zones are spotted with the drain water sample, filtrates collected each day from the mixture of environmental samples were diluted 5 times and spot test is again performed with the dilutions to obtain single plaques of phage which confirms the presence of phage. The clear plaques containing phage are picked from the overlay agar. These are then dissolved in SM buffer and stored at -20°C as phage stocks for further purification.

Phage growth and stability Analysis

Several phage stocks were isolated and the phages MOI were studied by co-culturing of phage and bacteria. Absorbances were measured at 590nm using UV-VIS spectrophotometer. Regarding temperature stability, the phages also showed different properties. The infectivity of Phage decreased gradually upon increasing the temperature when exposed for 1 h to temperatures ranging from 30 to 60 °C, dropped significantly at 70 °C, and was completely lost at ≥80°C.

TEM analysis

For electron microscopy (TEM), purified phages were spotted onto carbon-coated grids and negatively stained with 2% phosphotungstic acid (pH 6.5) through outsourcing. The observed phages were icosahedral heads and contractile tails with small rod (Fig. 1). As such, the phages belonged to the order Caudovirales and the Myoviridae family

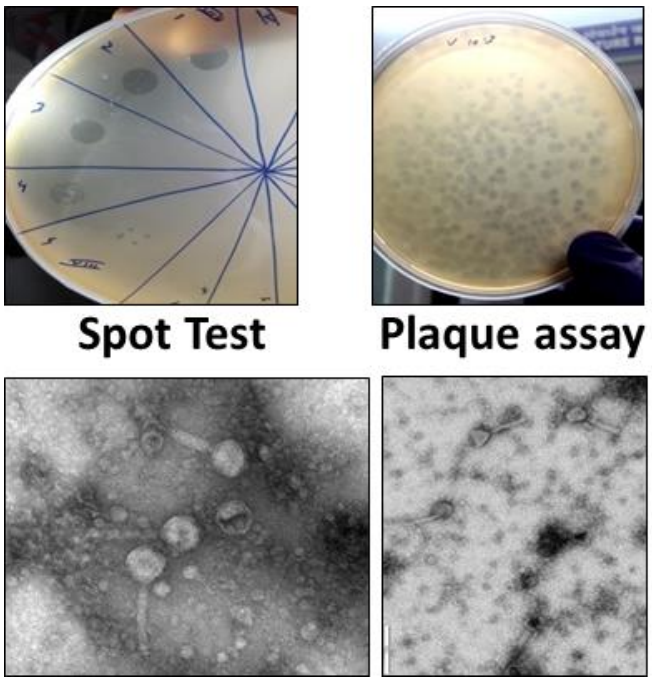


Figure 1: TEM images of newly isolated phages

Phage cocktail and in vivo application

The isolated phages were mass cultured for preparation of phage cocktail (2-3 phages) for *in vivo* application. Larvae were infected with the pathogenic bacteria and phages were applied in the host leaves (pot experiments) in different treatment combination (remedial and prophylactic regimen). The experiment couldnot be completed due to nationwide lockdown. The experiments will be done again for confirmation.

Project Code: AIB-5894

Project Title: *In-situ* conservation of Muga and other wild silk moths in natural habitat

Project Period	: Sep 2016 to March 2021
Funding Agency	: MOT under NERTPS scheme
Total Budget	: Rs. 41.00 lakhs
Scientists involved	: Dr. G. Subrahmanyam, PI Dr. KH. Subadas Singh, CI

Objectives

1. Development of in-situ conservation site for muga silkworm and other wild silk moths species.
2. Utilization of muga silkworm germplasm for breeding and seed production

Summary of the findings/achievements

Assam: *In situ* conservation area is found to be rich in Muga host plants *Litseae monopetala, Persea bombycina*, *Litisea saliciifolia*, *L. citreta* etc. The team visited approx. 2.5 km area in peripheral zone and examined the muga population dynamics and host plants development. Around 10,000 no's of Som plants to support the conservation activities have been planted by DOS, Assam in peripheral zone at Upper Doigrung. The growth of the plantation was found to be satisfactory. The team did not find Muga silkworm larvae, cocoons and silk moths in the peripheral zone. Nevertheless, Local farmers informed the presence of 5th instar muga silkworm larva in peripheral zone and prodcused documented evidence. Weather station has been installed in the peripheral village (Bankathar Village) for recording the meteorological parameter of Upper Doigrung Wild Life area. Muga grainage for *in situ* conservation was constructed at Bankathar Village, Upper Doigrung, Golaghat (Fig. 1).

Figure 1: Field visit to *in situ* conservation site at Upper Doigrung, Golaghat.

Kuklung Forest Area of Chirang District, BTC:

The natural habitat of Muga Silk Worm has been fortified by planting more food plants. The most of the plantation has found in the peripheral zone of the conservation site. The interior area of the site has very less number of food plants and the most of the area remains vacant. There is sufficient human disturbance in the periphery zone. The whole area has been protected with barbed wire fencing. Steps have been made to aware and involve the local community in the conservation process. An Automatic Weather Station have been installed however the same has not been brought under functional condition. In December 2019, 100 cocoons of muga silkworm were released. Necessary steps have been taken to develop Ex-situ conservation site at Bollamguri ECC.

Mebo reserve forest, Pasighat, Arunachal Pradesh:

The team visited approx. 5 km area in peripheral zone and examined the Muga silkworm host plants distribution/development. Muga primary and secondary food plants such as Soalu (*Litsaea monpetala*, Lauraceaea family), Dighleti (*Litsaea salisifolia,* Lauraceaea family), Mezankari (*Litsaea citrata,* Lauraceaea family) and Pathihanda (*Cinnamonum obtusifelium,* Lauraceaea family) host plants are available in the peripheral zone of the site. Among all the food plants, Dighleti (*Litsaea salisifolia,* Lauraceaea family) is found to abundant in the peripheral zone of the teh site. The team also found natural food plants for Eri silkworm such as Keeseru*Heteropanax fragrans* and Borpat (*Ailanthus grandis*) in the peripheral zone of the conservation site.The team noticed that scarcity of Muga food plants in the earlier proposed conservation site ("Aohali site", Mebo reserve forest), Therefore, it is proposed that current location (near compensatory aforestation area, Mebo reserve forest) is much suitable for *in situ* Muga conservation activities.DraftMoU document was prepared and sent to Arunachal Pradesh Forest Department, and CMER&TI. CSB, Lahdoigarh; and with Department of Textiles and Handicraft, Pasighat, Arunachal Pradesh for signature.

Project Code: ARP-5889

Project Title: Studies on the cross transmission of pebrine spores from lepidopteran caterpillars to muga silkworm (*Antheraea assamensis* Helfer) and its control measures

Project Period	: June 2017 to May 2020
Funding Agency	: CSB, Bangalore
Total Budget	: Rs. 15.55 lakhs
Scientists involved	: Dr. KH. Subadas Singh, PI Dr. M. Chutia, CI

Objectives

1. Isolation of pebrine spores from infected Muga silkworms and other lepidopteran insects from different Muga silkworm rearing sites.
2. Seasonal prevalence and cross infection of pebrine spores from lepidopteran caterpillars to Muga silkworm.
3. Morphological and molecular characterization of isolated pebrine spores.Final report of the project

Summary of the findings/achievements

Different caterpillars are coexisting in the Muga rearing fields in different crop season throughout the year. More than 30 lepidopteran species including both Saturniids and other other lepidopteran caterpillars of Noctuidae, Pyralidae, Papilionidae, Lymantriinae and Nymphalidae family are collected and tested for carrying pebrine spores. Among the above mentioned families, insects belonging to Saturniidae, Nymphalidae, Papilionidae and Noctuidae are frequently detected with pebrine spores (Fig. 1). Altogether, 24 species were detected with pebrine spores. However, focus was made towards saturniid insects as those are

the most probable hosts for cross-transmission to muga silkworms. Therefore collection and pathogenicity test was conducted with insects belonging to saturniidae family. Among the saturniids, *Cricula trifenestrata* is abundantly available in Muga ecosystem, feeding same host plant of muga silkworm i.e. *Persea bombycina* and they are voracious in nature. Collected larvae of *C. trifenestrata* were tested for pebrine spores, positive results were obtained. *Attacus atlas* is also available in muga ecosystem occasionally in minimum number in soalu plants; however, no pebrine spore was detected. Henceforth, more *Cricula* was collected from different muga rearing fields and kept testing for pebrine spores.

Figure 1: Pebrine spores isolated from wild lepidopteran *Graphium sarpedon* caterpillars

Spores isolated from *C. trifenestrata* were preserved for further studies. Rearing of *C. trifenestrata* was conducted at isolated place and pathogenicity test was conducted using the same spores isolated from itself, and positive result was obtained. Repeated studies of pathogenicity were conducted to confirm the result. After every pathogenicity tests, number of spores was counted using Neubauer slide and found spore number increased in the subsequent tests. Further, cross infectivity test was conducted from *Cricula* to Muga silkworm, positive result obtained. Again cross infectivity process was conducted from Muga to *Cricula*, positive result obtained, which confirms cross transmission of pebrine spores from *Cricula* to Muga silkworm. Further, dose response studies were studied both in *Cricula* and Muga. Morphometric studies of different pebrine spores isolated from saturniid species has been studied using Scanning electron microscopy (SEM). Spores of *Cricula* and Muga found same, but spores from other non saturniid lepidopteran caterpillars are found different. This shows that spores found in different species of lepidopteran caterpillars are not same. However, spores found in *Cricula* and Muga are found same morphologically. Molecular characterization of different spores are under process.

Project Code: APR-5892

Project Title: Formulation of Semi-synthetic diet for rearing of Muga silkworm, *Antheraea assamensis* Helfer

Project Period	: April 2017 to July 2020
Funding Agency	: CSB, Bangalore
Total Budget	: Rs. 16.46 lakhs
Scientists involved	: Dr. T. James Keisa, PI
	Dr. Subadas Singh, CI
	Dr. Arun Kumar K. P, CI

Objectives

1. Formulation and standardization of Semi-synthetic diet for rearing of Muga silkworm, *Antheraea assamensis* Helfer.

Summary of the findings/achievements

Periodical collection of young, medium and semi mature leaves of Som, Soalu and Digloti from Farm No. 1, 2 and 3 was carried out. After removing the branches and mid-ribs, the leaves were washed with clean water and shade dried for four to five days. After that dried in oven at 45°C to 60°C for 4-6 hrs per day for few days so that all the remaining moisture contents removed. Dried leaves were crushed and ground in the Mixer Grinder and sieved in wire mesh no. 36 and fine leaf powders were kept in an air tight plastic container for further use.

Figure 1: Second instar muga larvae feeding on semi-synthetic diet.

Five different types of combination of ingredients along with leaf powders of Som, Soalu and Digloti were prepared separately as semi-synthetic diet for rearing of Muga silkworms in laboratory conditions (Figure 1). The necessary parameters of larvae rearing on semi-synthetic diets and control are recorded periodically. It is observed that among the five different types of diets prepared, D10 diet is performing better in the chawki rearing of Muga silkworms in respect of less mortality and more weight gain. In the experiments 100 numbers each of newly hatched worms were brushed on the semi-synthetic diets of Som, Soalu and Digloti. The 3rd instar larvae were transferred to natural food plants in the field and the ERR% of semi-synthetic 13 % (in Som), 14% (in Soalu) and 16% (in Digloti) respectively. Whereas the worms reared on control Soalu and Som plant were 14% and 20% ERR.

Project Code: AIB05006SI

Project Title: Breeding of muga-silkworms for improved silk quality and disease tolerance

Project Period	: Oct 2019 to Sep 2022
Funding Agency	: CSB, Bangalore
Total Budget	: Rs. 18.32 lakhs
Scientists involved	: Dr. Arun Kumar K.P, PI
	Dr. Mahesh D. S, CI
	Dr. Manjunath R. N, CI

Objectives

1. Selection of better parents by field collection of muga silkmoth samples.
2. Classical breeding studies to select better lines for muga silkmoths.
3. Mass production for limited trials.

Summary of the findings/achievements

Genetic improvement of wild silkworms in the form of high yielding disease tolerant breeds will directly help the stakeholders in increasing the production and subsequently improve the local economy by increased profit. In this project systematic breeding experiments have been planned to develop better breeds in muga silkworms (*Antheraea assamensis*). Muga being reared outdoors is difficult to breed through conventional breeding methods as the breeders will have less control over the whole process of breeding.

Collection of genetic resources for initiation of breeding program

A major prerequisite for any breeding program is the availability of genetic variation in the species. Therefore, our first and foremost objective was to

collect wild samples with significant genetic diversity. Field visits were conducted to collect superior genetic stock both from wild habitats and also from farmers' fields. First expedition to collect wild muga samples was performed in December 2019 to the Manipur state (Fig. 1). We visited several areas around Imphal in search of muga samples either in larval or cocoon stage. The visit was very much educational in nature. We learnt a great deal about the muga ecosystem of Manipur. Imphal area in Manipur has a large number of natural Soalu vegetation.

Considering the mild summer in Manipur, the natural Soalu trees may be exploited for rearing seed or pre seed crops during peak summer months to make enough DFLs available for rearing during commercial season. This way we can avoid the sterility problem during summer time in grainage. After this visit we also visited nearby farmers' fields in Jorhat district to collect the muga cocoons. We selected cocoons based on their weight. Initially we selected the male cocoons which are more than 4g and female cocoons more than 6g. The selected cocoons were brought to the institute for further processing.

Figure 1: Collection of wild samples of muga in the forests of Manipur

Cold reeling procedure to select better genetic stock based on filament length

There are many challenges for developing high yielding breeds in muga silkworms owing to many limitations as described below. They are reared outdoors on trees and therefore the breeders will have less control over the whole process of breeding. The varying environment varies the cocoon characteristics and yield, thereby affecting the selection for better characteristics. The absence of egg diapause or pupal hibernation makes it much more difficult to maintain the lines in unfavorable seasons. The possible existence of inbreeding depression will also affect the maintenance of breeds. Lack of suitable artificial diet further complicates the breeding program during unfavorable seasons. Hence, the breeding procedure in muga silkworms is a different ballgame compared to the domesticated silkworm. Therefore, we need to develop methods or adapt the procedures developed for other insects to overcome the limitations.

While selecting cocoons for developing elite breeds in the muga silkworms, we were faced with a challenge of selecting the particular pupa that has better cocoon characteristics. If we reel the cocoons with normal hot reeling technique, we can obtain the characteristics but the pupa dies during the reeling process and hence we will not be able to use it for crossing experiments. And when the cocoons are cut open to obtain live pupa for crossing experiments, we cannot obtain the cocoon characteristics except for cocoon weight, shell ratio, etc. To overcome these problems we developed a cold reeling procedure for muga cocoons, whereby we can reel the cocoons to obtain all the cocoon characteristics without killing the pupa inside. Once we have cocoon characteristics we can undertake the selection process to shortlist only those pupae that have longer filament lengths.

In the cold reeling procedure, a sample cocoon is dipped into a 0.8% NaOH (sodium hydroxide) solution to dissolve the sericin proteins.

This facilitates the easy reeling of filament without damaging the live pupae inside the cocoon. An 'epprouvette' device was used in 'cold reeling method' to measure the length the silk filament. After reeling, the pupae were dipped in 1% acetic acid (CH_3COOH) solution for 5 minutes to neutralize the NaOH on the surface of the naked pupae. Finally, the pupae were washed with tap water and water droplets on the pupa were removed using the blotting paper. The naked pupae were kept in an incubator till the moth emergence.

Using the 'cold reeling' procedure we obtained the following information for each cocoon: sex of the pupae; weight of the cocoons (in g); filament length (in m); weight of the filament (in g); weight of the pupae (in g); shell ratio (in %); shell weight; denier; non-breakable filament length (in m); mortality of pupae.

Selection of pupae based on the cocoon characteristics

Once we had the information on cocoon characteristics of all the pupae that are still alive after cold reeling (we found a few pupa already dead upon reeling, which could not be processed further) we proceeded for the next round of selections. Currently, we rely on filament length as the criterion for selection. Those pupae whose cocoons had more than 400m filament length were selected for further breeding experiments. The breeding experiments are underway now through cellular based rearing on the Institute's farm.

Project Code: AIB05007SI

Project Title: Standardization of chawki rearing practices for Eri silkworm, *Samiaricini* (Donovan)

Project Period : Oct 2019 to Sep 2022
Funding Agency : CSB, Bangalore
Total Budget : Rs. 18.15 lakhs
Scientists involved : Dr. Mahesh D. S, PI
Dr. Arun Kumar K.P, CI
Dr. Kh Subadas Singh, CI

Objectives

1. Establishment and management of eri host plant garden for eri chawki rearing.
2. Design and fabrication of Eri silkworm chawki reaing equipment.
3. Development of new rearing method and ideal environment for eri chawki rearing.

Summary of the findings/achievements

The young age silkworm rearing or chawki rearing is a vital aspect of sericulture industry for the development of healthy larvae and harvesting of successful cocoon crop. The success of the chawki rearing technology depends upon the proper understanding of the requirements of silkworms at this stage, manipulation of nutritional and ecological conditions to obtain maximum growth and care to raise robust and healthy batch of young silkworms. Incidence of silkworm diseases in late instars, poor cocoon crop and sometimes even complete crop failures have been attributed to the bad management during young age silkworm rearing and hence chawki rearing must be carried out scientifically with technical skill and expertise.

The main objective of the project is to standardize the chawki rearing practices for eri silkworm by adopting various technologies. Systematic practices have been planned for standardization of suitable castor garden, fabrication of rearing equipment, disinfection methods, rearing of different ecoraces (Fig. 1) through various techniques. Suitable chawki rearing practices will be field tested under different regions and the economics of chawki rearing will be calculated. The work will lead to standardization of suitable chawki rearing practices which will eventually help in developing the eri industry for higher productivity of the cocoons and silk.

Establishment and management of eri host plant garden for eri chawki rearing

The basic requirement for a chawki rearing is a well maintained exclusive chawki castor garden. Establishment of castor garden have been started under the objective establishment and management of eri host plant garden for eri chawki rearing. Castor leaf quality plays an important role for healthy and successful chawki rearing and the nutritional requirement of chawki worms is completely different from that of late age worms. The castor varieties *Viz.,*NBR-1, Kalpi-6, DCH-519, DCS-9 and ICH-66 seeds has been sown at GCC, Chenijan. 100 % germination percentage have been recorded. The higher mean plant height was recorded in KALPI-6 (104.7 CM and 134.8 CM) over NBR-1 (83.2 CM and 113.1 CM) and the higher mean number of leaves was recorded in KALPI-6 (15 and 28.4 Nos.) over NBR-1 (11 and 23 Nos) at 60 and 90 DAS. The equipment and raw materials required for design and fabrication of equipment in rearing house was finalized and the procurement is under progress.

Figure 1: Eri strains maintained at GCC, Chenijan.

Host Plant Division

CONCLUDED PROJECTS

Project Code: PPS-5884

Project Title: Soil health cards for sericulture farmers of Assam, Meghalaya, Manipur, Mixoram, Nagaland, Arunachal Pradesh and Sikkim

Project Period	: Sep 2016 to Aug 2019
Funding Agency	: CSB Bangalore
Total Budget	: Rs. 22.89 lakhs
Scientists involved	: Dr. V.K. Naik, PI
	Dr. D. K. Jigyasu, CI
	Dr. Reeta Luikham, CI

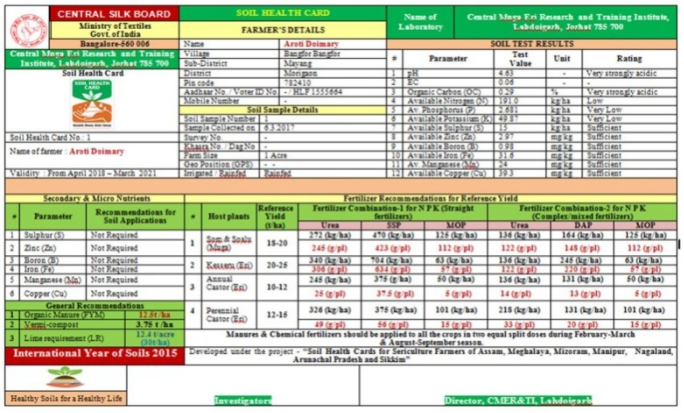
Objectives

To make the farmers aware about the importance of soil fertility on the production of quality leaves of muga and eri host plants by issuance of soil health cards.

Summary of the findings/achievements

The project was executed in 06 North Eastern states (Assam, Meghalaya, Manipur, Mizoram, Nagaland, Arunachal Pradesh and Sikkim). Soil samples were drawn from selected muga and eri farmers' field. Diagnostic soil health assessment of farmer fields were taken up periodically so as to issue health cards at least once in 3 years. Soil samples from each farmer were collected from ten to twelve different sites of same field by making V shaped cut to a depth of 15-20 cm at each site. Weight of the soil sample was reduced to 300-500 g by quartering method. The soil samples were properly labeled with details for each farmer/field/distinct survey number to which soil health card was subsequently issued. Farmers' basic details were also collected along with the soil sample for records. Against the assigned target, 608, 987 and 405 samples were collected, analyzed and SHCs were distributed to the seri-farmers in the first (2016-17), second (2017-18) and third (2018-19) year, respectively. A total of 2000 samples were collected, analyzed, digitized and SHCs issued in three years. Sample Soil Health Cards were prepared in English and local languages. English version of the Sample Soil Health Card is reflected in fig. 1.

The general observation drawn out of the project is that, the soils of NER are sick with acidity which in-turn hinders the availability of nutrients resulting in quality degradation of host plant leaves. The awareness about the soil status of the indudual farmers' field and amendments required for harvesting quality leaves for muga and eri rearing was created among the farmers in different farmer gatherings arranged during krishimela, awareness programmes, technology orientation training programmes, state dept. programmes and trainings organized by the Institute, etc. The farmers were trained for correcting the soil pH (Through soil amendments, carbon sequestration, etc.) and proper organic/ inorganic fertilization. The findings of the project have enormous contribution to the Muga and Eri industry as farmers can adopt soil specific amendment techniques to harvest quality leaves around the rearing seasons.



CENTRAL SILK BOARD
Ministry of Textiles
Govt. of India
Bangalore-560 006

Central Muga Eri Research and Training Institute, Lahdoigarh, Jorhat 785 700

Soil Health Card

Soil Health Card No. 1

Name of farmer : Arati Doimary

Validity From April 2018 – March 2021

SOIL HEALTH CARD

FARMER'S DETAILS

Name	Arati Doimary
Village	Bangfer Bangfer
Sub-District	Mayang
District	Morigaon
Pin code	782410
Aadhaar No. / Voter ID No.	- / RLF1555684
Mobile Number	-

Soil Sample Details

Soil Sample Number	1
Sample Collected on	5.3.2017
Survey No.	-
Khasra No. / Dag No.	-
Plot Size	1 Acre
Geo Position (GPS)	- , -
Irrigated / Rainfed	Rainfed

Name of Laboratory: Central Muga Eri Research and Training Institute, Lahdoigarh, Jorhat 785 700

SOIL TEST RESULTS

#	Parameter	Test Value	Unit	Rating
1	pH	4.83	-	Very strongly acidic
2	EC	0.06	-	-
3	Organic Carbon (OC)	0.29	%	Very strongly acidic
4	Available Nitrogen (N)	191.0	kg/ha	Low
5	Av. Phosphorus (P)	2.681	kg/ha	Very Low
6	Available Potassium (K)	49.87	kg/ha	Very Low
7	Available Sulphur (S)	15	kg/ha	Sufficient
8	Available Zinc (Zn)	2.97	mg/kg	Sufficient
9	Available Boron (B)	0.93	mg/kg	Sufficient
10	Available Iron (Fe)	21.6	mg/kg	Sufficient
11	Av. Manganese (Mn)	24	mg/kg	Sufficient
12	Available Copper (Cu)	19.3	mg/kg	Sufficient

Secondary & Micro Nutrients

#	Parameter	Recommendations for Soil Applications
1	Sulphur (S)	Not Required
2	Zinc (Zn)	Not Required
3	Boron (B)	Not Required
4	Iron (Fe)	Not Required
5	Manganese (Mn)	Not Required
6	Copper (Cu)	Not Required

General Recommendations

1	Organic Manure (FYM)	12.5 t/ha
2	Vermi-compost	4.75 t /ha
3	Lime requirement (LR)	12.4 t acre (10.0 ha)

Fertilizer Recommendations for Reference Yield

#	Host plants	Reference Yield (t/ha)	Fertilizer Combination-1 for N P K (Straight fertilizers) Urea	SSP	MOP	Fertilizer Combination-2 for N P K (Complex/mixed fertilizers) Urea	DAP	MOP
1	Som & Soalu (Muga)	15-20	272 (kg/ha)	470 (kg/ha)	125 (kg/ha)	136 (kg/ha)	164 (kg/ha)	125 (kg/ha)
			248 (g/pl)	423 (g/pl)	112 (g/pl)	122 (g/pl)	148 (g/pl)	112 (g/pl)
2	Kesseru (Eri)	20-25	340 (kg/ha)	704 (kg/ha)	63 (kg/ha)	136 (kg/ha)	246 (kg/ha)	63 (kg/ha)
			306 (g/pl)	634 (g/pl)	57 (g/pl)	122 (g/pl)	221 (g/pl)	57 (g/pl)
3	Annual Castor (Eri)	10-12	245 (kg/ha)	375 (g/ha)	50 (kg/ha)	136 (kg/ha)	131 (kg/ha)	50 (kg/ha)
			28 (g/pl)	37.5 (g/pl)	5 (g/pl)	14 (g/pl)	13 (g/pl)	5 (g/pl)
4	Perennial Castor (Eri)	12-15	326 (kg/ha)	375 (kg/ha)	101 (kg/ha)	218 (kg/ha)	131 (kg/ha)	101 (kg/ha)
			49 (g/pl)	56 (g/pl)	15 (g/pl)	33 (g/pl)	20 (g/pl)	15 (g/pl)

Manures & Chemical fertilizers should be applied to all the crops in two equal split doses during February-March & August-September season.

International Year of Soils 2015

Developed under the project - "Soil Health Cards for Sericulture Farmers of Assam, Meghalaya, Mizoram, Manipur, Nagaland, Arunachal Pradesh and Sikkim"

Healthy Soils for a Healthy Life

Investigator

Director, CMER&TI, Lahdoigarh

Fig. 1: Sample SHC distributed among Seri-farmers of NER (English Version)

ONGOING R&D PROJECTS

Project Code: PPF-5893

Project Title:Impact assessment of petroleum crude oil activities on Muga Silkworm (*Antheraea assamensis* Helfer) and its host plants in Assam

Project Period : Aug 2017 to July 2020
Funding Agency : CSB Bangalore
Total Budget : Rs. 22.89 lakhs
Scientists involved : Dr. D. K. Jigyasu, PI
Dr. KH. Subadas Singh, CI
Dr. Amit Kumar, CI

Objectives

Determination of crude oil contamination in Muga Silkworm rearing and its mitigation measure

Summary of the findings/achievements

The study of the impact of pollution of petroleum oil on muga silkworm and their host plants in Assam has important scope for the protection and production of muga ecosystems near to oil and natural gas field activities. Toxic substances released from petroleum oil industry and consistent human activity disturbs the plant system. Accumulation of deposits on leaf surfaces affects the feeding efficiency of silkworm. During the year 2019, rearing data of four crops was recorded from the contaminated site and it was observed that the average effective rate of rearing (ER%) was reduced by 5.86% as compared to control (Fig. 1). Cocoon yield production per dfl also reduced significantly at contaminated site (37.17% reduction) as compared to control (Fig. 1). Similarly, the weight of male and female cocoons also reduced significantly at contaminated site in comparison with control (Fig. 2). Significant reduction in shell weight of both male (44.65%) and female (41.28%) was recorded at oil contaminated site as compared to control site (Fig. 3). Significantly lower silk ratio of both male (28.16%) and female (24.38%) were recorded at oil contaminated site as compared to control site (Fig. 4).

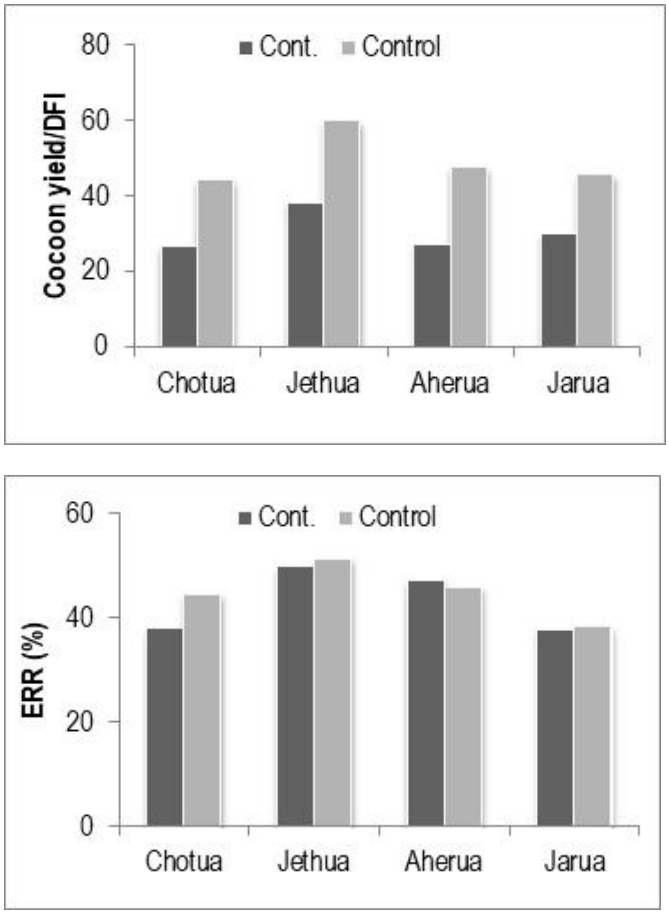
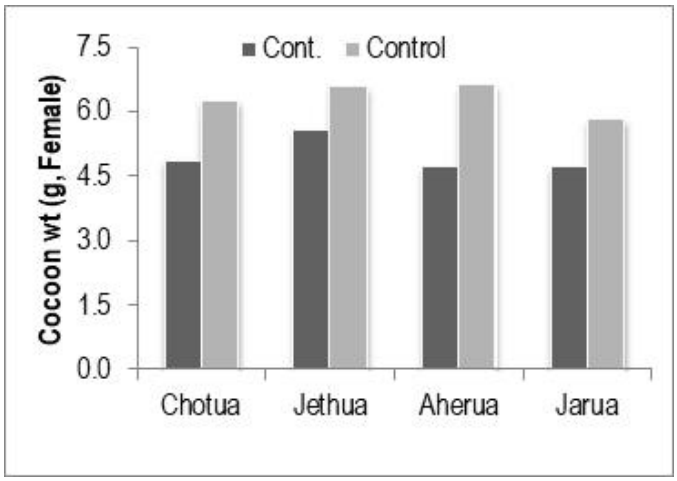


Figure 1: Cocoon yield per dfl and effective rate of rearing (%) in 2019 at contaminated site in comparison with control.



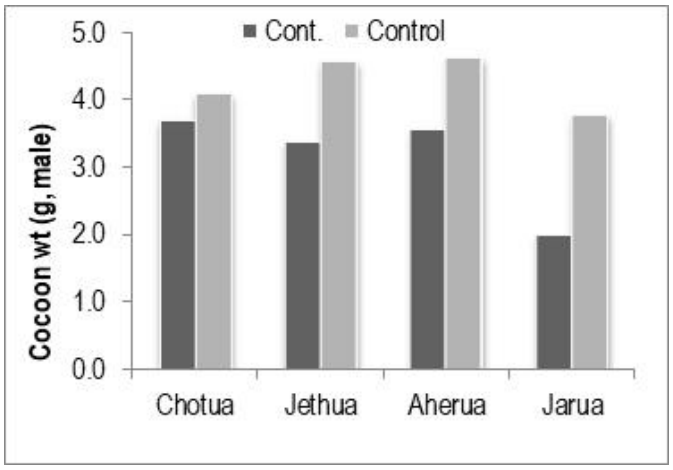
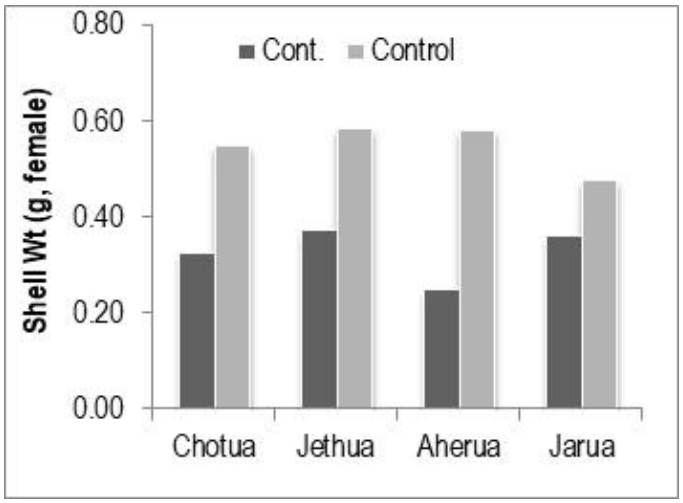


Figure 2: Cocoon weight (g) of female and male silkworm at contaminated site compared with control



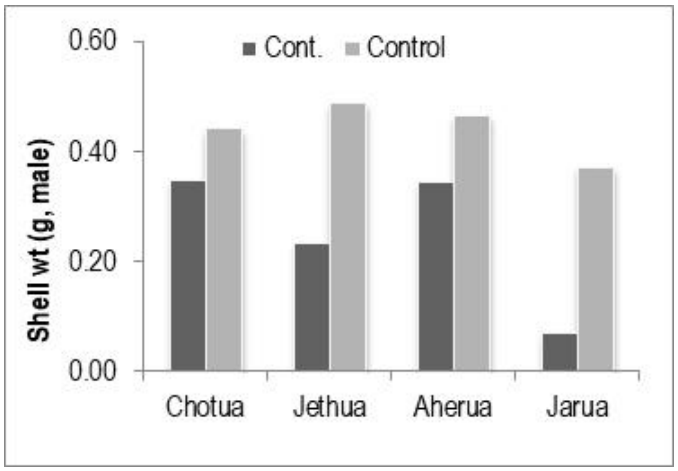
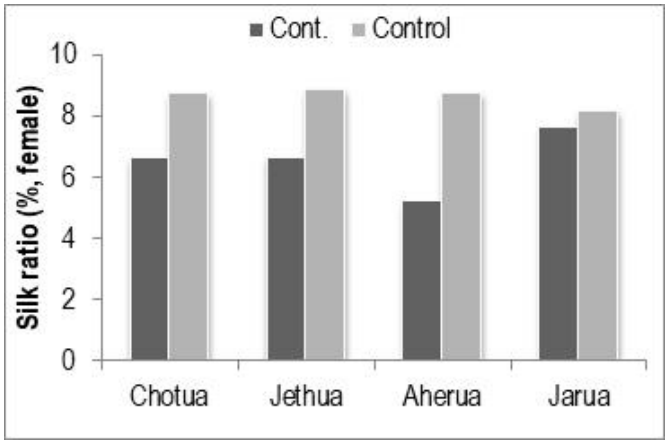


Figure 3: Cocoon shell weight (g) of female and male silkworm at contaminated site compared with control.



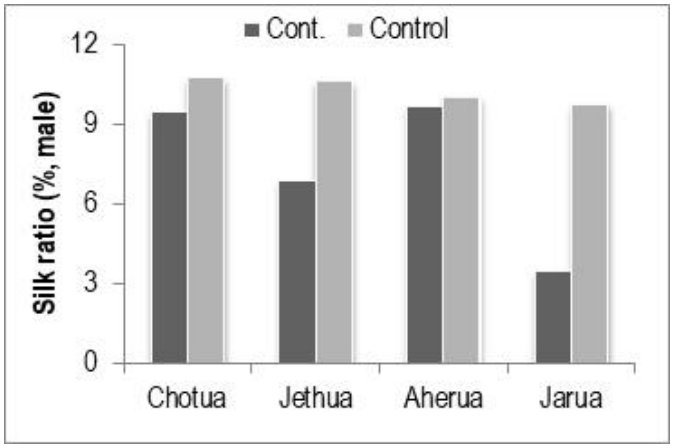


Figure 4: Silk ratio (%) of female and male silkworm at contaminated site compared with control.

Project Code: PPA-5879

Project Title:Assessment of phytochemical diversity in Som (*Persea bombycina* Kost), the primary host plant of *Antheraea assamensis* Helfer from Northeast India

Project Period	: Sep 2016 to Feb 2021
Funding Agency	: CSB Bangalore
Total Budget	: Rs. 15.20 lakhs
Scientists involved	: Dr. Prashant S, PI
	Dr. Amit Kumar, PI
	Dr. D. K. Gogoi, CI

Objectives

1. Assessment of phyto-chemical constitutes of Som during different rearing seasons under agro-climatic zones of northeast region
2. To develop a comprehensive nutrient management package for muga host plant.

Summary of the findings/achievements

It was observed that narrow diversity exists in morpho-metric traits of som cultivated at different locations in NE. However, it is ascertained that phyto-chemical diversity exists in som cultivated under different environmental conditions. This study envisages region and season specific difference in the different phyto-chemical constituents and their quantities, stress magnitude and intrinsic protection potential of som. Anthocynin levels were observed significantly lower at Dakuakhanna compared to Tura and Goalpara during Bhodia-19 in all three leaf stages. Extractable pH was observed significantly higher in mature leaf at all three locations.

The soil data reveals that the soil physical and chemical properties influence the soil intrinsic nutritional capacity to som plant for muga culture. The meteorological difference in these studied locations also reveals that the magnitude of the bioavailability of the nutrients is highly affected by the seasonal/regional surface runoff/leaching potential of the soil. The results generated during the year are reflected in table 1 to 10.

Table 1: Photosynthetic pigments of the Som in Aherua Season (composite samples).

Leaf Stages	Chl a (mg/g)		Chl b (mg/g)		Total Chl (mg/g)		Carotenoids (mg/g)	
	Tura	Goalpara	Tura	Goalpara	Tura	Goalpara	Tura	Goalpara
Tender	0.50 ±0.04	0.515 ±0.026	0.15 ±0.05	0.222 ±0.035	0.54 ±0.08	0.825 ±0.028	0.21 ±0.02	0.228 ±0.042
Semi-mature	1.31 ±0.08	1.324 ±0.064	0.65 ±0.13	0.565 ±0.056	1.89 ±0.07	1.860 ±0.085	0.47 ±0.05	0.225 ±0.025
mature	1.55 ±0.08	1.502 ±0.038	0.97 ±0.14	0.798 ±0.045	2.36 ±0.07	2.236 ±0.178	0.72 ±0.03	0.465 ±0.055

Table 2: Anthocynin and Protein contents of the Som in Aherua Season (composite samples).

Leaf Stages	Anthocyanin (mg/g)		Protein (mg/g)	
	Tura	Goalpara	Tura	Goalpara
Tender	3.54 ±0.22	3.283 ±0.173	7.26 ±0.73	7.546 ±0.311
Semi-mature	3.20 ±0.41	2.729 ±0.256	8.40 ±0.40	11.940 ±0.292
mature	3.34 ±0.35	2.429 ±0.141	13.70 ±0.82	12.594 ±0.549

Project Code: PIB-05005SI

Project Title: Genetic enhancement of Castor (*Ricinus communis* L.) germplasm as a source material for development of productive perennial varieties

Project Period : Oct 2019 to Sep 2022
Funding Agency : CSB Bangalore
Total Budget : Rs. 13.30 lakhs
Scientists involved : Dr. Aftab A Shabnam, PI
Dr. Amit Kumar, CI
Dr. V.K. Naik, CI
Dr. L. Somen Singh, CI

Objectives

1. Genetic enhancement of castor germplasm.
2. Development of pre-bred intermediate castor with perennial characteristics.

Summary of the findings/achievements

- Geographical coordinates of 08 wild/cultivated perennial castor accessions growing in North East were collected for their utilization in the pre-breeding programme (Table 1).
- 03 crosses between perennial NBR (Manipur) and annual & local cultivated perennial castor were executed during Dec. 2019 and F_1 seeds were harvested (Fig.1).
- 08 perennial source accessions were planted along with NBR-1 as control. These accessions will be characterized and hybridization work will be carried out between selected accessions.
- 12 castor accessions (07 perennial and 05 annual accessions) were characterized based on 12 seed variability characteristics (Fig. 2).

Enrichment of Gene Pool:

- Gene pool was enriched with 21 castor accessions [14 perennial and 03 annual castor accessions collected from North East region, 03 annual castor varieties (DCS-9, ICH-66 and DCH-519) collected from IIOR, Hyderabad under the project APR05007SI and Kalpi-6 collected from UP]. This includes 01 Non-Blooming Green (NBG) perennial accession collected from Manipur.

Table 1: Geographical coordinates of identified perennial Castor accessions

Manipur	Assam	Nagaland
RSRS Campus, Imphal 24.8383734”N, 93.9432798”E Alt: 782 m **Leimakhong, Kangpokpi** 24.9432019”N, 93.8356038”E Alt: 929 m **Pukhao Wakhong, Imphal (E)** 24.9692699”N, 94.0396317”E Alt: 811 m **L. Phaikot, Kangpokpi** 24.9326756”N, 93.8358211”E Alt: 866 m	**Near Morigaon** 26.254789”N, 92.392415”E Alt: 67 m **Near Golaghat** 26.3834994”N, 93.7926580”E Alt: 143 m **Near Mariani (Jorhat)** 26 41'37''N 94 16'13''E Alt: 107 m	**Ghotovi, Nuiland, Dimapur** 25.56506”N, 94.00584”E Alt: 433.5 m

Fig. 1: Perennial castor plant growing at RSRS, Imphal Campus crossed with NBR-1 at Quarter Campus of CMER&TI, Jorhat.

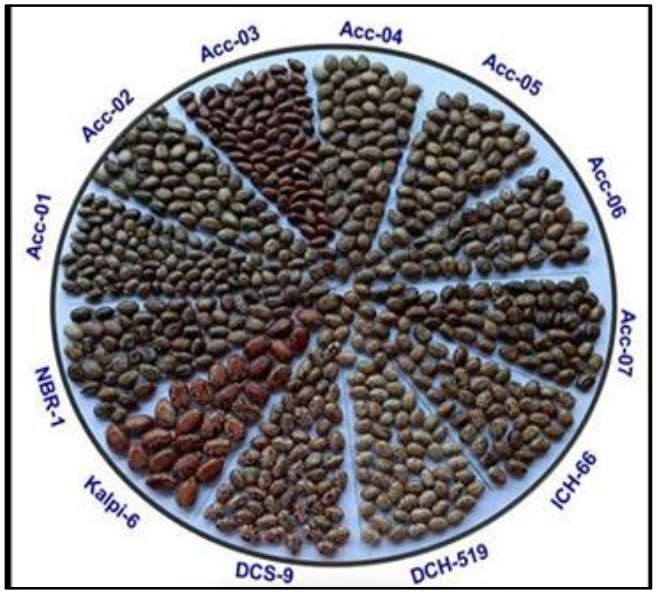


Fig. 2: Seed colour variability of 12 castor accessions/varieties

Project Code: AIP-05013SI

Project Title: Impact of elevated CO_2 and temperature on muga silkworm and its primary host plant

Project Period : Mar 2020 to Feb 2023
Funding Agency : CSB Bangalore
Total Budget : Rs. 44.72 lakhs
Scientists involved : Dr.Amit Kumar,PI
Dr. Aftab A Shabnam, CI
Dr. G. Subrahmanyam, CI

Objectives

1. To assess the influence of elevated CO_2 and temperature on growth and yield attributes of primary host plant (Som).

2. To assess the impact of elevated CO_2 and temperature on muga seed crop production, cocoon characteristics and fecundity.

3. To design strategies for adoption in muga silkworm rearing under the changing environmental scenario in Assam.

Summary of the findings/achievements

The project was initiated w.e.f. March 2020. 03 year old som plantation was selected for the experiment and is being maintained as per recommended package of practices. Procurement of equipment and recruitment process for appointment of project staff was initiated.

Biotechnology Division

CONCLUDED PROJECTS

Project Code: ARP-5874

Project Title: Development of Decision Supporting System (DSS) for early warning of selected Muga Silkworm Diseases & Pest with Geospatial Technique

Project Period : Mar 2017 to Sep 2019

Funding Agency : CSB, Bangalore
Total Budget : Rs. 20.598 lakhs
Scientists involved : Dr. DK Gogoi, PI
Dr. G. Subrahmanyam CI
Dr. R. Das CI

Objectives

1. Identification of various landscape and climatic parameters crucial for disease incidence.
2. Development of DSS for early warning of selected muga silk worm diseases.
3. Dissemination of advisory services to farmers linking with SILKS portal.

Summary of the findings/achievements

In this study five Muga rearing farms were taken into account, three from Assam and two from Meghalaya. MSSO P-3 Unit, Nongpoh from Ri-bhoi district and MSSO P-4 Unit, Tura from West Garo hill district of Meghalaya, RSRS, Boko from Kamrup District, Jogduar State Sericulture Farm from Jorhat district and REC, Lakhimpur from Lakhimpur district of Assam. A buffer zone of 3 km has been created, from the centre of the Muga farm to understand the varying spatial patterns and its relation. Corresponding Rearing, disease incidence and Meteorological data (historical & real time) were collected from the respective farms.

For physiographic characterization of Muga farms different satellite datasets of different year has been used. For change detection of land use land cover of four years multispectral images of 2008 to 2018 are taken along tack with rearing data and corresponding land surface temperature maps are prepared. DEM data is utilized to calculate elevation, slope and aspect. These satellite data are acquired by recognized sites and the software used for processing of data and for output generation are ArcGIS, EARDAS Imagine, Ecognition, and Excel Spreadsheets.

Meteorological correlation matrix with disease

The meteorological parameters such a humidity, temperature and rainfall has been analyzed taking ten year datasets of each farms. Average of each meteorological parameter has been taken prior to fifteen days of brushing till the date of harvest. The disease incidence is found to be associated with change in weather parameters. A relative humidity more than 80% and temperature above 30^{o}C is found to be associated with occurrence of severe disease incidence. Muga silkworms are extremely delicate to their environment. The optimum temperature and relative humidity ranges are 24-25°C and 75-80%. For commercial crop minimum temperature requirement is 16-20°C.

From our observation it is found that temperature and humidity when crossing the threshold limit prior to 15 days of harvest when the larva are in their 3rd to 5th instar the weather parameters plays a significant role in their growth. During this period rise in temperature and humidity beyond the threshold give rise to inevitable disease incidence of flacherie. Among the five farms Boko, Lakhimpur and Jogduar are found to be the more prone to flacherie disease as the average temperature in these farms are above 27^{o}C and average relative humidity above 85%. On the other hand farms of Meghalaya are less prone to flacherie disease.

Multiple regression was run to predict Flacherie from 15 days average maximum temperature and maximum Humidity data before 10 days of harvest. These variables statistically significantly predicted Flacherie with R2=0.623, p<0.0005. Both the variables added statistically significantly to the prediction, p<0.05. This model can explain approximately 62% of variance in flacherie incidence due to these two variables as shown below:

Flacherie% = -290.449+1.892 maxRH+5.725maxT ..... Equation 1

Average maximum temperature and maximum Humidity of 15 days before 5 days of harvest statistically significantly predicted Flacherie with R2=0.776, p<0.0005. Both the variables added statistically significantly to the prediction, p<0.05. This model can explain approximately 78% of variance in flacherie incidence due to these two variables as shown below (Fig. 1).

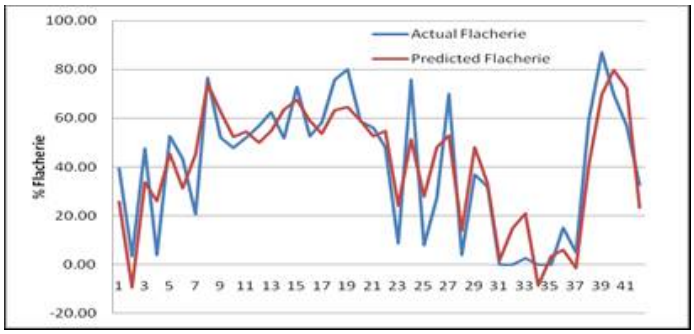


Figure 1: Prediction of Flacherie infestation from 15 days average of maximum temperature and maximum Humidity data before 5 days of harvest

Muga Disease Early Warning System (MDEWS) and linking with SILKS portal:

MDEWS has been developed integrating forecasting model developed for an early warning of percent Flacherie disease incidence of Muga Silkworm both 5 days and 10 days in advance before harvesting (Website link:- https://apps.nesdr.gov.in/MDEWS) as shown in figure 8 . A mobile app has been developed where users need to incorporate 15days daily Maximum Temperature and Maximum Humdity data before 5 days and 10 days of harvesting to get prediction of Flacherie infestation percentage. An excel sheet with required meteorological data can also be uploaded to get prediction of percent Flacherie infestation. MDEWS is linked with SILKS portal. SILKS is a single window, ICT-based information and advisory services system for the farmers, sericulture extension workers, administrators and planners working in the field of sericulture development. SILKS web portal is in the public domain under the domain name http://silks.csb.gov.in. MDEWS has been developed initially to collect data and validate the model by the authorized users. More emphasis has been given on linking to SILKS geoportal to have wider use by the farmers as well as different stakeholders of the sericulture industry in the state in future (Figs.2 and 3).

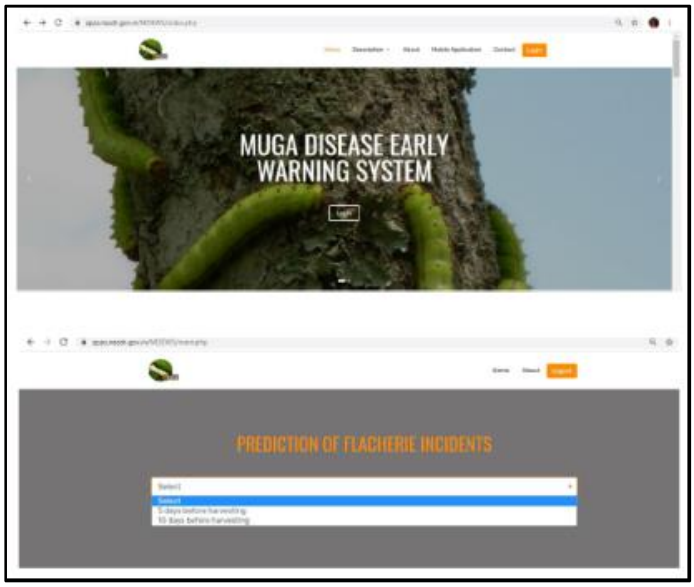


Figure 2: MDEWS using web link https://apps.nesdr.gov.in/MDEWS

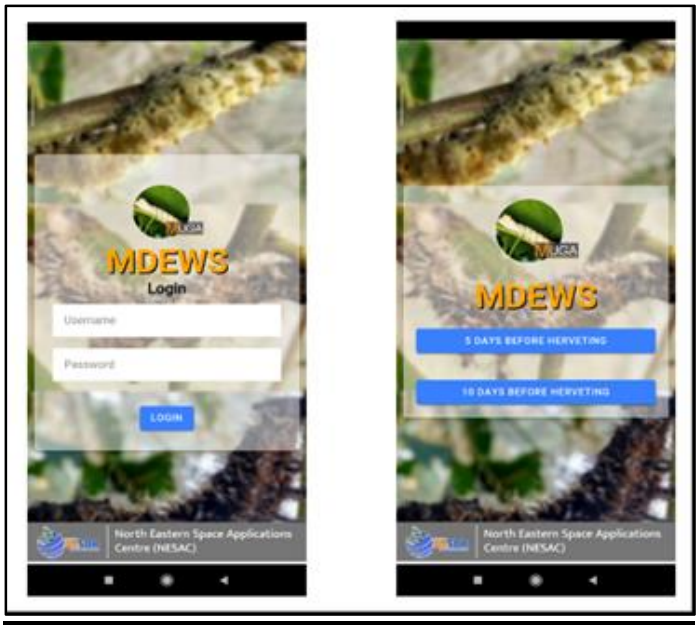


Figure 3: MDEWS mobile application

Project Code: APR- 5890

Project Title: Biodiversity assessment of wild silkmoths and rearing potentialities of muga (*Antheraea assamensis* Helfer) and eri silkworm (*Samia ricini* Donovan) for sustainable development in Nagaland

Project Period : Feb 2017 to Jan 2020

Funding Agency : DBT, New Delhi
Total Budget : Rs. 15.00 lakhs
Scientists involved : Dr. Kartik Neog, PI
Dr. Rajal Debnath, PI

Objectives

1. Crossbreeding and hybridization of cultivated an wild stocks
2. Assessment of genetic diversity on molecular markers

Summary of the findings/achievements

Extensive and intensive survey was conducted for collection and identification of wild silk moths in different geographic and climatic eco pockets in Nagaland. The fauna comprise of four species of Antheraea (assamensis, roylei, proylei, frithi; two species of Actias (selene and rhodopneuma); two species of Samia (canningi and ricini); two species of Loepa (katinka and sikkima) and one species each of *Attacus atlas*, *Archaeoattacus* sp., *Cricula trifenestrata* and *Sonthonnaxia maenas*. Documentation of morphological details recorded. Taxonomic classifications when ambiguous were kept for molecular based identification.

Five adopted rearers for rearing of Muga and Eri silkworms in 3 villages i.e. Ungma (site I), Kobulong (Site II) and Aosenden (Site III) of Mokokchung district were selected considering the suitability of rearing of muga and eri silkworms. For suitability in rearing the regions were raised with Muga feed plant seedlings. Rearing appliances were provided and knowledge on cultural practices of muga host plants i.e. pollarding and pruning of existing food plants was initiated in the farmers' field before and after rearing of muga silkworms. By brushing ~90 dfls in the three sites, Aosenden (site III) showed better hatching percentage 61.59%, with a cocoon harvest of 3500 nos subsequently generating 10,500 Rs. income (Month April-May 2018). During October-November 2018, Aosenden yielded 6000 nos of cocoons by brushing 200 gm of eggs. Aosenden site also showed better performance in Eri indoor rearing on sequencing feed plant; 300 gms yielded 14200 cocoons of cultivated variety with an average shell weight of 0.37 gms (March-April 2019) (Detailed data not provided). Sequential feeding of eri silkworm on different host plants to improve rearing potentialities and cocoon harvest was checked during June 2018, which highlighted castor to the best if not combined with other feed plant in adult larval stage, however tapioca and payam were better than kesseru as second alternative plant in terms of Silk ration (SR% 10.13, 9.60, 9.20, 6.83 respectively). Combination of

tapioca and castor and vice-versa always yielded SR% above 10 during Autumn 2018).

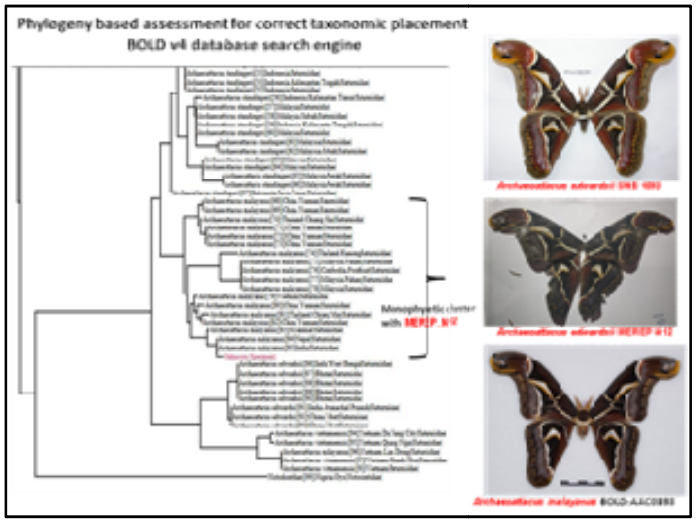


Figure 1: Phylogeny based assessment for correct taxonomic placement

The approach of barcode based characterization of silkmoths for diversity and distribution in Nagaland state was undertaken (Figure 1). Barcode based identification provides more consistent characterization of animals over and above morphology based characterization. Ambiguity in the classification of silkmoth was resolved for organisms which did not attain adult moth stage and when visual based characterization did not provide sufficient confidence. The following moths UNG_NU6, LUM_N07, LIDEN_N08, MEREP_N09, CTCMOK_N11, MEREP_N12 were either incorrectly assigned species level taxonomy or could not be processed because of unattainment of adult stage (Access the data here using the search term using the search term – "MT385724-MT385735[accn]" in the following link https://www.ncbi.nlm.nih.gov/genbank/. However *col* gene phylogeny based classification could resolve them into proper taxomony position. One moth species MEREP_N09 canonically classified as *Archaeoattacus edwardsii* was found to be *Archaeoattacus malayanus* when analyzed by barcode sequence. Previous studies of the silkmoth species from Nagaland did not report any barcode data for *malayanus* suggesting that *edwardsii* was conventionally tagged to moths based on pure morphology. A detailed literature review suggested that *edwardsii* species was concentrated in the Eastern Himalayan sect and the distribution of Archaeoattacus species changes, as we progresses geographically downwards malaynaus, staudingeri, vietnamensis occurred in distinct geographical pockets. We document the first report of *Archaeoattacus malayanus* species from Nagaland in this study and suggest that documenting of *Archaeattacus* species from the region be substantially supplemented with barcode data.

Project Code: AIT- 5876

Project Title: Establishment of Institutional Biotech Hub (2nd Phase)

Project Period : Oct 2017 to March 2020

Funding Agency : DBT, New Delhi
Total Budget : Rs. 69.68 lakhs
Scientists involved : Dr. M. Chutia, PI
Dr. Ranjana Das, CI

Objectives

The institutional biotech hubs will be providing basic biotechnology infrastructure facility for the students, faculties and researchers of individual institutions as well as nearby institutions.

Summary of the findings/achievements

As per objective of the project, the Biotech Hub facilities were created with an aim to develop better infrastructure facilities for the benefit of the researcher of the parent institute as well as for neighbouring institute. All the equipments purchased under the Biotech Hub were free to use by the any researcher as and whenever required based on the availability. The Hub is also providing

mentoring services to the schools (e.g. Chawkhat High School, Jorhat).

The Biotech Hub extended its support for the UG & PG and also PG Diploma course student for completion of their dissertation works since its inception. Many students from Schools, colleges and universities visited the Biotech Hub/institute and special talk/lecture or demonstration programme were organized time to time. As such, more than thousand students visited the Hub since its inception. Further, a few research fellows trained/associated with Biotech hub selected of teaching, Medical Supervisor job etc.

The following training programmes were organised since its inceptions by the Biotech Hub-

Title	Duration and Dates	No. of Partici-pants	Level of Participants (Ph.D./PG/UG)
National workshop cum training programme on "Emerging areas of Seri-Biotechnology".	3 days: 27-29th September 2011	31	PhD Students, Faculty from Colleges, Research Scholars
National workshop cum training programmed on "Advanced techniques and technologies in Sericulture".	3 days: 19-21st March 2013	38	PhD Students, PG, College students, Research Scholars
National workshop on "Diversity, Exploration, Taxonomy and Management advanced tools and techniques for Lepidopteran insects".	3 days: 26-28th March 2014	24	PhD Students, PG, College students, Research Scholars
Workshop on "Basic diagnostic techniques of microbes and insect in muga ecosystem".	3 days: 16th -18th March, 2015	43	PG & College students, Faculty, Research Scholars
Advanced diagnostic techniques of infectious diseases in insects	3 days: 21st -23rd March, 2016	31	Ph.D. Students, PG, UG students, Research Scholars
Economic Insects of NE India: Thrust on Recent Advances in Vanya Silks	2 days; 21st -22nd Feb., 2017	34	UG and PG students
Sericulture and Seri-biotechnology	3 days: 28th -30th March 2017	22	Research scholars & PG students
Internship Training Programme on Eri & Muga Culture	2 days: 18th -19th July 2017	19	UG students
Mushroom cultivation using bio-waste materials	1 day: 14th March 2018	40	Research Fellow, farmers and entrepreneurs
Techniques and Technologies of Seri-biotechnology	7 days: 27th March - 2nd April, 2018	40	Research Fellows, PG & UG students
Soil Health Management	4 days 3-6th April 2018	15	Research Fellows, PG students and Technical Staff

Impact of Biotech Hub

This institute has been implementing the 'Institutional Biotech Hub' project/scheme since December 2010 under financial support from Department of Biotechnology, Govt. of India. The infrastructure created under the project/scheme benefited a lot to organize need based training cum

science popularization programmes. The Biotech Hub successfully organized many workshops cum hands on training programmes to the selected participants besides organizing many other science popularization programmes from schools to postgraduate students in the area of Seri-biotechnology and related disciplines and the. Many graduate and postgraduate students completed their dissertation work in support with the Hub from nearby and other institutions. The facilities created under Biotech Hub have been utilizing continuously by the scientists and scholars of the institute and other neighbouring institute for their projects/Ph.D. research etc.

The Biotech Hub was able to disseminate knowledge and popularize basic science and R&D advancement in the area of modern bioscience through its different HRD programmes organized since its inception. Due to awareness and motivation, many college students came to the institute and availed the laboratory facilities for their dissertation work. All the outreach programmes organized under the Biotech Hub were appreciated by the school students and the authorities and marked as the very good initiative for raising awareness and motivation towards the need of basic sciences as a career. Mushroom cultivation training was also given to the farmers. Technical and mentoring support were also given to farmers on different aspects for self employment and earning. Consultancy services are provided as whenever required to the farm managers of Department of Sericulture, Assam of the nearby areas in terms of detection of Pebrine disease in muga silkworm. However, other related consultancies are also being provided to them on various diseases of muga silkworm and their control measures.

Project Code: APS05002EF

Project Title: Popularization and utilization of Foldscope for detection of pebrine disease (*Nosema assama*) in muga silkworm seed production areas

Project Period : May 2018 to April 2019

Funding Agency : DBT, New Delhi
Total Budget : Rs. 6.00 lakhs
Scientists involved : Dr.Rajal Debnath, PI

Objectives

Utilization of Foldscope for detection of pebrine disease in muga silkworm seed production areas.

Summary of the findings/achievements

Field level Training programs were conducted among the muga serifarmers, state sericulture department officers and demonstrators and school children of the serifarmers and alike. Briefly, each program included introduction of pebrine disease and modes of transmission in Muga silkworm, b) difference between egg laying in "khorika" (twigs of a tree as egg laying support for one silkmoth) and in non-khorikas, c) hands on bright field microscopy and testing of pebrinized samples, d) Mother moth examination workflow, e) Assembly of Foldscope and possible visualization.

A Total of 408 nos. of farmers, officials, students were covered in a total of 13 outreach programs. Five batch of DoS Assam officials and staffs have been trained on the assembly and probable use of foldscope in seed grainages. The training programs in all comprised of 45% seri-farmers, 31% students from schools, colleges, NGOs and 24% of technical officers of state sericulture under Govt. of Assam (Fig. 1).

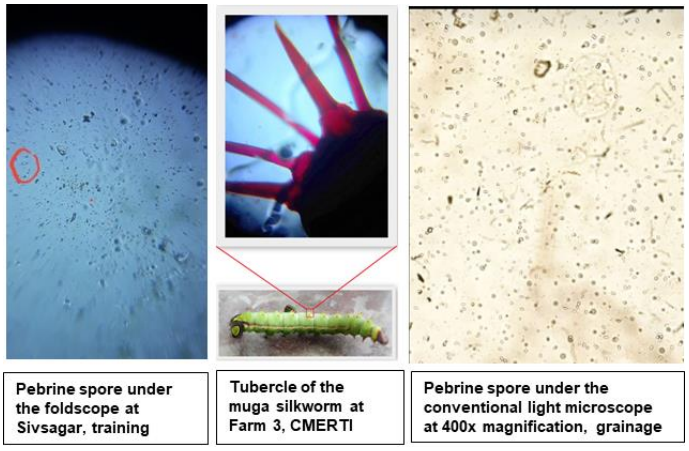


Figure 1: Pictures of images (Pollen/ microbes/ tissues etc.) observed using foldscope.

Foldscope microscopes currently are shipped with a 2.38 mm borosilicate glass ball lens (refractive index n=1.517 and radius=1200), which provides 140x magnification and 1.9 micron resolution (Cybulski et al., 2014). Although changing to a sapphire ball lens having a refractive index of 1.77 and a radius of 100 micron can provide a magnification upto 2180X, these high magnification lenses are still not commercially available.

The utility of foldscope in such application has been documented in different studies (Saeed and Jabbar 2018). But most of the diagnostic applications are limited towards parasitic diseases such as Schistosoma and soil-transmitted helminth infection (size range 50 µm and above). Foldscope is a utility microscope currently under active development and is shown to reach magnification upto 2180X. Currently, with the commercially available microscope, the developer has documented different aquatic life forms in free floating water samples ranging from diatoms, ciliates to motile bacteria. The promise that foldscope was used to detect motile bacteria whose size ranges from 0.5-2.0 µm diameter for average spherical bacteria and length (1-10 µm) and diameter (0.25-1.0 µm) for rod-shaped or filamentous bacteria, our motivation was to use it for pebrine detection and diagnostic. Free swimming bacteria which are highly motile were shown to be partially identified by foldscope microscope by its developer (https://vimeo.com/166558486) only after applying technical maneuvering and workarounds. But in our study samples, pebrine spores comparatively lacked motility and complexed with a very noisy debris background, it was hard for pebrine localization at this defined magnification. Although by oblique illumination technique and locking focus and field of view, experienced user can locate nosema spores with the 125X kit lens. However for diagnostic application when a posterior decision on the fate of the silkworm seed has to be made after moth examination, foldscope at its current magnification and developmental stage cannot be recommended for field utility. Many answers to problems such as shaky ramp stage, focus and field jumping while panning from one view to another, need to be addressed before one takes the tool for diagnostic application. Standard practice in Muga sericulture requires pebrine detection at 400X in order to minimize false positive and false negative during evaluation, as such foldscope at its current commercially available form at 125X cannot be used for field diagnostics of Muga silkworm seed. Availability of higher magnification lenses will surely be interesting tool to test its capability in nosema spores visualization.

ONGOING R&D PROJECS

Project Code: APS05001EF

Project Title: Development of technology for enhancing egg laying in Vanya Silk moths by application of host plant volatiles.

Project Period : Mar 2018 to Feb 2021

Funding Agency : DBT, New Delhi
Total Budget : Rs. 71.34 lakhs
Scientists involved : Dr. Kartik Neog, PI
Dr. D.K. Gogoi, PI
Dr. S. Prashant, CI

Objectives

1. To survey & establish population diversity of Muga & Eri silk moth across India
2. To establish potent food plants (=oviposition hosts) for Muga & Eri silk moth for egg production.

Summary of the findings/achievements

As per the objective of the project, different types of bioassay were done to find out the impact of different host plant on the realized fecundity and retained eggs of Muga (*Antheraea assamensis*) and Eri (*Samia ricini*) silkworm. The primary and secondary host plants considered for Muga silkworm assay were *Persea bombycina* (Som), *Litsea monopetala* (Soalu), *Litsaea salicifolia* (Dighloti), *Litsaea citrata* (Mejankari), *Actinodaphnae obovata* (Patihonda), *Zizyphus zuzuba* (Bogori), *Gmelia arborea* (Gamari), *Celastrus momosperma* (Bhomloti) and *Palaquium obovatum* (Kotholua).

Kharikas were prepared freshly from different primary and secondary Muga host plants and tied the mother moths on kharikas for oviposition. After three days of egg laying the potential fecundity, realized fecundity and nos. of egg retain was recorded.

The average results of three crops season revealed that Muga moth which ovipositioned on Soalu kharikas has got more fecundity (121.5) as compared to Control (100.8) followed by Som (114.3) and Digloti (113.3). Similarly the retained eggs were found least (Fig. 1) in Digloti (57.4) followed by Soalu (98) and Som (99.5) in comparison to control (111.8).

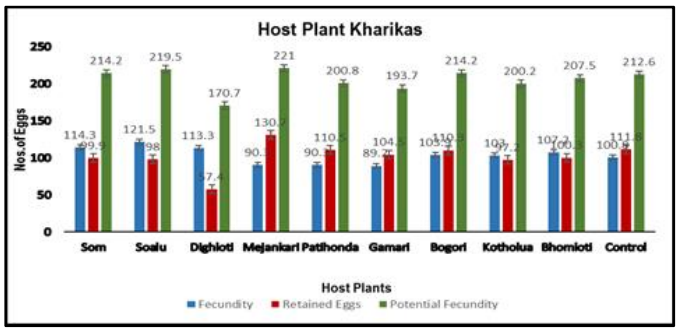


Fig.1: Impact of Kharikas prepared from different host plants on realized fecundity and egg retention in Muga silk moth

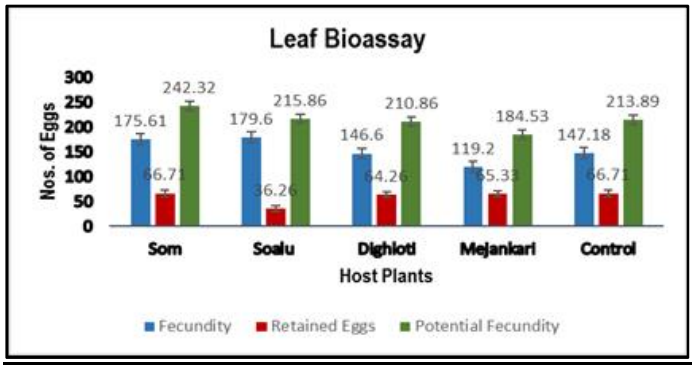


Fig. 2: Impact of leaves of different host plants on realized fecundity and egg retention in Muga silk moth.

Impact of host plant leaves:

Fresh leaves of four different host plants of Muga silkworm were crushed (partially) and tied with the Kharikas and allowed the mother moths for oviposition. After three days of egg laying the potential fecundity, realized fecundity and numbers of egg retain was recorded.

The results revealed that (Fig. 2) Muga moth treated with Soalu leaf got maximum fecundity (179.6) which was followed by Som (175.61) and Control (147.18). Negative impact was found when mother moth was treated with Mejankari leaf and recorded lowest fecundity (119.2). As compared to control (66.71), lowest retained eggs were found in Soalu (36.26) followed by Dighloti (64.26) and Mejankari (65.3).

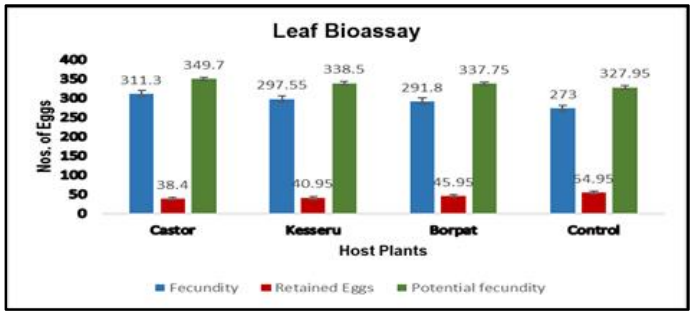


Figure 3: Impact of leaves of different host plants on realized fecundity and egg retention in Eri silk moth

The results revealed that Eri moth which ovipositioned on Castor leaf has more fecundity (311.3) as compared to Control (273) followed by Kesseru (297.55), Borpat (291.8). Least numbers of retained eggs were recorded in Castor (38.4), followed by Kesseru (40.95) in comparison to control (54.95) (Fig. 3).

Impact of host plant leaf extract:

Muga and Eri host plant leaf extracts were prepared by using n-Hexane as solvent. Resultant extracts were mixed in distilled water and sprayed on general kharikha's (Thatch made) before tying the moth. The resultant fecundity and numbers of retained eggs were recorded after three days of oviposition (Fig. 4).

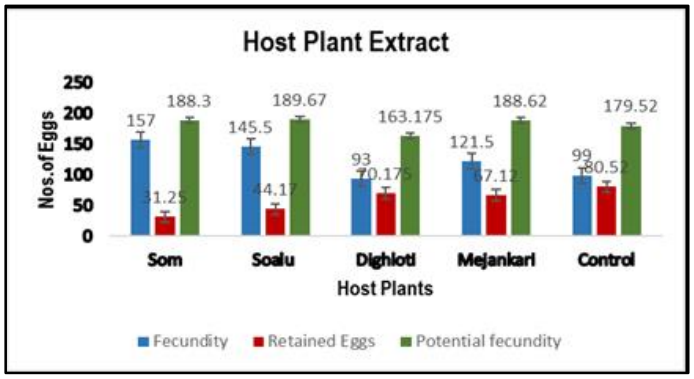


Figure 4: Impact of leaf extracts of different host plants on realized fecundity and egg retention in Muga silk moth

The results revealed that Muga moth which ovipositioned on Som plant extract has more (Fig.4) fecundity (157) as compared to Control (99), followed by Soalu (145.5). In case of retained eggs, Som has the lowest (31.25) followed by Soalu (44.17), Mejankari (67.12) and Digloti (70.17).

Project Code: AIT05011EF

Project Title: Molecular investigation into the lignocellulolytic system of a few wild silkmoth in North-East India

Project Period : Sep 2019 to Sep 2022

Funding Agency : DBT, New Delhi
Total Budget : Rs. 74.39 lakhs
Scientists involved : Dr.Rajal Debnath, PI
Dr. D.K. Gogoi, PI
Dr. Arun Kumar K P, CI

Objectives

1. Impact of host plant range on the microbial community in *Antheraea assamensis* Helfer and *Samia ricini* Donovan
2. Lignocellulose degradation by the gut microbes associated with *Antheraea assamensis* Helfer and *Samia ricini* Donovan
3. Molecular characterization of the lignocellulolytic biomass degrading enzyme

Summary of the findings/achievements

The project aims at studying the community of microbes that associate with muga and eri silkworm and provide beneficial dietary advantage to the insect host (degradation/digestion). In order to observe for core microbial groups that coevolve with the host, the silkmoths muga and eri are fed on different host plants viz; Som, Soalu, Dighloti, Mejankari for foliage and the microbe characterization by cultured and uncultivated techniques. Until now, total of 160 microbes isolated from the gut digestome of muga silkworms/moths were catalogued during the period (Lactobacillus differential agar media with Tween 80, Lactobacillus heteroform screen agar, MRS media, King's B Media, LB media for bacterial isolation (specifically lactic acid bacteria group) and Potato dextrose with chloramphenicol (0.05 gL^{-1}), modified Oat meal agar with 0.6 gL^{-1} CTAB and chloramphenicol (0.5 gL^{-1}) in place of 0.46 gL^{-1} dodine for fungus isolation) and we will expand the library in next rearing seasons.

Sort listing of strains for sequencing and identification was done by genomic fingerprinting (BOX, REP, ERIC PCR) and clustering approaches. Preliminary studies showed abundance of strains belonging to genera *Rummeliibacillus*, *Burkholderia*, and *Bacillus* sp. which has experimental evidence of enhancing growth improvement, immunity and resistance enhancement in non silkworm host animals. For lignocelluloses degradation β-glucosidase, α-L-arabinofuranosidase, β-xylosidase and endo-1,4-β-xylanase assays are being carried out. For community characterization amplicon sequencing as well as shotgun metagenomics will be carried out with the subset of DNA samples kept by extraction. ≥250 nos. of aerobic cultivable bacteria was isolated from gut system of Eri silkworm (*Samia ricini* Donovan) (fed on castor plants) among which 50 nos. were active for cellulose degrading enzyme. Sequencing data were also obtained for ~50 isolates which are being analyzed for taxonomic classification.

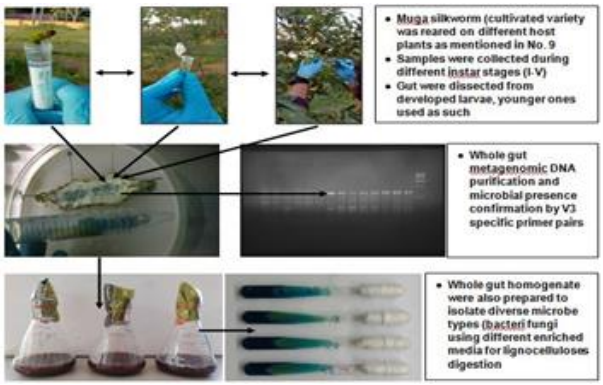


Figure 1: Gut microbiota characterization experiment

Compared to mean weight of Dighloti fed cocoons (4.4378 mg), on average Mejankari fed cocoons weigh 0.6305 mg less and Som cocoons are 0.7858 mg heavier. In terms of mean breadth of Dighloti fed cocoons (19.003 mm), on average Mejankari cocoons are 0.5283 mm narrower and Som cocoons are 1.5166 mm broader, but this difference between dighloti and mejankari cocoon breadths are not statistically significant. Mean Cocoon lengths also differed significantly between Mejankari fed and Dighloti fed worms (padj = 0.0084) and Som and Mejankari fed worms (padj = 0.0000011) but not between Som and Dighloti fed cocoons (padj=0.2322) (Figs.1 and 2)

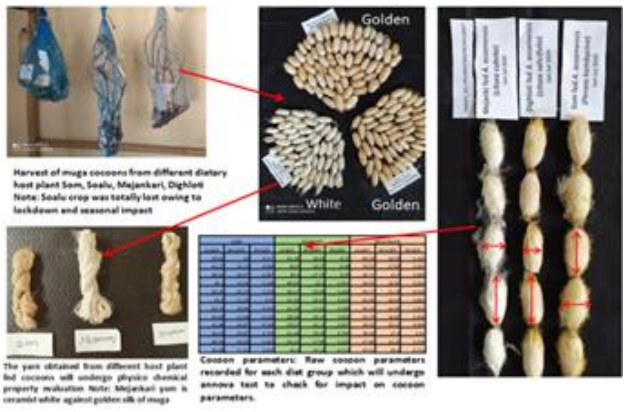


Figure 2: Harvest and scoring of parameters of different muga cocoons.

SEEM Division

ONGOING PROJECT

Project Code: MOE05004-EF

Project Title: Adoption of improved sustainabletechnologies of Muga culture for elevation of cocoonproduction in the tribal belt of Assam.

Project Period : Aug 2019 to Jul 2022

Funding Agency : DST, New Delhi
Total Budget : Rs. 25.51 lakhs
Scientists involved :Dr. Vijay N, PI
Dr. D. K. Gogoi, CI
Dr.D. Mech, CI
Dr. SAS Rahaman, CI
Dr K. Sathyanarayana, CI

Objectives

1. To promote adoption of improved Muga rearing technologies among tribal rearers through sustainable NGO-rearer linkages facilitated by CMER&TI, Lahdoigarh.
2. To improve the socio-economic status of tribal population by enhancing cocoon production through improved muga culture

Summary of the findings/achievements

The project was initiated to promote improved rearing technologies and their adaption by tribal rearers, which would inturn improve their socio-economic status by enhancing muga cocoon production. The progress made is presented briefly here.

- A total of 200 scheduled tribes(ST) farmers were selected from the study area viz., Lakhimpur, Dhemaji, Kamrup and Goalpara Districts to conduct the study on improved technologies of muga culture.
- Data pertaining to socio economic status like age, education, income etc. knowledge and adoption of improved technologies of muga culture, cocoon harvest, etc., was collected from the farmers through personal contact in prescribed questionnaire format from the beneficiary farmers (Fig. 1).
- A benchmark survey of 200 farmers was completed from the said study area through personal contact of the beneficiaries.
- The database consists of 141 male and 59 female farmers, whereas 50% farmers have passed secondary level of education. More than 70 farmers out of 200 have taken up Muga culture as primary occupation.
- Farmers are trained on improved technology of muga culture through Awareness program, Field day, Group Discussion programs.
- A total of 400 farmers consisting of beneficiary farmers including youth and women are trained in improved technologies of muga culture.
- Rearing inputs were distributed to beneficiary farmersfor rearing of muga.

Figure 1: Interaction meeting with muga farmers

EXTENSION AND TRAINING ACTIVITIES IN CMER&TI LAHDOIGARH

FIELD DAYS

Khonamukh (Sepon, Assam) on 23.11.2019: A field day on Eri culture was organized on

23.11.2019 at Khonamukh, Sepon, Sivasagar covering 60 farmers from the adjoining areas. Dr. Mahesh D S, Scientist-B, GCC Chenijan discussed various aspects Eri culture and stressed the importance of host plants. Dr. Vijay N. Scientist-B, Extension and statistics division was given field demonstration of Bamboo mountage and appealed to the farmer's use of bamboo mountage instead of jail for better and good quality of eri cocoons. Both the scientists discussed with farmers on host plant pest and disease management.

Tilikiam, Charingia, Jorhat: A Field Day program on Eri culture was organized Tilikiam, Charingia, Jorhat on 07.03.2020. About 63 farmers of the nearby villages and adjoining areas who are involved in sericulture activities attended the program. Dr. T. James Keisa, Scientist-D, Dr D. K. Gogoi, Sc-D, Smt Mamoni Das Hazarika, Supdt. And Dr Palash Dutta, Sr.F.A of this institute attended the programme. Dr. Keisa briefed about the modern rearing and grainage technologies of Muga and Eri silkworm including some problems at grass root level. Dr. Gogoi briefed about the present scenario of Eri silk productivity of the country and commercial prospect of Eri culture

Khonamukh, Tamulisiga, Sivasagar: A field day on Eri culture was organized on 26.10.2019 at Khonamukh, Tamulisiga, Sivasagar and covering 70 farmers from the adjoinING areas. Dr. Kh. Subadas Singh, Scientist-C, discussed various aspects of Eri silkworm rearing practices, disinfection activities, seed production and host plant plantation. Sri Vijay N. Scientist-B, advised farmers to maintain their own plantation of Eri food plants, so as to not to depend on castor or kesseru growing at open areas as they might have been contaminated with synthetic chemicals and other pollutants which may affect to silkworm health and cocoon production.

Bakata, Sivasagar, Assam: A Field Day on Muga culture was organized at Bakata, Sivasagar, Assam on 23.11.2019. About 52 farmers of the nearby villages and adjoining areas who are involved in sericulture activities attended the programme. Dr.(Mrs.) R. Das, Director (i/c), Smt. Syeda Hamim Sultana, SD and Sri. Jadumani Hazarika, Sr. F.A of this institute attended the Programme. Dr. Das shared her ideas with the progressive sericulturists about the improved scientific technologies of muga silkworm rearing, grainage and disease management and advised the farmers to take up muga culture as a source of family income and self employment and also to avail the facilities offered by the CSB and DoS under various schemes.

FARMERS' DAY


Borchoria, Lakhimpur: To create technology awareness on the improved technologies of Eri culture among the farmers, Farmers day programme was organized at Borchoria, Lakhimpur District on 05.03.2020. Nearly 60-70 farmers and local DOS staff participated in the programme. Dr. D Mech, Scientist –D of REC, Lakhimpur, discussed various aspects Eri silkworm rearing practices, disinfection activities, seed production and host plant plantation. Dr Vijay N. Scientist-B, Extension and statistics division advised to maintain their own plantation of Eri food plants, so as not to depend on castor or kesseru growing at open areas.


Simen Chapori, Dhemaji District: A Farmers Day Programme on Eri culture was organized at Simen Chapori, Dhemaji District, Assam on 18th January, 2020. About 70 farmers of the nearby villages and adjoining areas who are interested in sericulture activities attended the programme. Dr. (Mrs.) R. Das, Director (i/c), Dr. D. Mech, Scientist-D, REC, Lakhimpur, Mr. L. Sonowal, DoS, Jonai and Dr. D. K. Gogoi, Sc-D and other officials of this institute have attended the Programme. Dr. D. Mech briefed about the modern rearing and grainage technologies of Eri silkworm including some problems at grass root level. Dr. D.K. Gogoi briefed about the institute, its various activities and role in extension of sericulture in northeastern part of the country.

Sodiya, Assam: A "Farmers Day" on Eri culture was organized by CMER&TI, Lahdoigarh on 25th February, 2020 at Sodiya, Assam which is located around 247 Km away from the institute. About 71 farmers of the nearby villages and adjoining areas who are involved in sericulture activities attended the programme. Dr. D. Mech, Scientist-D, REC, Lakhimpur, Dr D. K. Gogoi, Sc-D, CMER&TI, Mr. Nabin Gogoi, Supdt.of Sericulture, Sodiya, The Farm Manager, Sodiya, Mr. Pranjal Phukan, SD, Sodiya and Dr. Palash Dutta have attended the Programme.

Rawnapara, Majuli District, Assam: A Farmers Day Programme on Eri culture was organized at Rawnapara, Majuli District, Assam on 18th February, 2020. About 65 farmers of the nearby villages and adjoining areas who are involved in sericulture activities were attended the programme. Dr. D. Mech, Scientist-D, REC, Lakhimpur, Dr D. K. Gogoi, Sc-D, CMER&TI, Mr. P. Kalita, Superintendent of Sericulture, Majuli and Mr D. Baruah, SD and other officials of this institute have attended the Programme. The programme was presided over by Mr. G. Saikia, social activist cum Secretary of NPC, Rawnapara, Majuli. Dr. D.K. Gogoi briefed about the institute, its various activities and role in extension of sericulture in northeastern part of the country.

Simaluguri, Udalguri, BTC, Assam: A Farmers' Day was organized at Simaluguri, Udalguri, BTC, Assam on 08th November 2019. Dr. T. James Keisa, Sc D highlighted the rearing Technology on Eri Culture for successful seed and cocoon production throughout the crop season. Dr. Mahesh, Scientist-B emphasized the importance Eri young age rearing for the better and quality good cocoon production. Shri Anjan Chakrabroty, Assistant Director of Sericulture, DoS, highlighted the importance and activities of farmers in sericulture in Udalguri area.

AWARENESS MEET

Jiya, Arunachal Pradesh: A Technology Awareness Meet on Eri culture was organized at Jiya, Arunachal Pradesh on 24thFebruary, 2020. About 60 farmers of the nearby villages and adjoining areas who are involved in sericulture activities attended the programme. Dr. D. Mech, Scientist-D, REC, Lakhimpur, Dr D. K. Gogoi, Sc-D, CMER&TI, Mr. M. Partin, Development officer of Sericulture, Jiya and other officials of this institute attended the Programme.

Gohain Tekela, Lakhimpur: In view of creating technology awareness about the improved technologies of Muga culture among the farmers, technology awareness programme was organized at Gohain Tekela, Lakhimpur District on 04.03.2020. Nearly 90-100 no of farmers and local DOS staffs participated in the the programme. Dr Vijay N. Scientist-B explained the aims and objectives of the Technology awareness program and emphasized use of improved technologies to tap the resources and get better yield. Dr. D Mech, Scientist D of REC, Lakhimpur, explained the recent development of technologies and their impact on muga production.

Kasor Gaon, Borpool, Dibrugarh: A Technology Awareness Programme on Muga culture was organized on 04th September, 2019 at Kasor Gaon Village, Borpool, Dibrugarh which is located around 180 Km away from the institute. About 55 farmers of the village and adjoining areas, Dr. (Mrs.) R. Das, Director (i/c), Dr. (Mrs.) J. Tirkey, Ex-Director and scientists/staff of this institute attended the Programme.

Dirang, West Kameng District, Arunachal Pradesh: A Technology Awareness Programme on Muga culture was organized at Dirang, West Kameng District, Arunachal Pradesh on 29th December, 2019. About 42 farmers of the nearby villages and adjoining areas who are interested to sericulture activities attended the programme. Dr. (Mrs.) R. Das, Director (i/c), Mr. Dorjee Phuntso, Deputy Director, Department of Textile and Handicraft, Govt. of Arunachal Pradesh, Mr. Bhupen Singh, Superintendant, West Kameng District, Textile and Handicraft, Govt. of Arunachal Pradesh, Dr. N. I. Singh, Dr. Debraj Singh, Dr. S. Singh and scientists/staff of this institute attended the Programme.

Dimoria, Kamrup: An awareness programme on Eri and Muga culture was organized at Dimoria, Kamrup District, Assam on 25th January, 2020. About 55 farmers of the nearby village and adjoin areas who are interested to sericulture activities were attended the programme. Dr. M. Chutia, Sc-D, Dr. G. Subramaniyam, Sc-C, Dr. Vijay N, Sc-B and Dr. Palash Dutta, Sr. F.A of this institute have attended the programme. Dr. M. Chutia briefed about the modern rearing and disease of Muga and Eri silkworm including at grass root level. Dr. G. Subramaniyam briefed about various pests and diseases of Eri and Muga silkworm, which is one of the major reasons for crop loss.

Dihingia, Titabor, Assam: A technology Awareness Programme on Sericulture was organized at Dihingia village of Titabor on 16.03.2020 as per the provision of action plan. Sri Gunaram Bora, Village headmaster, Dihingia, Dr. Aftab Ahmad Shabnam, Scientist-D, Dr. D.K. Jigyasu, Scientist-C, Dr. Palash Dutta, Sr.F.A, Shri Janardan Boruah, Manager, State Sericulture Department, Titabor, Smt. Kalpana Rajonshi, Sericulture Demonstrator, Titabor and Smt. Manshi Kachari, Sericulture Demonstrator, Titabor attended this event. A total of 69 farmers actively participated in the programme. Prime objectives of the programme and activities of Central Silk Board in the field of sericulture were elaborated. Dr. Jigyasu explained the importance of treated bamboo appliances especially strip type collapsible mountage and their effective utilization in Eri culture.

Lukakuchi, Morigaon: In view of creating awareness about the improved technologies of Eri culture among the farmers; an awareness programme was organized at Lukakuchi, Morigaon Districts on 23.09.2019. Nearly 80-90 no of farmers and local DOS staffs were participated in the programme. Dr.SAS Rahaman, Scientist D of RMRS, Boko, explained the recent development of technologies and their impact on Eri production. Dr. Vijay, Scientist-B, explained the cultivation practice of castor plants and its maintenance by using the improved technologies.

GROUP DISCUSSION


DaDhara, Golghat: AGroup Discussion programme was organized at Dadhara, Golghat, to discuss the problems of Eri cocoon formation, double cocoons among the farmers on 21.09.2019. A group of 20 farmers discussed their problems of cocoon formation in previous crop and enquired about the necessary measures to be taken for next crop. Dr. Vijay N, Scientist-B, explained different types of cocoon formation. Dr Reeta Luikham, Scientist-D explained regarding the bamboo spinning tray to avoid deformation of cocoons and to get better quality cocoons.


Basapathar, Golaghat: A Group Discussion Programme on Eri culture was organized on 25th Oct., 2019 at Basapathar, Golaghat. About 30 farmers of the village and adjoining areas; Dr. (Mrs.) R. Das, Director (i/c), Dr. D. K. Gogoi, Scientist-C and staff of this institute have attended the programme. Dr. Das described the modern scientific rearing techniques for Eri silkworm.

Bebejia Gaon, Titabor: A Group Discussion Programme on Eri culture was organized on 01.11.2019 at Bebejia Gaon, Titabor. About 30 farmers of the village and adjoining areas, Dr. T. James Keisa, Sri Jadumoni Hazarika and Mrs Nilakhi Nath Saikia of the institute attended the programme. Dr. Keisa interacted with the farmers and answered the questions asked by the farmers.

TECHNOLOGY DEMONSTRATION

Rawnapara, Majuli: A Technology Demonstration Programme on raising of perennial Eri silkworm host plant *Ailanthes grandis* and its management was organized at Rawnapara State Sericulture Farm, Majuli on 18 February 2020, where 48 farmers participated in the programme. Dr. D. Mech demonstrated the raising of *Ailanthes grandis*. Dr. D.K. Gogoi, described various high yielding varieties of Eri host plants and their proper season for nursery raising and plantation.

Borbam, Dibrugarh District, Assam: A Technology Demonstration Programme on raising of Muga silkworm host plants and their management was organized at Borbam, Dibrugarh on 4 September 2019. About 32 farmers of the village and adjoining areas participated in the programme. Dr. R. Debnath demonstrated the raising Muga host plant nursery techniques and its management.Dr. D. K. Gogoi described about various high yielding varieties of Muga host plants and their proper season for nursery rising and plantation.

Gual Gaon, Golghat: A Technology demonstration programme was organized at Gual gaon, Golghat on 21.09.2019 to discuss on ericulture and transfer of improved technology of ericulture among the farmers. A group of 30 farmers participated in the technology demonstration programme. Farmers discussed their problems in previous crop and ask the necessary

measures to be taken for next crop. Dr Reeta luikhma explained about bamboo platform rearing practices and its importance in the large numbers of dfl rearing.

Jamuguri, Golaghat District, Assam: A Technology Demonstration Programme on raising of Muga silkworm host plant and their management was organized at Jamuguri, Golaghat District, Assam on 25 October 2019. About 30 farmers of the village and adjoining areas participated in the programme. Dr. D. K. Gogoi demonstrated the improved strip bamboo mountage developed by the institute. After the demonstration, a very fruitful interaction and discussions were held with the sericulture farmers on related fields of sericulture.

BRIEF NOTES ON ACTIVITIES OF NESTED UNITS

RSRS, BOKO

HIGHLIGHTS OF ACTIVITIES/ACHIEVEMENTS

- Sexual multiplication of S3 & S6 morphotypes of Som, their maintenance and supply to stakeholders as and when needed.
- A total of 20950 (against the target of 20000) seedlings were raised apart from supplying 60 kg of Kesseru and 11 kg Castor seeds to CMER&TI, Lahdoigarh and 17223 (against the target of 20000) numbers of seedlings were supplied to DOS Meghalaya, MSSO Guwahati, DOS Assam, DOS Manipur, DOS Kolkata and NGOs & private farmers. During the period two new plots of Dighloti and Kesseru (one each) were developed at RSRS, Boko farm.
- Under extension and technology awareness programme 1235 farmers were covered through Krishimela, Workshop, Awareness Programmes, Field Days, Farmers' day and Group Discussions.
- Under training programme for farmer's skill development, 4 batches of 5-days training programme were conducted and covered 100 Nos. of farmers by RSRS, Boko.
- An experimental rearing of Muga silkworm was conducted to see the effect coupling time on fecundity and hatching.
- Under grainage activity, 3125 DFLs were prepared out of which 2450 DFLs were supplied, while 675 DFLs were utilized for own rearing.
- Under commercial Muga crop rearing 2970 g DFLs were reared against target of 2500 g DFLs to produce 50205 Nos. of commercial cocoons against target of 150000 Nos of cocoons.
- The centre generated a total revenue of Rs. 306675/- against the target of Rs. 600000/-.

ONGOING PROJECT

Project Code: MOE05003EF

Project Title: Socio-economic uplifting of farmers through adoption of improved technologies and skill development in Eri culture

Project Period : Nov 2018 to Oct 2021

Funding Agency : DST, New Delhi
Total Budget : Rs. 21.57 lakhs
Scientists involved : Dr. Barman H, PI
Dr. S. A. S. Rahman CI

Objectives

1. To adopt improved technologies (both pre and post cocoon sectors) at farmers' level.
2. To improve the economies of scale through group approach.
3. Diversification of Eri-culture towards income and employment generation.

Summary of the findings/achievements

For economic uplifting through adoption & skill development of Eri-culture technologies, 200 nos. tribal women beneficiaries have been covered from 19 villages. Due to project intervention, their annual income increased at an average of 64% from intercropping and 289% from cocoon production. They have been adopted Food Plant Gardening with intercropping practices. There rearing capacity increased from 2-3 crops to 6-7 crops and DFLs from 30-40 nos. to 93 (Fig. 1).

Figure 1: Eri Cocoon shell coloring technique innovated and extended to beneficiaries

ACTIVITIES OF THE CENTER

Krishi Mela organised at Coochbehar on 01.02.2020 with 125 participants. Vice Chancellor, Uttar Banga Krshi Biswa Vidyalaya, Dr. C Chattapadhay , Dr. Ranjana Das, Director, CMER&TI, Dr. S N Bagchi, Scientist-D, SSPC, Berhampore, Dr. N Biswas, Scientist-D, REC, Agartala, Dr. Zakir Hussein, Scientist-D, RSRS, Kalimpong, S A S Rahman, Scientist-D & Head, RSRS, Boko and Sri B N Choudhury Scientist-D, RSRS, Boko attended the occasion.

Workshop on “Package of Practices of Muga and Eri Silkworm Rearing and Their Host Plant Management” organised at Turukpara, Kamrup on 22.02.2020 with 130 participants. Dr. J Deori, Director of Sericulture, BTC, Assam, Sri B Choudhury, Scientist-D & Head, MSSO, Guwahati, Smt. M Sahu, Retired Scientist-D, CSB, Sri B B Singha, Scientist-D Eri Basic Seed Farm, Topatoli, Sri Manabendra Saikia, ADS, Kamrup, Dr. Binita Tamuli, Scientist-D, SSPC, Koliabari, Mrs M Pamehgam, Scientist-D, MSSO, P3 Unit, Hahaim,

Sri M Sankar, Scientist-D, MSSO, P3 Unit, Kowabill, S A S Rahman, Scientist-D & Head, RSRS, Boko and Sri B N Choudhury Scientist-D, RSRS, Boko attended the occasion.

Farmer's Day Programme organized at RSRS, Boko, Kamrup on 20.10.2019 with 95 participants.

Awarness Programme organised at Garovita, Goalpara 20.10.2019 with 95 participants.

Farmer's Skill Development Training Programme organised at Lengupara, Goalpara w.e.f. 03.02.2020 to 07.02.2020 with 25 participants.

Field Day Programme held at Turukpara, Boko on 11.02.2020 with 93 participants.

PUBLICATIONS

1) Baishya M, Barman H, Rahman SAS (2019) Value addition to raw cocoon shell of eri silkworm through colouring with bio-materials. JETIR, 6(6): 360-364.

2) Baishya M, Barman H, Rahman SAS (2019) Present status of eri-muga culture in ne region and related biodiversity resources as tool for sustainable economic uplifting of seri-stakeholders. SSR Inst. Int. J. Life. Sci., 5(3): 2284-2290.
3) Baishya M, Barman H, Rahman SAS (2019) Scientific approach for economic uplifting of rural tribal women folk through diversified eri culture. National Seminar on Global Climatic Impact on sustainable development of Sericulture Industry in N. E. India, Organized by Dept. of Geog., Bikali College, NE India Geographical Society, and Director of Sericulture, BTC.

RSRS, IMPHAL

HIGHLIGHTS OF ACTIVITIES/ACHIEVEMENTS

- Executing five research projects funded by CSB (4 nos.) and DBT (1 no.) and progress achieved are as per milestone. Three collaborative mulberry based projects are also being carried out in the station.
- Produced 38,761 dfls with 104.75 % achievement and supplied to State govt. and ASRs for further multiplication during spring crop 2020.
- In the silkworm GPB, two species of Oak tasar silkworm *A. proylei, A. pernyi,* and 9 evolved breeds, three eco-races of eri and muga silkworm are being maintained. In host plant GPB, all the primary food plants of oak Tasar, eri, muga & mulberry are being maintained.
- Two ToT programmes on Oak Tasar culture and Muga culture were conducted achieved improvement in productivity against control.
- Conducted 3 (three) training programmes on Farmers skill training and Post Cocoon technology in ericulture and oak Tasar culture and organized 1(one) Exposure visit for the farmers.
- Imparted 3 (Three) months' Intensive Practical Training to 6 (six) PG Diploma (Sericulture) students on various aspects of Non-mulberry sericulture from July to September, 2019.
- Published 3 nos. of research papers in scientific journals and 3 nos. abstracts in International Seminar/ conference respectively.
- Published two booklet entitled "Integrated Pest Management of uzi fly: A serious pest of oak tasar silkworm" and Sodium hypochlorite disinfection: An effective disinfection for silkworm eggs to protect against tiger band disease" and one leaflet entitled" Management of tiger band disease in oak tasar culture ".
- One Scientist attended International conference at Japan and two Scientists of the station participated in two nos. training programmes during the year 2019-20.
- A Seri-Model village of oak Tasar culture was developed at Thayong and its adjoining villages, Imphal East district covering 100 farmers who reared 20,000 DFLs and obtained an average yield of 27 cocoons/DFLs.
- A Sericulture Krishi Mela was organised on 22.01.2020 at RSRS, Imphal campus to popularize the latest technologies of four different types of sericulture among farmers & attended by 200 stakeholders.
- Organized one day workshop on "Technology intervention for enhancement of Oak Tasar cocoon production"on 4th November 2019 at RSRS office premises & attended by 150 participants like officials of N.E. States, Entrepreneurs, Reelers, Weavers, Farmers, etc.
- Under ECP: Conducted 5 (five) Nos. Group discussions, 7 (seven) Nos. Field day/Farmer Days, 8 (eight) Nos. Awareness Programme, 3 (three) Nos. Technology Demonstration programme and sensitized 1411 stakeholders during the year 2019-20.
- DCB realization**:** In the year 2019-20 a sum of Rs. 2,87,640/- was received towards sale of oak Tasar dfl and sale proceed of pierced cocoons.
- Conducted Hindi workshop on quarterly basis and Hindi Pakhwada (fortnight) from 16th to 30th September, 2019.

ONGOING PROJECTS

Project Code: ARP3606

Project Title: Development of a diagnostic tool for early detection of baculovirus causing tiger band disease in *Antheraea proylei*

Project Period	: Mar 2017 to Aug 2020
Funding Agency	: DBT, New Delhi
Total Budget	: Rs. 17.14 lakhs
Scientists involved	: Dr. S. Subharani Devi, PI Dr. N.I. Singh CI Dr. Y. Debaraj, CI

Objectives

1. To characterize the baculovirus pathogen causing tiger band disease in oak tasar silkworm, *Antheraea proylei*.

2. To study the pathogenesis, source and mode of transmission of the viral pathogen.
3. Validation of developed diagnostic tools in Oak tasar grainages and egg production centers

Summary of the findings/achievements

- Developed an effective egg disinfection method for minimizing the viral infection.
- Analysis of the presence of ApnrNPV infection in the haemolymph of tiger band infected silkworm larvae was done through light microscopy (Fig. 1).
- Confirmed the presence of AnprNPV in the egg surfaces through PCR technique.
- PCR technique revealed AnprNPV infection in the haemolymph of *A. proylei* larva.
- Histopathological study of larval midgut and silk gland showed variation in the normal and infected larvae.
- Multilocational trial of eggs disinfected with 0.2 % Sodium hypochlorite under progress.
- Demonstrated and trained DOS officials on Egg disinfection technology.
- Published a bilingual technology booklet on Egg disinfection technique using Sodium hypochlorite and preventive measures for control of tiger band disease and a leaflet on management of tiger band disease.

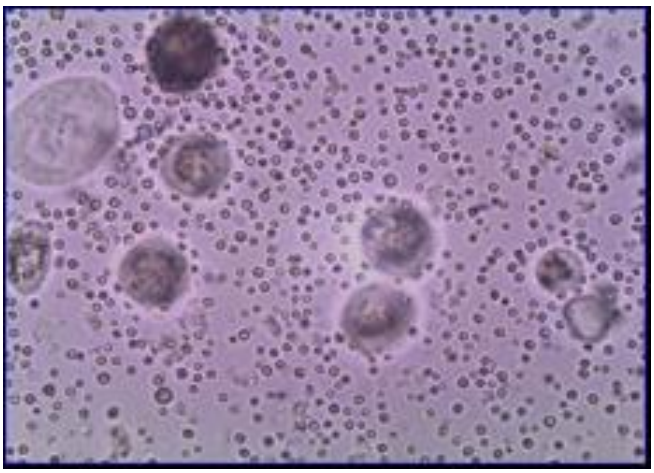


Figure 1: Light microscopic view of polyhedral occlusion bodies in haemolymph of *A.proylei* infected with AnprNPV.

Project Code: ARE4726

Project Title: Bio-ecology, economic injury level and management of insect pest infesting oak ecosystem

Project Period : June 2017 to May 2020

Funding Agency : CSB, Bangalore
Total Budget : Rs. 18.31 lakhs
Scientists involved : Dr. S. Subharani Devi, PI
Dr. Y. Debaraj, CI
Dr. Ritwika, CI

Objectives

1. To study the population dynamics of Uzi fly, *Blepharipa sugan* infesting oak tasar silkworm, *A. proylei* and oak semilooper, *Hyblaea puera* and hairy caterpillar, *Phalera raya* infesting oak plant.
2. Studies on the biology of Uzi fly, *Blepharipa sugan*
3. Studies on the biology of *Hyblaea puera* and *Phalera raya*
4. To determine the ETL of major insect pests infesting oak silkworm and its preferred host.
5. Integrated management practices for control of *Blepharipa sugan*
6. To evaluate the efficacy of biopesticides for control of *Hyblaea puera* and *Phalera raya*

Summary of the findings/achievements

- Determined the Economic Injury level of *H. puera*5.90 larva /plantand 1.45 larva per plantin case of *P. raya* .
- Bioneem is found to be the most effective treatment in reducing the *Hyblaea puera* and *Phalera raya* population
- Management of uzi fly through IPM revealed that physical method using PET bottle uzi trap is 61% more efficient than control; chemical method by spraying 3% bleaching powder exhibited reduced infestation of 22.49% against 42.83% in control.
- Demonstrated PET bottle uzi trap technology to DOS officials and oak tasar farmers.

- Published a bilingual technology booklet on "Integrated Pest Management of uzi fly: A serious pest of oak tasar silkworm".

Studied the economic threshold level (ETL) of *P. raya* and *H. puera* at which appropriate control measures should be taken up, in order to keep the population of both the pestbelow economic injury level (EIL). The leaf yield of *Q. serrata* was significantly reduced with increase in larval population of *P.raya* (Figure 1)and*H. puera*. Leaf yield had a significant negative association with the pest population.

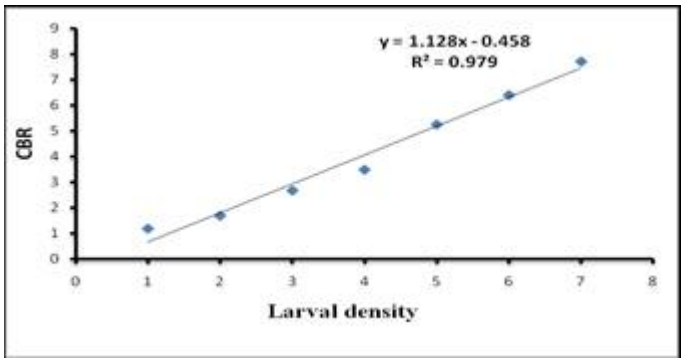


Figure 1: Relationship between larval densities and CBR of *P. raya* in*Q. serrata*

The economic injury level for *P.raya* and *H.puera* was calculated by fitting in the regression equation Y= 1.28X-0.458 and Y= 0.204X-0.125 between larval population levels and Cost benefit ratio (CBR). The larval density corresponding to cost benefit ratio was the economic injury level and economic threshold level was set at 75% of EIL. Economic Injury level for *P. raya andH.puera* was determined from the above equation as 1.45 larva per plant and Economic threshold Level was 1.08 larva per plant for *P.raya* whereas in case of *H.puera* EIL is determined as 5.90 larva per plant and Economic threshold Level was 4.42 larva per plant**.**

The effectiveness of PET bottle uzi trap technology was studied during spring crop in three different oak tasar farms in Manipur. It showed an increase in the seed cocoon recovery ranging from 13% to 16% as against control (Figure 2).

Figure 2: Uzi flies trapped in PET bottles in oak tasar field

Project Code: APR05008SI

Project Title: Standardization of Rearing and Grainage technology of *Antheraea frithi* Moore

Project Period : Oct 2019 to Sep 2022

Funding Agency : CSB, Bangalore
Total Budget : Rs. 12.85 lakhs
Scientists involved : Dr. L. Somen Singh, PI
Dr. S. Subharani Devi, CI

Objectives

To standardize the rearing and grainage technologies to suit for commercial adoption.

Summary of the findings/achievements

Survey for collection of *Antheraea frithi*cocoons were carried out at Senapati, Ukhrul and Imphal East districts. Collected 22 nos. seed cocoons from Senapati and 17nos. from Imphal East. Designed and prepared different devices for cocoon preservation and oviposition for observation during1st crop 2020.

Project Code: APR05010SI

Project Title: Evaluation of eri silkworm races suitable for different agro-climatic conditions of Manipur

Project Period : Oct 2019 to Sep 2022

Funding Agency : CSB, Bangalore

Total Budget : Rs. 11.80 lakhs
Scientists involved : Dr. Y. Debaraj, PI
Dr. L. Somen Singh, CI

Objectives

To identify the best performing eri silkworm race in different agro-climatic conditions of Manipur

Summary of the findings/achievements

Procurement of materials & infrastructure development not yet complete as approval is awaited for purchase of required articles. Three eco-races, one breed & six strains already collected and maintained. Three food plants *viz*., castor, kesseru & tapioca collected & maintained. One crop rearing has been completed and data under compilation.

ACTIVITIES OF THE CENTER

Sericulture Krishi Mela at RSRS, Imphal held on 22.01.2020: Sericulture Krishi Mela was organized by Regional Sericultural Research Station, CSB, Mantripukhri, Imphal on 22nd January 2020. The programme was inaugurated by the Chief Guest of the function, Shri S. Kunjakishore Singh, MCS, Director of Sericulture; Govt. of Manipur. Dr. Ranjana Das, Director (i/c), CMER&TI, Lahdoigarh, Jorhat presided over the function. An exhibition with 14 stalls showcasing yarn samples, oak tasar fabrics, cocoons, reeling machines, different silk products was also set up which evoked much interest among farmers and invitees. Two booklets and a leaflet were released. Awards were also distributed to the best farmers selected as per their rearing performances during spring crop 2019. The programme was actively participated by about 200 participants including rearers, SHG, NGO, entrepreneurs and Officials from Central and State sericulture Departments.

Workshop on Oak tasar at RSRS, Imphal held on 4th November, 2019: One day Work Shop on "Technology Intervention for Enhancement of Oak Tasar cocoon Production" was organized at RSRS, Imphal on 4th November 2019 as per action plan of the station. The programme was graced by Shri S. Kunjakishore Singh, MCS, Director of Sericulture; Govt. of Manipur as Chief Guest, Dr. B. K. Singh, Director (Retd.), CSB & Consultant, DOS, Govt. of Nagaland as Guest of Honour and Dr. Ranjana Das, Director (i/c), CMER&TI, Lahdoigarh, Jorhat presided over the function. An interaction programme with the participants was also held at the end of the programme. About 150 participants including officials of DOS, Manipur, Nagaland, Arunachal Pradesh, entrepreneurs and farmers were attended the programme. An exhibition of about 10 stalls was also opened exhibiting technologies of oak tasar culture in RSRS stall and silk fabrics of private firms.

Field Day Programme organized at Luwangsangol village, Kangpokpi district, Manipur on 29-08-2019: The programme was graced by Mr. Haokholal Kilong, Chief of the village authority as Chief Guest and presided over by Dr.Y. Debaraj, Scientist-D, RSRS, Imphal. The function was attended by about 75 farmers along with staffs of CSB & DOS, Manipur.

Field day programme held at Kha Potsangbam, Bishnupur Dist, on 21.11.2019: To create awareness about the latest ericulture & mulberry sericulture technologies among the farmers. 51 farmers along with staff of DOS and CSB attended the event.

Field day programme held at Yumnam Khunou, Imphal East dist. on 19.03.2020: To create awareness about the latest ericulture technologies among the farmers. 56 farmers along with staff of DOS and CSB attended the event.

Field day programme held at Yumnam Khunou, Imphal East dist. on 19.03.2020: to create awareness about the latest ericulture technologies among the farmers. 56 farmers along with staff of DOS and CSB attended the event.

Farmers' day programmes were held at three places. Dirang, Arunachal Pradesh (29.11.2019), Samurou Awang Leikai, Imphal West (30.12.2019) and TSF Thamnapokpi, Manipur (19.03.2020) to creat awareness about latest ericulture and oak tasar technologies and other sericulture technologies.

Group discussion meetings were held at five locations, namely Saranamai Khaikho village, Tadubi, Senapati Dist., Manipur (04-05-2019). Ishikha village, Imphal East district, Manipur (23-09-2019), Terakhong, Kumbi, Bishnupur District (24.09.2019), Khurai Larikyengbam Leikai, Imphal East, Manipur (23-11-2019) and Khurai Konsam Leikai, Imphal East district, Manipur (16-03-2020) to create awareness latest vanya sericulture technologies among farmers.

Awareness programmes were organized at six locations, namely, Yumnam Khunou village, Imphal east district (25-09-2019), Jiribam, Jiribam District (21.12.2019), Tushen, Ukhrul District (28.01.2020), Khurkhul, Imphal West District (30.01.2020), Sangaithel Makha Leikai, Imphal West (04.02.2020) and Haotak, Kumbi, Bishnupur District (20.02.2020), with an objective of creating awareness among farmers about improved sericulture technologies.

Technology Demonstration programmes were organized at three locations namely, Khurkhul, Imphal West district (30.01.2020), T. Khullen, Senapati district (07.02.2020) and State Tasar Grainage, Chingarel (14.02.2020) to demonstrate and create awareness about the latest technologies developed by the station.

PUBLICATIONS

a) Scientific journals

1. Chaudhuri RS, Debaraj Y, Singh NI (2019) Impact Assessment of frontline demonstration of technologies on oak tasar cocoon yield and economics. *Sericologia*,58(2):132-139
2. Chaudhuri RS, Debaraj Y, Subharani Devi S, Ibotombi Singh N (2019) Evaluation of oak tasar silkworm hybrids in different seasons for improvement in productivity. *Munis Entomology & Zoology*, 14 (2): 629-633.
3. Subharani S, Debaraj Y, Chaudhuri RS, Ibotombi Singh N (2019) Biology and morphometrics of *Phalera raya* Moore (Lepidoptera: Notodontidae) infesting *Quercus serrata* Thunb. *Munis Entomology & Zoology*, 14 (2): 643-647.

b) Abstracts:

1. Ponnuvel, K.M., Devi, S.S., Mishra , R.K., Terenius, O and Kobayashi, J. (2019) Molecular characterization, tissue distribution and transmission of nucleopolyherovirus in oak tasar silkworm, *Antheraea proylei*. Abstract of the 25th International Congress on Sericulture and silk Industry, Tsukuba, Japan, 19-22nd Nov. 2019, pp. 94.
2. Singh, L.S, Singh, N.I, Debaraj, Y and Das, R. (2019) Estimation of General and combining ability of six inbreed lines of eri silkworm, *Samia ricini* Donovan. Abstract of the 25th International Congress on Sericulture and silk Industry, Tsukuba, Japan, 19-22nd Nov. 2019, pp. 82.

c) Booklets:

1. Subharani, S**.,** Ponnuvel, K.M., Singh, N.I & Mishra, R.K. (2019) Sodium hypochlorite disinfection: An effective disinfection for silkworm eggs to protect against tiger band disease, pp. 1-10.
2. Subharani, S**.,** Debaraj, Y., Somen,L., Priyadarshini, O & Singh, N.I. (2020) Integrated Pest Management of uzi fly: A serious pest of oak tasar silkworm, pp. 1-10.

d) Leaflet:

Subharani, S., Debaraj, Y., Somen, L., Rojini, A.& Singh, N.I. (2020) Management of tiger band disease in oak tasar culture.

RESEARCH EXTENSION CENTRE COOCHBEHAR

CONCLUDED PROJECT

Project Code: APR- 5886

Project Title: Improvement of Muga Cocoon yield through technology intervention and refinement of crop schedule in Terai region of W.B.

Project Period : Dec 2016 to Nov 2019

Funding Agency : CSB, Bangalore
Total Budget : Rs. 35.28 lakhs
Scientists involved : Dr. N. Biswas, PI
Sri SAS Rahman CI

Objectives

4. Isolation and characterization of bacteriophages against muga silkworm bacterial pathogens.
5. Study of the phage biology and genome organization.
6. Evaluation of the potential phages cocktail against muga silkworm pathogens.

Summary of the findings/achievements

As a result of global warming and climate change in 21st century the winter spell is reducing. So, there is a need to change the cropping schedule of highly environmental sensitive muga silkworm in Terai region of West Bengal. The Bhadia crop (pre-winter seed crop) and the Jethua crop (Post winter commercial crop) were chosen for fine tuning for suitable brushing date in the changing climatic conditions. An experiment was carried out from December 2016 to November 2019 at REC, Cooch Behar. The final results are as follows:

Jethua crop: in case of Jethua commercial crop improvement of Muga cocoon yield during Jethua crop in the region may be achieved if rearing is undertaken on or before first week of May 2020.

Bhadia crop: In case of Bhadia seed crop last week of August is better for taking Bhadia seed crop.

Extension Activities

ECP	Date of event	Place
Group Discussion-I	17th Sept 2019	Dinhata, Cooch behar
Group Discussion-II	19th Sept 2019	Majbil, Jalpaiguri
Group Discussion-III	20th sept 2019	Tufanganj, Cooch behar
Group Discussion-IV	5th Feb 2020	Dalapchand, Kalimpong
Group Discussion-V	6th Feb 2020	Bong Busti, Kalimpong
Group Discussion-VI	6th March 2020	Kalimpong
Field day	15th Nov 2019	West Chengmari, Kumargram
Farmers Day	03.02.2020	Cooch behar
Technology Awareness-I	5th March 2020	Sangsey, Kalimpong
Technology Awareness-II	17th March 2020	Kumargram, Alipurduar
Technology Demonstration	18th Feb 2020	Cooch behar

RESEARCH EXTENSION CENTRELAKHIMPUR

TECHNOLOGIES UNDER MULTI-LOCATIONAL TRIAL

From the concluded research project entitled'Validation of Indigenous Technical

Knowledge (ITK) associated in muga culture', following two technology packages were developed based on the study.

1) Integrated Practice of ITK and Modern Technology for Higher Muga cocoon yield
2) Integrated Practice of ITK and Modern Technology for Muga Silkworm Seed production

Both the technology packages were trialed at the farmers' field in different locations as per target assigned in the Annual Action plan 2019-20. A brief of multi-locational trial conducted for both the technology packages are highlighted below.

Integrated Practice of ITK and Modern Technology for Higher Muga cocoon yield: The technology package was trialed as OFT covering 21 farmers in Lakhimpur and Sivsagar district in two crop seasons viz., August-September and February-March during the year 2019-20. Assessment of feedback from the two crops seasons indicated that average yield of muga cocoon was increased by 21.2% in OFT over the benchmark.

Integrated Practice of ITK and Modern Technology for Muga Silkworm Seed production: The technology package was trialed as OFT amid 11 private graineurs field in Lakhimpur and Sivsagar district during November and January grainage seasons in the year 2019-20. Assessment of feedback from the two grainage seasons indicated that average fecundity of muga silkworm seed was enhanced by 22.5% in OFT over the normal practice.

ECP	Date of event	Place
Group Discussion-I	25^{h} Sept 2019	Katarichaporai, Lakhimpur
Group Discussion-II	27th Sept 2019	Charaimoria, Lakhimpur
Group Discussion-III	20th Jan 2020	Mohemari, Dhakuakhana
Group Discussion-IV	21st Jan 2020	Jamuguri, Dhakuakhana
Group Discussion-V	31th Jan 2020	Bhati Jalbhari, Dhakuakhana
Group Discussion-VI	01st Feb 2020	Banto Gaon, Dhakuakhana
Field day - I	21st Nov 2019	Deolia Gaon, Assam
Field day - II	18th Feb 2020	Rowanapara Eri seed farm, Majuli
Farmers Day - I	27th Dec 2019	Japisajia, Lakhimpur
Farmers Day - II	20th Dec 2019	Jalbahi, Lakhimpur
Technology Awareness-I	15th Nov 2019	Laimekuri, Jonai
Technology Awareness-II	20th Nov 2019	Ghuguha, Dhemaji
Technology Awareness-III	18th Jan 2020	Simen Chapori, Dhemaji
Technology Awareness-IV	27th Jan 2020	Serum, Arunachal Pradesh
Technology Demonstration - I	28th Sep 2019	Ujalpur, Lakhimpur
Technology Demonstration - II	13th Mar 2020	Gohin Tekela, Lakhimpur

IMPORTANT EVENTS

Vanya Reshom Krishimela at Simen ChaporiDhemaji

Central Muga Eri Research & Training Institute (CMER&TI), organized a Mega Vanya Resham Krishi Mela at Siman Chapori, Dhemaji district (Assam) on 6th February, 2020. A total of 400 sericulture farmers from different localities of Dhemaji districts of Assam participated in the programme. The inaugural session was graced by Shri Pritom Kumar Das, Asst. Commissioner, Jonai; Dr. Rajeswar Pegu, Principal, Jonai Science College; Shri Basistha Chandra Kalita, Superintendent of Sericulture, Jonai. Dr. Khageswar Das, Rtd. Scientist, CMER&TI and Dr. Ranjana Das, Director (i/c), CMER&TI, Lahdoigarh, Jorhat was also attended the programme.

The scientists and staffs of the institute organized an exhibition to showcase the different technologies and products developed by CMER&TI for enhancement of Eri and Muga sericulture of the country. The daylong programme was initiated with the inauguration of exhibition stall by the Chief Guest Shri Das. In his welcome address, Dr. Dip Kumar Gogoi, Sc-D briefed about the institute, its various activities and role in extension of sericulture in northeastern part of the country. Shri Basistha Chandra Kalita, Superintendent of Sericulture, Jonai described about the various sericulture activities going on in the district and appealed the farmer participant to take sericulture in commercial venture. Dr. Pegu, Principal, Jonai Science College emphasized on the significance of sericulture for economic upliftment of poor farmers. Shri Das, Asst. Commissioner, Jonai Sub-Division advised the stakeholder to utilize the technologies developed by CMER&TI, CSB for enhancement of production of Muga and Eri culture. He appreciated the scientists of this institute for their contribution towards the socioeconomic upliftment through modern sericulture.

The participants expressed their sincere gratitude towards the institute for providing technical know-how during the meeting. A good number of rearers, reeler and seed producers took active part in the programme making the interaction fruitful.

Swachhata Hi Seva Campaignat RSRS, Imphal

A Cleanliness drive as part of the Swachhata Hi Seva Campaign was observed by Regional Sericultural Research Station, Central Silk Board, Mantripukhri, Imphal w.e.f 11.09.2019 to 02.10.2019, 2019. The programme was participated by all the officials of the station by cleaning the road median, drains and footpaths

for 1000-metre stretch on the eastern side of the National Highway no. 39. The drive helped in making our environment Swachh and Single-Use-Plastic Free. The programme was closed by observing cleanliness drive on 2nd October.

Swachhata Hi Seva Campaign at RSRS, Boko

RSRS, Boko carried out Swachhata Hi Seva Programme from. 11.09.2019 to 02.10.2019 at RSRS, Boko, DND High School, Deochar, Boko, and Doledonga, Ratanpur, Kamrup.

Swachhata Hi Seva Programme at CMER&TI, Lahdoigarh

The day long programme was conducted at CMER&TI, Lahdoigarh under the chairmanship of Dr. R. Das, Director (i/c) in conference hall. At the outset Sri S. K. Hazarika, Superintendent (Admin.), coordinator welcomed the staffs and participants from Sri Sankardev M. E. School, Lahdoigarh and briefed the day long programme. He has particularly emphasized the importance of sanitation in the work area, School and in surroundings. As a part of competition, all the participants from Sri Sankardev M. E. School, Lahdoigarh and Springdale High School, Lahdoigarhwere asked to participate in artand quiz competitions on "Swachhata hi Seva". Further a speech competition on the topic "plastic waste management". Dr. T.J. Keisa, Sc-D, Dr. Reeta Luikham, Sc-D and Dr. Aftab, Sc-D were coordinated the art competition. Dr. M. Chutia, Sc-D, and Dr. Subadas Singh, Sc-C and Sri Simata Saikia, SrFA were coordinated the quiz and speech competitions. All the school students were participated actively in these programmes. All the technical, administrative and field staffswere actively involved in the celebration of swachhata Hi Seva campaign.

TRANSFER OF TECHNOLOGY PROGRAMS

1. On Farm Trials (for demonstration of Technologies at farmers' level)

Sl. No	Name of the Technology	Unit Cost (Rs.)	No. of locations	No. of stakeholders	Fund utilisation (Rs.)	Findings
1	INM for Castor host plant	1,000	02	30	2000	
2	Beneficial gut microflora	1,000	02	30	2000	
3	Popularization of high yielding eri eco-races (YP X GBZ and GBS X GBZ)	300	02	50	10000	
4	Popularization of Kesseru eri host plant HF005 and HF008.	2,000	02	10	20000	2000 seedlings of these superior Kesseru accessions (HF005 and HF008) were raised and are ready for supply to selected 10 farmers during forth coming plantation season (Feb-March 2020).
5	Popularization of Borpat kissan nursery	10,000	02	-	20000	02 farmers were selected and nursery technique for raising Borpat was demonstrated. The seeds of Borpat will be available in February. Therefore, the selected farmers will start raising the Borpat nursery during forth coming plantation season (Feb-March 2020) with a minimum target of 10,000 seedlings/ farmer.
6	Popularization of CMR-1 and CMR-2.	2,000	04	20	0.00	
7	Popularization of Package of practices of Oak tasar silkworm cultivation (Chawki rearing/late age rearing,mounting and harvesting).	4,000	01	40	125960	
8	Enhancement of Muga cocoon production in Manipur through Technology intervention.	4,000	01	20	80000	
				Total	**259960.00**	

2. On Station Trials (for validation of technology at CSB institutes/ RSRSs/ DoS units etc.)

Sl. No	Name of the Technology	Unit Cost (Rs.)	At CSB institutes	RSRSs	DOS Units	Total	Funds utilized (Rs.)	Findings
1	Integrated practice of ITK and improved technology for muga silkworm seed production.	2,000	-	-	11	11	19000.00	Cocoon yield increased by 33.3% in ToT over benchmark during Bhadia seed crop (Aug-Sep-2019)
2	Integrated practice of ITK and improved technology for higher muga cocoon yield.	2,000	-	-	21	21	39800.00	Fecundity gain by 36.6% in ToT over normal practice
							58800.00	

Capacity Building and Training Institute-wise for financial year of 2019-2020

#	Name of the Training Programme	Target for the Year		Progress till end of the year	
		Physical	Financial	Physical	Financial
1	Exposure visit for Technology Awareness	200	8.00	121	0.833
2	Farmers' Skill Training	500	21.40	419	10.713
3	Technology Orientation Programme (Officials from DoS & CSB)	200	7.60	104	1.876
4	Training under Post cocoon sector	50	1.80	50	1.589
5	Training under Sericulture Resource Centre	900	6.75	888	1.755
6	Training under STEP by Institute	50	0.70	45	0.307
	Sub Total	**1,900**	**46.25**	**1,627**	**17.073**
7	Training funded under - NON CBT	400	-	157	-
8	Training funded under - NON CSB	-	-	107	5.066

	Sub Total	**400**	**0**	**264**	**5.066**
	Grand Total	**2,300**	**46.25**	**1,891**	**22.139**

PLAN FOR LAND USE RESOURCE CONSERVATION

Sl.No.	Programme / Unit	Target for 2019-20	Achievement during 2019-20
A.	**Raising of Som / Soalu seedlings / saplings** (Raising cost Rs 5/ seedling in ploy tube)		
1.	CMER&TI, Lahdoigarh	50000	18122
2.	RSRS, Boko	100000	15000
3.	REC, Lakhimpur	5000	5000
4.	REC, Coochbehar	5000	5000
	TOTAL	**160000**	**43122**
B.	**Raising of Kesseru / Borpat seedlings** (Raising cost Rs. 4/ seedling in ploy tube)		
1.	CMER&TI, Lahdoigarh	8000	3676
2.	RSRS, Boko	--	5950
	TOTAL	**16000**	**9626**
C.	**Supply of seedlings / saplings**		
	Som / Soalu seedlings (@ Rs. 5/- per seedling)		
1.	CMER&TI, Lahdoigarh	10000	10880
2.	RSRS, Boko	20000	17223
3.	REC, Lakhimpur	5000	5028
4.	REC, Coochbehar	5000	2400
	TOTAL	**40000**	**24651**
	Kesseru seedlings (@ Rs. 5/- per seedling)		
1.	CMER&TI, Lahdoigarh	8000	1500
	TOTAL	**8000**	**1500**
D.	**DFLs brushing**		
I.	**Muga commercial crop (Cost @ Rs. 10/- per dfl)**		
1.	CMER&TI, Lahdoigarh	3000	2030
2.	RSRS, Boko	2500	2970
3.	REC, Lakhimpur	500	550
4.	REC, Coochbehar	500	500
	TOTAL	6500	**6050**
II.	**Muga Seed crop (Cost @ Rs. 10/- per dfl)**		
1.	CMER&TI, Lahdoigarh	1700	3188
2.	RSRS, Boko	700	1500

3.	REC, Lakhimpur	400	550
4.	REC, Coochbehar	600	450
	TOTAL	**3400**	**5688**
III.	**Eri (Cost @ Rs. 5/- per dfl)**		
1.	CMER&TI, Lahdoigarh	300	275
2.	REC, Fatehpur	200	-
	TOTAL	**500**	**275**
E.	**Muga commercial cocoon production**		
1.	CMER&TI, Lahdoigarh	180000	49401
2.	RSRS, Boko	150000	50205
3.	REC, Lakhimpur	30000	30520
4.	REC, Coochbehar	60000	12192
	TOTAL	**420000**	**142318**
F.	**Muga seed cocoon production**		
1.	CMER&TI, Lahdoigarh	68000	54043
2.	RSRS, Boko	28000	22722
3.	REC, Lakhimpur	16000	17075
4.	REC, Coochbehar	24000	113
	TOTAL	**136000**	**93953**
G.	**Eri cocoon production (kg)**		
1.	CMER&TI, Lahdoigarh	30	7
2.	REC, Fatehpur	7.5	-
	TOTAL	**37.5**	**7.0**
H.	**Muga dfl production**		
1.	CMER&TI, Lahdoigarh	13600	14752
2.	RSRS, Boko	7000	3125
3.	REC, Lakhimpur	2400	2614
4.	REC, Coochbehar	4000	2525
	TOTAL	**27000**	**23016**
I.	**Eri dfl production (kg)**		
1.	CMER&TI, Lahdoigarh	1900	780
	TOTAL	**1900**	**780**
J.	**Muga dfl supply**		
1.	CMER&TI, Lahdoigarh	13600	9364

2.	RSRS, Boko	7000	2450
3.	RSRS imphal	--	3800
4.	REC, Lakhimpur	2400	2414
5.	REC, Coochbehar	4000	2225
	TOTAL	**27000**	**20253**
K.	**Eri dfl supply**		
1.	CMER&TI, Lahdoigarh	1600	630
	TOTAL	**1600**	**630**

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PUBLICATIONS OF THE INSTITUTE (2019-20)

Research articles

1. Gohain, A., Sarma, R.K., Debnath, R. et al. (2019) Phylogenetic affiliation and antimicrobial effects of endophytic actinobacteria associated with medicinal plants: prevalence of polyketide synthase type II in antimicrobial strains. *Folia Microbiologia*, 64: 481–496.
2. Kumar A, Kumar A, Cabral-Pinto MMS, CP., Chaturvedi AK, Shabnam AA, Subrahmanyam G, Mondal, R & Yadav KK (2020) Lead Toxicity: Health Hazards, Influence on Food Chain, and Sustainable Remediation Approaches. *International Journal of Environmental Research and Public Health*, 17(7): 2179.
3. Kumar A, Subrahmanyam G, Mondal R, Cabral-Pinto MMS, Shabnam AA, Jigyasu DK, Malyan SK, Kishor-Fagodiya R, Khan SA, Kumar A, Yu ZG (2020) Bio-remediation approaches for alleviation of cadmium contamination in natural resources, *Chemosphere,* https:// doi.org/10.1016/j.chemosphere.2020.128855.
4. Liu J, Li S, Li W, Peng L, Chen Z, Xiao Y, Guo H, Zhang J, Cheng T, Goldsmith MR, Arunkumar KP, Xia Q, Mita K (2019) Genome-wide annotation and comparative analysis of cuticular protein genes in the noctuid pest *Spodoptera litura*. *Insect Biochemistry and Molecular Biology,* 110: 90-97.
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6. Mahesh, D.S., Muthuraju, R., Vidyashree, D.N., Narayanaswamy, T.K., & Subbarayappa, C.T. (2020). Effect of Silkworm Pupal Residue Protein (SPRP) and Silkworm Pupal Residue Extract (SPRE) Spray on Major and Micronutrients Status of Mulberry. *Ind. J. Pure App. Biosci.* 8(1): 110-114.
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8. Meccariello A, Salvemini M, Primo P, Arunkumar KP, Bourtzis K, Mathiopoulos K, Ragoussis J, Vitagliano L, Tu Z, Papathanos P, Robinson M, Saccone G (2019) Maleness-on-the-Y (MoY) orchestrates male sex determination in major agricultural fruit fly pests. *Science,* 365: 1457-1460
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10. RohelaGK, JogamP, MirMY, Shabnam AA, Shukla P, Abbagani S and Kamili AN (2020) Indirect regeneration and genetic fidelity analysis of acclimated plantlets through SCoT and ISSR markers in *Morus alba* L. cv. Chinese white. *Biotechnology Reports 25 e0041.*doi.org/10.1016/j.btre.2020.e00417
11. Roy D and Singh Subadas (2020). *Gynautocera papilionaria* (Lepidoptera: Zygaenidae): a newly reported pest of Muga silkworm host plant (Soalu) in Brahmaputra valley of Assam. *Food and Scientific Reports*, 1(6): 42-45
12. Roy D and Singh Subadas (2020) *Nesolynx thymus* (Hymenoptera: Eulophide)-A promising pupal endo-parastoid to control uzifly infesting muga silkworm. *Food and Scientific Reports,* 1(7): 36-39.
13. Singh S, Jigyasu DK, Roy D, Shabnam Aand Das R (2019) Feeding Behaviour of Two Important Predator Bugs *Eocanthecona furcellata* Wolff and *Sycanus collaris* Fabricius in Muga Ecosystem. *Research Journal of Agril. Sci*. 10(1): 185-188.

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16. Vijay, N., Yarrzari, S. P. and Mech, D. (2020), Influence of improved muga culture technology on knowledge level of farmers. *Journal of Pharmacognosy and Phytochemistry,* 9(1): 1954-1957
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Retirement from Board Service

Name	Designation	Date of retirement
Dr. Ranjana Das	Scientist-D	29.02.2019
Dr. NI Singh	Scientist-D	31.01.2020
Mr. K. Kalita	Asst. Director	31.08.2019
Sri Bokul Dutta	Technical Assistant	31.01.2020
Sri Tofqul Hussain	Technical Assistant	29.02.2020
Marim Azoy Joyful Chothe	Technical Assistant	29.02.2020
Ms. Chingakham Borkeina Devi	Technician	29.02.2020
Sri Thokcom Sudhir Singh	Assistant Technician	29.02.2020

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वर्ष के दौरान संस्थान में राजभाषा हिन्दी के कार्यान्वयन तथा उसकी उपलब्धियों

वर्ष २०१९-२० के दौरान संस्थान में राजभाषा हिन्दी के कार्यान्वयन से संबंधित विभिन्न गतिविधियों का संक्षिप्त विवरण नीचे मद वार दिया गया है-

1. राजभाषा अधिनियम 1963 की धारा 3(3) की स्थितिः

राजभाषा अधिनियम 1963 की धारा 3(3) के अंतर्गत जारी कुल कागजातों की संख्या- ३२३

2. हिन्दी पत्राचार की स्थितिः

3. राजभाषा कार्यान्वयन समिति की बैठक -

वर्ष के दौरान संस्थान में संस्थान की राजभाषा कार्यान्वयन समिति की ६ बैठकें आयोजित हुईं लेकिन कोरोना आपातकाल के दौरान वर्ष २०१९ मे हिन्दी राजभाषा कार्यान्वयन समिति की बैठकें वर्ष २०२० मे की गयी।

4. हिन्दी कार्यशाला -

संस्थान में कार्यरत सभी अधिकारी व कर्मचारी को हिन्दी संबंधी नई-नई जानकारी देने और हिन्दी संबन्धित अद्यतन जानकारी के लिए इस वर्ष ३ हिन्दी कार्यशालाए एवं ३ बैठकें आयोजित की गई। दिनांक २८.१२.२०२० को हिंदी कार्यशाला का आयोजन किया गया जिसमे श्री अजय कुमार, सचिव, नगर राजभाषा कार्यान्वयन समिति, जोरहाट, उत्तर-पूर्व विज्ञान तथा प्रौद्योगिकी संस्थान, जोरहाट ने हिंदी व्याकरण के बारे मे पूरी जानकारी दिया। दिनांक ३०.१२.२०२० को विभागीय/संगठनीय राजभाषा कार्यान्वयन समिति की बैठक का आयोजन किया गया जिसकी अध्यक्षता संस्थान की निदेशक महोदया ने किया।

इन कार्यशालाओं में भाग लेने वाले अधिकारी व कर्मचारी की संख्या निम्न प्रकार है-

(क) **हिन्दी कार्यशाला के आयोजन की तिथिः-**

1. दिनांक २९.०६.२०२० को
2. दिनांक ०५.०९.२०२० को
3. दिनांक २८.१२.२०२० को

(ख) **हिन्दी बैठक के आयोजन की तिथिः-**

1. दिनांक २९.०६.२०२० को
2. दिनांक १०.०९.२०२० को
3. दिनांक ३१.१२.२०२० को

(ग) **भाग लेने वाले अधिकारी व कर्मचारी की कुल संख्याः-**

प्रशिक्षित अधिकारी की कुल संख्या- ६२

प्रशिक्षित कर्मचारी की कुल संख्या- ७६

5. राजभाषा निरीक्षण एवं प्रोत्साहनः-

वर्ष के दौरान संस्थान के विभिन्न प्रभागों/अनुभागों में राजभाषा कार्यान्वयन की प्रगति का निरीक्षण किया गया तथा हिन्दी के प्रोतसाहान के लिए संस्थान द्वारा श्रेष्ठता पुरस्कार (चल शील्ड) की शुरुआत की गयी। वर्ष २०२० की तिमाही (अक्टूबर - दिसम्बर, २०२०) में बेहतर कार्य निष्पादन करने पर संस्थान के स्थापना अनुभाग को प्रदान किया।

6. संस्थान में हिन्दी पखवाड़ा व हिन्दी दिवस मनाया गयाः

हर वर्ष की तरह इस वर्ष भी संस्थान में दिनांक १६.०९.२०१९ से दिनांक ३०.०९.२०१९ तक हिन्दी पखवाड़ा मनाया गया। पखवाड़े के दौरान हिन्दी भाषा तथा इसके कार्य से संबंधित विषयों पर कई प्रतियोगिताएं जैसे-

हिन्दी नोटिंग व ड्राफ्टिंग, हिन्दी तत्काल भाषण, हिन्दी कविता पाठ तथा हिन्दी गीत (केवल मल्टी टाक्सिंग स्टाफ के लिए) आयोजित हुई जिसमें संस्थान के सभी वैज्ञानिकों, अधिकारियों तथा ने भाग लिया।

संस्थान में दिनांक १४.०९.२०१९ को हिन्दी दिवस तथा हिन्दी पखवाड़ा समापन समारोह का आयोजन किया जिसकी अध्यक्षता संस्थान की निदेशिका महोदया ने किया।

अध्यक्ष महोदया द्वारा दीप प्रज्ज्वलन के साथ कार्यक्रम का शुभारम्भ किया गया। हिन्दी दिवस के उपलक्ष्य में जारी केन्द्रीय रेशम बोर्ड के अध्यक्ष महोदय तथा माननीय गृहमंत्री, भारत सरकार के संदेशों का पाठ किया गया।

इस अवसर पर डॉ रीता लुईखाम, वैज्ञानिक- डी ने कहा कि अब हर क्षेत्र में हिन्दी की प्रगति और परिणाम कार्यालय, सामाजिक, स्थान और वाणिज्यिक क्षेत्र में प्रदर्शित हो रहा है। देश के लोग खास तौर पर पूर्वोत्तर भारत के सभी राज्यों के लोगों को हिन्दी बोलने में इसके पहले जो झिझक थी, वह अब दूर होने लगी है।

अपने अध्यक्षीय भाषण में डॉ. आर. दास, कार्यवाहक निदेशक ने कहा कि केन्द्रीय सरकार के कार्यालयों में हिन्दी दिवस आयोजन कर राजभाषा हिन्दी को गरिमा के साथ मर्यादा प्रदान करना ही नहीं बल्कि केन्द्रीय सरकार के कर्मचारियों के बीच हिन्दी भाषा का प्रचार व प्रसार करना अति आवश्यक है। उन्होने इस अवसर पर आयोजित सभी गतिविधियां तथा रंग-बिरंगे कार्यक्रमों को देख कर खुशी जाहिर की।

समापन समारोह के दौरान सभी प्रतियोगिताए में विजयी प्रतिभागियों को क्रमशः प्रथम, द्वितीय, तृतीय तथा प्रोत्साहन पुरस्कार से पुरस्कृत किया गया। इसके अतिरिक्त वर्ष २०१९-२० के दौरान जिन अधिकारी व कर्मचारी ने मूल रूप में हिन्दी में कार्य करते हुए १०००० या इससे अधिक शब्द लिखा हैं, को इस अवसर पर नकद राशि से पुरस्कृत किया गया।

7. प्रकाशनः

वर्ष के दौरान हिन्दी में कई प्रकाशन किए गए हैं। इन में से दो पत्रिकाएं तथा 4 लीफलेटस् हैं जो निम्न प्रकार हैं-

पत्रिकाएं

1. हिन्दी न्यज लेटर (वार्षिक, २०१९-२०)
2. एरी रेशम कीटपालन पुस्तिका का संशोधित प्रकाशन, २०२०

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