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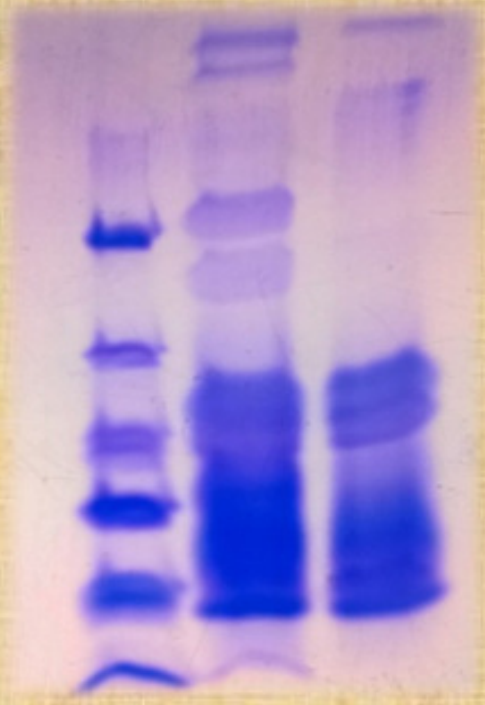
Annual Report
2015-16



केन्द्रीय रेशम बोर्ड Central Silk Board,
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Central Muga Eri Research and Training Institute
(आईएसओ ISO 9001: 2015 प्रमाणित संस्थान certified institute)
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लाहदोईगढ़- Lahdoigarh-785700, जोरहाट, Jorhat, असम, Assam

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Dr. B.K. SIngh
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Phone: (91) 0375-2335513/2335124
Fax: (91) 0376-2335528

Complied & Edited by:
Dr. Mahananda Chutia
Dr. R. Kumar
Dr. (Mrs.) U. Hazarika

Cover Design by
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G. Taye

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ANNUAL REPORT 2015-2016

केन्द्रीय मूगा एरी अनुसंधान व प्रशिक्षण संस्थान

(आई एस ओ 9001: 2008 प्रमाणित संस्थान)

Central Muga Eri Research and Training Institute

(ISO 9001:2008 Certified Institute)

केन्द्रीय रेशम बोर्ड Central Silk Board

वस्त्र मंत्रालय, भारत सरकार Ministry of Textiles, Govt. of India

लाहदोईगढ़ Lahdoigarh-785700, जोरहाट, Jorhat, असम, Assam

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प्रस्तावाना

पूर्वोत्तर भारत में विविध वनस्पति ,पक्ष-पौधा तथा जीव-जन्तुओं का एक प्राकृतिक वास स्थान है। इस क्षेत्र में विद्यमान सीजिन्नियस् कीट तथा इन कीटों का लिए वश्यक खाद्य पौधा का लिए उपयुक्त व सहायक पर्यावरण पाया जाता है। इस क्षेत्र में लाणिज्यिक रूप में हन रेशम का चार प्रकार का कीट यथा- शहतूत ,मूगा एरी तथा ओक तसर का अतिरिक्त लाणिज्यिक रूप में आ हन रेशम कीट – *Attacus atlas, Samia canningie, Cricula trifenestrata* ि पर्याप्त रूप में उपलब्ध हैं।

असम की ब्रह्मपुत्र घाटी एरी रेशम शलभ का मल निवास स्थान है। एरी रेशम सा उत्पा ित रेशम जा वाणिज्यिक रूप सा विश्व में तृतीय अहम रेशम है जा कि शहतूत तथा चीनी तसर का क्रम में ता है। ेश में पूर्वोत्तर भारत द्वारा 98 प्रतिशत कता हु एरी का स और कता रेशम उत्पा ित हाता है। पूर्वोत्तर भारत का अतिरिक्त एरी संवर्धन ेश का उत्तर प्रा ेश , न्ध्र प्रा ेश ,ता मिलनाडू और उड़िसा में हाता है। एरी रेशम का उपा न की मांग ि न प्रति ि न ढ़ता जा रहा है। इसका उत्पा न वर्ष २०१४-१५ का ौरान 4600 मि्रिक टन ्र्ज किया गया है। मूगा पूर्वोतत्र भारत का स्थानिक रेशम है जिसका सुनहरा रंग) गा्र्न (का उत्कृष्ट रेशम उत्पा न हाता है। वर्ष २०१४-१५ का ौरान 158 मि्रिक टन मूगा रेशम उत्पा न हु है जा मूगा रेशम उत्पा न में सा सा अधिक उत्पा न अभिलक्ष्य है। इस उद्यागा का निश्चित जीवीय तथा अजैव जैसी चुनौतियां का सामना करना का कारण इसका संभावीय कच्चा रेशम उत्पा न में धित हा रहा है। इसका अलावा विश्वव्यापी गरमी ,निरन्तर मौसम का ा लाव तथा मूगा उद्यागा में विद्यमान पर्यावरणीय प्रा ूषण मुख्य वजह हैं जिसा मकार नहीं किया जा सकता है।

केन्द्रीय मूगा एरी अनुसंधान व प्रशिक्षण संस्थान,ल्ह ईगढ़ केन्द्रीय रेशम ा ि का प्रमुख संस्थान है जिसा नियाी तथा अनुप्रयागा अनुसंधान ,विकासात्मक व प्रसार गतिविधियां सा जुड़ा कार्यों का करना का लिए ाशित है जिससा ेश का मूगा तथा एरी क्षेत्रों का विकास में मा मिलें। संस्थान द्वारा रेशमकीट पालन प्रबंधन ,खाद्य पौधा सुधार व प्रबंधन ,विकसित प्रजनन ,पीड़क व रा ग नि न का प्रबंधन ि की ि श में कृषकों की अनुकूलन प्रौद्यागिकियां का विकास का साथ कृषकों की सहभागिता का व्यापक रूप में प्रसारण का अभियान तथा राज्यिक रेशम विभागों का साथ सुसमन्वय नार रखना पर जार ा ता रहा है।

मुझा यह नाट करता हुए ह खुशी हा रही है कि संस्थान द्वारा वर्ष २०१४-१५ का ौरान महत्वपूर्ण गतिविधियां इसका लक्ष्य पूरा कर सका है। संस्थान द्वारा अधिक उत्पा न करना वाला एरी रेशमकीट प्रजनन सी-२ विकसित किया गया जिसका अनुमा न संकर प्रा धिकरण समिति, केन्द्रीय रेशम ा ि ना किया है तथा एरी कृषक स्तर पर व्यापक रूप सा ग्रहण किया है। केन्द्रीय रेशम ा ि का "इनवा टिव यूज ऑफ जी. ई.एस. टाक्नालॉजी इन ई-गवन्च" नामक परियाजना का कार्यान्वयन पर राष्ट्रीय पुरस्कार सा सम्नानित किया गया है। यह संस्थान इस परियाजना का कार्यान्वयन में प्रमुख ेणाकार रहा है। इस संस्थान ना असम का जारहाट,गा्र्घाट और शिवसागर जिला में २० एस.एच.जी. का साथ मॉडल एरी विलाज विकसित किया गया जिसमें उत्तरवर्ती व पूर्ववर्ती का का स का नों क्षेत्रों में तथा एरी रेशम का उत्पा न िजाइन तथा विविध व प्राकृतिक रंगन की प्रौद्यिगिकी का जरिए महिला सशक्तिकरण, अतिरिक्त य

और रोजगार का सृजन करने पर केन्द्रित रहा है। घर एस.एच.जी. और उघरिया एस.एच.जी. का एरी कोसा उत्पादन पर राज्यिक स्तर पर प्रथम व द्वितीय पुरस्कार प्राप्त हुआ है। संस्थान ने रहमानी खाद्य पौधा एलाईन्टस का उत्कृष्ट जीवप्ररूप की पहचान व मूल्यांकन, हुप्रजनन वृद्धि का लिए वन्य मूगा रेशाम कीट का मूंल्यांकन तथा कवच भार, पीड़क व राग की पूर्वसूचना व पूर्वचेतावनी की प्रणाली का विकास, मूगा रेशामकीट जननद्रव्य स्वस्थाने संरक्षण, एरंड का एकीकृत पोषक प्रबंधन पैकेज तथा मूगा तथा एरी का रेशामकीट बीज का लम्बी अवधि का लिए परिरक्षण आदि पर अध्ययन भी किया है। संस्थान ने वैज्ञानिक,तकनीकी और प्रशासनिककी श्रमशक्ति पर जोर देते हुए एन.ए.ए.आर.एम. है राजभाषा तथा एन.ई.आर. ई.एल.पी. ई.टी. ,जोरहाट जैसे आंतरिक संस्थानों का जरिए प्रशिक्षण आयोजित किया गया है। इसका अतिरिक्त,संस्थान का वैज्ञानिकों का अन्य जगहों पर राष्ट्रीय संस्थानों में प्रतिनियुक्त किया गया है। कृषकों का घर-घर में प्रशिक्षण तथा प्रौद्योगिकी स्थानांतरण पर अधिक भरोसा दिखाने व्यवस्था की गई तथा संस्थान ने सेरी मॉडल विलीज, कृषकों प्रेक्षण स्कूल, असम, मेघालय, नगालैंड, पश्चिम बंगाल तथा उत्तर प्रदेश का भारी संख्या में कृषकों का शामिल करते हुए मूगा व एरी पर क्लस्टर प्रदर्शन प्रोग्राम जैसे कई कार्यक्रमों का आयोजन किया। विविध प्रशिक्षण कार्यक्रम का तहत 5000 से अधिक कृषकों, रेशाम उत्पादन विभाग का कर्मचारियों, टीम तथा गैर सरकारी संगठनों का अधिकारी व कर्मचारियों का प्रशिक्षण प्रदान किया गया। संस्थान तथा इसका अधीनस्थ इकाईयों में प्रौद्योगिकी जागरूकता कार्यक्रम, रेशाम कृषि मेला, प्रेक्षण दिवस, प्रदर्शनियां, समूह चर्चा परिचर्चा, फ्रन्टलाईन प्रदर्शनियां आदि आयोजित किए गए। संस्थान ने सेरीजिनस् इन्सेक्ट रिपोसिटरी की स्थापना कर इसका दुनियाभी सूविधाएं का भी मजबूत बनाया है तथा इस प्रकार की स्थापना पूर्वोत्तर भारत में पहली है।

मुझे प्रो. दिलिन कुमार कंवर, उपकुलपति, नगालैंड विश्वविद्यालय तथा अध्यक्ष, अनुसंधान सलाहकार समिति (अर.ए.सी.), केमूएअवप्रस,लाहौलाईगढ तथा अनुसंधान सलाहकार समिति का सभी सदस्यों का अनुसंधान व विकास का सभी अग्रणी क्षेत्रों में और मूगा व एरी उद्योग में विद्यमान समस्यों का हल करने में उनका द्वारा दिए गए मूल्यवान व अहम मार्गदर्शन तथा सुझाव का प्रति कृतज्ञता व्यकत करने में खुशी हो रही है।

मैं केन्द्रीय रेशाम बोर्ड ,बेंगलूरू का सक्षम प्राधिकारी का संगठन का लक्ष्य का पूरा करने का संबंध में अनुसंधान व विकास की गतिविधियों का निष्पादन में सतत सहयोग प्रदान करने का लिए धन्यवाद ज्ञापित करता हूं तथा मैं उत्तर-पूर्वी क्षेत्र का रेशाम उत्पादन का विभागों का विकासात्मक व विस्तार सूचनाओं का आदान-प्रदान का कार्यक्रमों का प्रभावी सा कार्यान्वयन किए जाने का लिए निष्ठापूर्वक प्रशंसा करता हूं। मैं सभी सहयोगी संस्थानों तथा निधि प्रदान करने वाले अभिकरणों यथा डिब्रुगड़ विश्वविद्यालय,गुवाहाटी विश्वविद्यालय ,उत्तर-पूर्वी विज्ञान तथा प्रौद्योगिकी संस्थान,जोरहाट ,आई .आई .टी ,.खरगपुर , आई.ए.आर.ई ,.नई दिल्ली ,असम कृषि विश्वविद्यालय,जोरहाट ,विज्ञान तथा प्रौद्योगिकी विभाग,भारत सरकार तथा जैव-प्रौद्योगिकी विभाग ,भारत सरकार का निष्ठापूर्वक प्रशंसा करता हूं जिनका सहयोग से क्षेत्र में एक अग्रणी अनुसंधान व विकास संस्थान का रूप में सक्षम बनाया है। अन्त में ,मैं उन कृषकों का अत्यधिक धन्यवाद व कृतज्ञता व्यक्त करता हूं जिन्होंने मूगा व एरी का दोनों क्षेत्रों में विस्तार तथा

अनुसंधानात्मक सहायता में सामंजस्य कर रही चुनौतियों का विरूद्ध लड़ाई करने में जरूरतमंद तथा उपयोगी सहयोग किया है।

डॉ बी के सिंह

निदेशक

FOREWORD

The North East region of India is a natural abode for diverse flora and fauna. The conducive environment of the North East India has made the region a natural home for sericigenous insects as well as their host plants. Four types of commercially exploited silks, viz., mulberry, muga, eri and oak tasar are available in this region besides numerous commercially un-exploited sericigenous insects such *Attacus atlas*, *Samia canningie*, *Cricula trifenestrata*, etc.

Brahmaputra river valley of Assam is considered as original home of cultivated eri silkmoth. The silk produced by eri silkworm is considered economically the third most important silk in the world after mulberry silk and Chinese Tasar. The North Eastern region of India alone produces more than 98 % of the total amount of eri cut cocoons and spun silk in the country. Besides these, the eri culture has also undertaken in Uttar Pradesh, Andhra Pradesh, Tamil Nadu and Odisha. The production and demand of eri silk is increasing day by day and its production has reached all time high i.e. more than 4600 MT during 2014-15. Muga silk is endemic to North East region producing golden coloured exquisite silk. The muga raw silk production has been also increasing gradually up to 158 MT during 2014-15 which is the highest reported so far. The muga silkworm is facing certain biotic and abiotic challenges hindering its potential raw silk production. Impact of global warming coupled with climate changes and environmental pollution on muga silk industry cannot be ignored.

The Central Muga Eri Research and Training Institute under Central Silk Board is the leading institute mandated to carry out basic as well applied research, developmental as well as extension support for the growth of muga and eri silks industry in the country. The institute has been focusing on development of farmers' friendly technologies in the areas of silkworm rearing management, host plant improvement and management, development of improved breeds, pest & disease management, etc. and its diffusion and dissemination through farmers' participatory mode and in coordination with State Department of Sericulture.

I am happy to note the institute could fulfill its goal in a remarkable extent during 2016-17. The institute has developed first high yielding eri silkworm breed C2 which was approved by Hybrid Authorization Committee of CSB and widely accepted by the eri farmers. The Central Silk Board was awarded prestigious National award in e-governance on "Innovative use of GIS Technology in e-Governance" in which the institute was one of the major stakeholder in implementing the project. The institute has developed Seri Model Villages in Jorhat, Golaghat and Sivasagar districts of Assam focusing women empowerment, additional income and employment generation through technological interventions both pre and post cocoon sectors as well as product design, diversification and natural dyeing of eri silk.

The institute has also carried studies on identification and evaluation of superior genotypes of perennial food plant Ailanthus, evaluation of wild muga silkworm for enhancement of fecundity and shell yield, development of forecasting and forewarning system for pest and diseases, *ex-situ* conservation of muga silkworm germplasm and integrated nutrient management package for castor, long term preservation of eri and muga silkworm seed, etc. More thrust was given on training and transfer of technologies to the doorsteps of farmers and institute implemented programmes such Seri-Model Village, Farmers' Field Schools, Cluster Promotion Programmes on muga and eri covering large numbers of farmers in Assam, Meghalaya, Nagaland, West Bengal and Uttar Pradesh. More than 5000 farmers, DOS staffs, officials of Insurance companies and NGOs were trained under various training programme. The institute and its nested units also organized a

numbers of technology awareness programme, Reshom Krishi mela, field days, exhibition, group discussions, frontline demonstration, etc. The institute also strengthened its infrastructural facilities by establishing Sericigenous Insect Repository which is first of its kind in NE Region.

It gives me immense pleasure to record my deep sense of gratitude to Prof. Bolin Kumar Konwar, Vice Chancellor of Nagaland University and Chairman, Research Advisory Committee (RAC) and all the members of RAC of the institute for their invaluable guidance and suggestions to keep up the momentum of spirit and involvement in frontier areas of R&D and to tackle the problems of muga and eri silks industry.

I would like convey my thanks to Competent Authority of Central Silk Board, Bangalore for providing support for development of the institute to carry out the R&D activities in fulfilling the vision of the organization. I sincerely acknowledge and appreciate the supports and cooperation extended by Department of Sericulture of all North Eastern States in implementing developmental and extension communication programmes effectively. I also sincerely appreciate all the collaborating institute and funding agencies such as Dibrugarh University, Gauhati University, NEIST, Jorhat, IIT, Kharagpur, IARI, New Delhi, Assam Agricultural University, Jorhat, Department of Science & Technology, Government of India and Department of Biotechnology, Government of India whose cooperation and support enabled the institute a frontier R&D institute in the country. Last but not the least I would like to convey my heartfelt thanks and gratefulness to the farmers for cooperation and sharing challenges faced in grassroots level for carrying out need based and useful research and extension services in eri and muga silk sectors.

Dr. B.K. Singh
Director

INTRODUCTION

CMER&TI, LAHDOIGARH AT A GLANCE

Central Muga Eri Research & Training Institute is a R&D institute in the field of muga and eri culture, which is under the control of Central Silk Board, Ministry of Textiles, Government of India. The institute has been successfully undertaking entire gamut of R&D activities to cater the needs of the on-farm and post-cocoon sector of muga and eri culture. Muga and eri culture is a rural industry of all the North Eastern States and parts of the country. The institute is strengthening the infrastructural facilities in recent years for conducting research in the frontier lines. The main objectives of the institute are to evolve new technologies for increasing the productivity of muga and eri silkworms and thereby transforming these cultures from the state of traditional culture to a profit making and sustainable enterprises.

A. MANDATE OF THE INSTITUTE

- To act as an apex Research Institute for providing R&D support for muga and eri culture.
- To conduct basic, strategic and applied research to increase production and productivity of silkworms and their host plants.
- 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.

B. HUMAN RESOURCES (including extension units)

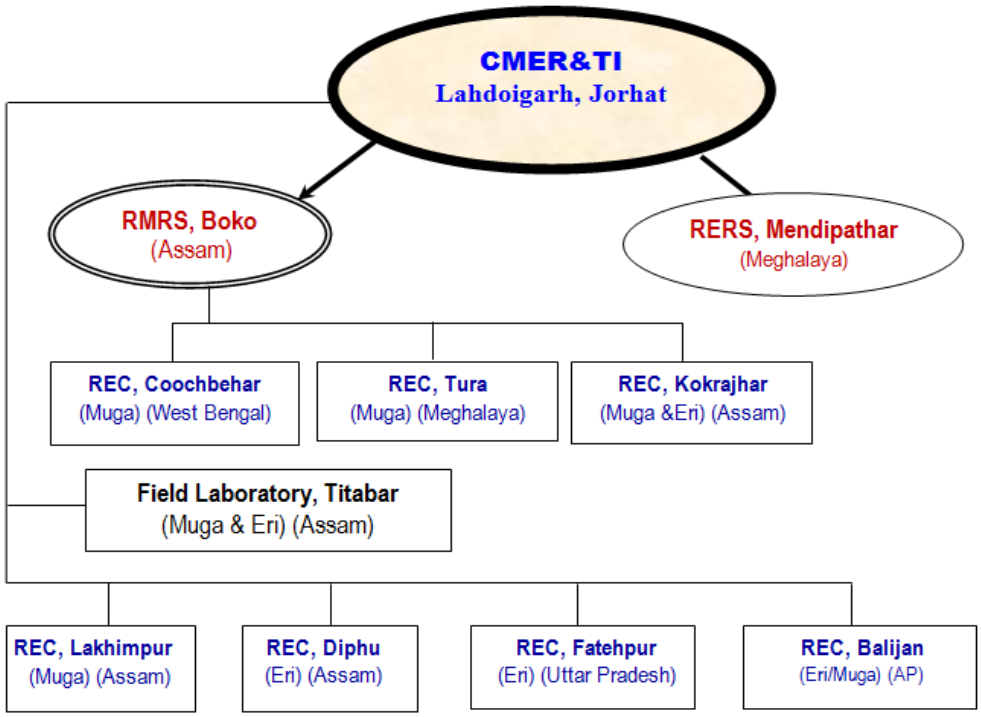
Scientists	36
Technical staff	57
Administrative Staff	57
Supporting Staff	37
Total Staff	**178**

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's 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 under twelve divisions.There is a Project Monitoring Cell (PMC) in the institute for planning and monitoring of the institutional R&D activities.

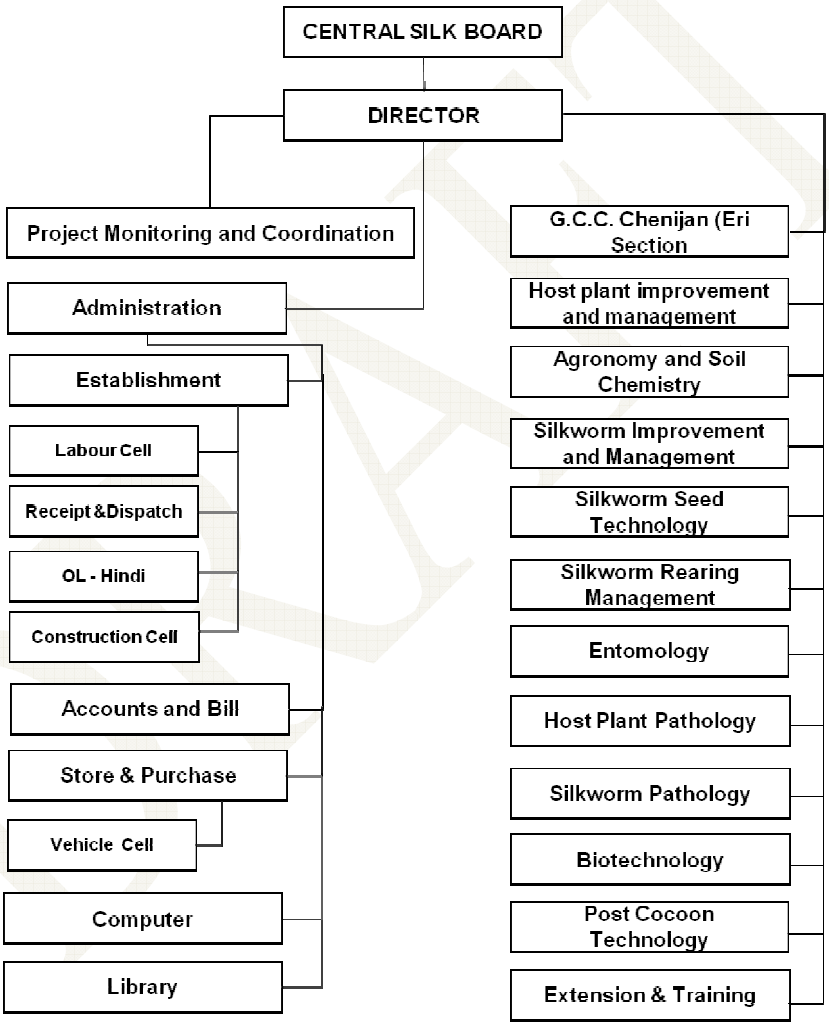
The administrative activities are carried out by ten sections *viz.,* Establishment, Accounts & Bill, Stores and Purchase, Library, Vehicle, Construction, Labour, Computer, Hindi and Receipt & Dispatch.

To facilitate effective transfer of technologies developed by the institute and their validation in the field, Regional Research Stations and Research Extension Centres (REC) are established. Regional Muga Research Station (RMRS) is located in one of the major muga growing zones of Assam namely, Boko in the district of Kamrup. The station has been carrying out region specific adaptive research suited to the regional requirements besides providing training to farmers and grass root level extension workers. The RECs have the responsibilities of transferring technologies to the beneficiaries and also to provide all technological and input support to them. Besides these, REC, Tura in Meghalaya is sharing the responsibility of maintaining basic stocks of muga silkworm. Two Regional Eri Research Stations (RERS) are located at Mendipathar (Meghalaya) and Shadnagar (Andhra Pradesh) with similar responsibilities for eri. There are two RECs for eri, located at Diphu (Karbi Anglong, Assam) and Fatehpur (Uttar Pradesh). There is a composite REC located at Mongaldoi, Assam and one at Navsari, Gujarat.

C. EXTENSION NETWORK



D. ORGANIZATIONAL SET-UP



E. SCIENTIFIC PERSONNEL (As on 31st March 2016)

I. MAIN INSTITUTE

1.	Dr. K. Giridhar	Director	Retired 30.11.2015
2.	Shri B. Choudhury	Scientist – D	
3.	Shri P.K. Handique	Scientist – D	Retired 31.12.2015
4.	Shri D. Goswami	Scientist – D	
5.	Dr. R. Das	Scientist – D	
6.	Mrs. Ranuma Das	Scientist – D	

7.	Dr. N.I. Singh	Scientist – D	
8.	Shri G. Rajkhowa	Scientist – D	
9.	Shri D. Mech	Scientist – D	
10.	Dr. K. Neog	Scientist – D	
11.	Dr. M.C. Sarmah	Scientist – D	
12.	Dr. Urmimala Hazarika	Scientist – D	
13.	Mrs. M.D. Senapati	Scientist – C	
14.	Dr. B.N. Sarkar	Scientist – C	
15.	Dr. M. Chutia	Scientist – C	
16.	Dr. D.K. Gogoi	Scientist – C	
17.	Dr. Rajesh Kumar	Scientist – C	
18.	Dr. S. A. Ahmed	Scientist – C	
19.	Shri D.K. Jigyasu	Scientist– B	joined on Nov. 2016
20.	Dr. K. Subadas Singh	Scientist– B	Do
21.	Dr. G. Subrahmanyam	Scientist– B	Do
22.	Shri Rajal Debnath	Scientist– B	Do
23.	Dr. Vinodakumar S. Naik	Scientist– B	Do
24.	Dr. Ranjini M.S.	Scientist– B	Do
25.	Dr. P. Sangannavar	Scientist– B	Do
26.	Shri Jevan B.	Scientist– B	Do
27.	Shri Vijay N.	Scientist– B	Do

II. RMRS, BOKO, Assam

01	Dr. S. Paliwal	Scientist – D
02	Shri A.K. Gogoi	Scientist – D
03	Shri L. Sonowal	Scientist – B

III. RERS, MENDIPATHAR, Meghalaya

01	Shri P.N. Borgohain	Scientist – C
02	Dr. H. Barman	Scientist – B

IV. RERS, SHADNAGAR, Andhra Pradesh

01	Dr. T. Ravi Verma	Scientist – D

V. REC, LAKHIMPUR, Assam

01	Shri S. Saikia	Scientist – D

VI. REC, COOCHBEHAR, West Bengal

01	Shri S. N. Bagchii	Scientist – D
02	Dr. N. Biswas	Scientist – D

VII. REC, TURA, Meghalaya

01	Mr. G.K. Bharali	TA

VIII. REC, KOKRAJHAR, BTC, Assam

01 Mr. J. Hazarika TA

IX. REC, FATEHPUR, Uttar Pradesh

01 Dr. A.U. Khan Scientist – D

X. REC, Diphu, Karbianglong, Assam

01 Mr. D. Khonikar TA

XI. REC, NAVSARI, Gujarat

01 Mrs. Hemlataben Patel TA

XII. REC, BALIJAN, Arunachal Pradesh

01 Mr. S. Pertin TA

F. DELEGATED AND NON-DELEGATED UNITS OF CMER&TI

DELEGATED UNITS

- Central Muga Eri Research & Training Institute, Lahdoigarh, Assam (Main Institute)
- Regional Muga Research Station, Boko, Kamrup, Assam
- Regional Eri Research Station, Shadnagar, Andra pradesh

NON-DELEGATED UNITS

- Regional Eri Research Station, Mendipathar, Meghalaya
- Research Extension Centre, Tura, Meghalaya
- Research Extension Centre, Coochbehar, West Bengal
- Research Extension Centre, Kokrajhar, Assam
- Research Extension Centre, Diphu, Assam
- Research Extension Centre, Lakhimpur, Assam
- Research Extension Centre, Fatehpur, Uttar Pradesh
- Research Extension Centre, Balijan, Arunachal Pradesh

वर्ष 2016-2015 में अनुसंधान संबंधी उपलब्धियां का मुख्यांश

केंद्रीय मूग□और एरी अनुसंधा□ एवं प्रशिक्षण संस्था□,ल□ह□ ईगढ़,ज□रह□ट क□स□थ अपन□ नेटवर्क अनुसंधा□ इक□इयों –क्षेत्रीय मूग□ अनुसंधा□ क□न्द्र,□क□ ,क्षेत्रीय एरी अनुसंधा□ क□न्द्र , श□□नगर) □ न्ध्र प्र□श , (क्षेत्रीय एरी अनुसंधा□ क□न्द्र ,म□नि□ पथ□र) मेघ□लय (तथ□ लखीमपुर,कूच□ह□र)प.□ंग□ल(, तुर□) मेघ□लय(, □फू) क□र्बि□ ग्ल□ंग(, क□क□र□झ□र) □ी.टी.सी (.और फतेहपुर)उ.प्र (.में स्थित संस्था□ क□ अनुसंधा□ विस्त□र क□न्द्रों द्व□र□ अनुसंधा□ एवं विक□स क□ तहत मूग□ और एरी उद्य□ग की विक□सात्मक गतिविधिय□ में सह□यत□ प्र□□ किय□ ज□ रह□ है।

वर्ष 2015-16 क□□ौर□ क□न्द्रीय मूग□ एरी अनुसंधा□ व प्रशिक्षण संस्था□,ल□ह□ ईगढ़ तथ□ इसक□ क्षेत्रीय क□न्द्रों में पर्याव□रणीय चुनौतियों और ग्ल□□ल व□र्मिंग,कठिन परिश्रम न्यूनीकरण एवं महिल□ओं क□ अनुकूल प्रौद्य□गिकियों और पर्याव□रण अनुकूल और जैविक कृषि क□ भिन्न-भिन्न क्षेत्रों में क□न्द्रीय रक्षा□ □□ की वित्तीय सह□यत□ स□ 4 परिय□जनाएं, □ी.□ी.टी. की वित्तीय सह□यत□ स□ 4 परिय□जनाएं, □ी.एस.टी. की वित्तीय सह□यत□ स□ 5 अनुसंधा□ परिय□जनाएँ कार्यान्वयित ह□ रही हैं जिन में स□ 8 परिय□जनाएं समाप्त ह□ गई तथ□ 5 परिय□जनाओं ज□री है। इसक□ अलाव□, क□न्द्रीय रक्षा□ □□ द्व□र□ 2 नयी परिय□जनाएं तथ□ □ी.□ी.टी. द्व□र□ 1 परिय□जन□ अनुम□□ित की गयी है। इसक□ अलाव□, संस्था□ में इस रिपो□ट प्रस्तुत करन□ की अवधि क□□ौर□ 2 नियमित कार्यक्रमों, विस्त□र संच□र कार्यक्रमों, क्षेत्र □िवस,कृषि मेल□,ज□गरूकत□ कार्यक्रम,प्रौद्य□गिकी स्थाना□रण कार्यक्रमों और प्रशिक्षण कार्यक्रमों क□ □ यो□न किय□ गय□। क□न्द्रीय मूग□ एरी अनुसंधा□ व प्रशिक्षण संस्था□, ल□ह□ ईगढ़ द्व□र□ किए गए अनुसंधा□ में प्राप्त प्रमुख उपलब्धियों क□ मुख्यांश निम्नवत □र्शाय□ गय□ है।

खाद्य पौधा सुधार, उत्पादन और सुरक्षा

- असम क□ विभिन्न भाग□ें में जंगली स्थिति में उगनीवाली अरं□ी की rhizospheric मिट्टी स□ पृथक किए गए rhizobacteria क□ एक समूह क□ संभा□ित biofertilizer क□ रूप में पहचा□ कर

इससे ई.एन.एम INM नुस्खे पैकेज विकसित किये गये है जो अरंडी खली की लिए सिफारिश अकार्बनिक एन.पी.के खुराक की मात्रा के 50% तक घटाये जा सकते हैं।

- एरी रेशमकीट पालन के लिए पत्तियों के व्यावसायिक उत्पादन, व्यापारिक bioassay, जैव रासायनिक और पोषण विश्लेषण करते हुए यह पाया गया कि *Ailanthus grandis* (अरुसा Borpat) से अच्छे गुणवत्ता की भोज्य पौधे है और एक्सेलसा excelsa (अरुसा रू) में भी इसके अच्छे परिणाम पाये गये है जिसे एरी रेशमकीट पालन के लिए उपयोग किये जा सकते है। गोलाघाट जिले के अरुपथार, जोरहाट जिले के नागाजांगक Nagajangka व मरांगियल Morangial और तिनसुकिया जिले के बरेकुरी Barekuri में Ailanthus के एरी रेशमकीट पालन में लोकप्रिय बनाने के लिए फील्ड परीक्षण आयोजित किये गये जिसमें 250 किसानों के शामिल किये गये। औसत कोकून कवच खोल उपज 11.83 किलोग्राम/0.51 ग्रा के एकल कवच खोल वजन और 3.47g के एकल कोकून वजन के साथ 100 एफएलएस के रूप में दर्ज की गई।

- *Ailanthus grandis* के बड़े पैमाने पर गुणन के लिए धरतीमुलीसिंग, बरेकुरी सही मॉडल विलीज में तीन किसान नर्सरी विकसित किये गये है। मिसिंग स्वयंसेवी परिवार ने एरी संवर्धन के उपयोग के लिए बड़े पैमाने पर अरुसा वृक्षारोपण करने की शुरुआत कर दी है।
- क्षेत्रीय एरी अनुसंधान केन्द्र, शिलांग में क्लस्टर जीनोटाइप विकास के मापदंडों,शारीरिक मापदंड, chemoassay और bioassay के आधार पर मूल्यांकन किये गये तथा इसे आंध्र प्रदेश के अर्द्ध शुष्क परिस्थितियों में उपयुक्त क्लस्टर जीनोटाइप के रूप में पहचान की गयी।

रेशमकीट सुधार, उत्पादन और सुरक्षा

मूगा अंडा संरक्षण मूगा अंडा संरक्षण अनुसूची विकसित किये गये है जिसके द्वारा 48 घंटे के पुराने भ्रूण अवस्था पर कोई प्रतिकूल प्रभाव के बिना 20 दिनों तक कम तापमान (7 सी.ग्रा) में संरक्षित किये जा सकते है। मिश्रण उम्र (24-72 घंटे) के अंडे अवस्था भी और प्रदर्शन के पालन पर कोई प्रतिकूल प्रभाव के बिना 7o सी और 75-85% R.H. पर संरक्षित किये जा सकते है 15 दिनों के लिए। ।

- मूगा अंडा संरक्षण की अनुसूची विकसित किये गये है जिससे 48 घंटे के पुराने भ्रूण अवस्था के दौरान कोई प्रतिकूल प्रभाव पड़े बिना कम तापमान (7 डी..सा.ग्रा.) में 20 दिन तक संरक्षित किये जा सकते है। अंडे स्फुटन तथा कीटपालन में भिन्न-भिन्न आयु (24-27 घन्टे) के अंडे के 15 दिनों तक कम तापमान 7 डी..सा.ग्रा. तथा 75-85 % आर.एच. में कोई प्रतिकूल प्रभाव पड़े बिना संरक्षित किये जा सकते है तथा विकसित प्रौद्योगिकी से थोक आपूर्ति और समकालिक अंडे सत्रों में बड़े पैमाने पर वाणिज्यिक जिजागारू में की सुविधा उपलब्ध होगी।
- मूगा रेशम के कीटों के अधिक उपज क्षमता विकसित नस्ल सी.एम.आर.-1 में 166 में औसत उपजाऊपन (संख्या) तथा 72.28 में अंडे स्पूटन (%) पाये गये जो कि नियंत्रण की तुलना में क्रमशः 155 उपजाऊपन व 68.38 अंडे स्पूटन है। नस्ल सी.एम.आर.-2 में 164 में औसत उपजाऊपन (संख्या) तथा 70.12 में अंडे स्पूटन (%) पाये गये जो कि नियंत्रण की तुलना में

क्रमशः 155 उपजक्रपन व 68.38 अं स्पूटन पाए गए और इन नस्लक मल्टीलक्शनल परीक्षण कियजरहहै।

- मूगरक्षाम कीट क ंत माईक्रफ्लरक कृति विज्ञान और जैवरसायन क तौर पर लक्षण वर्णन कियगयहै। सस हतर cellulose, lipase और antagonistic gut-bacteria क क्रमशः *Bacillus cereus* strain MGB011, *Bacillus stratosphericus* strain MGB05 and *Bacillus atrophaeus* strain MGB14 करूप में पहचान की गई।
- मूगरक्षाम कीड़ों ंत-microflora कृति विज्ञान और biochemically विशषता थ। सस कुशल Cellulase, lipase और विरोधी पद बैक्टीरिय करूप में *Bacillus cereus* strain MGB011, *Bacillus stratosphericus* strain MGB05 और *Bacillus atrophaeus* strain MGB14 क्रमश: पहचान की गई। लभकारी पद क बैक्टीरियभागीरी कउपचर औसत लर्व वजन 10.3%, पुरुष कक्रून वजन स5.9%, महिलकक्रून वजन स14.35%, पुरुष खान वजन स10.34%, महिलखान वजन स17.34% स पुरुष एस र 5.62% की वृद्धि हुई महिल एस र नियंत्रण (इलज रक्षाम कीड़ों) की तुलनमें 3.43% और 27.2% सERR द्वर।
- भरत क उत्तर-पूर्वी रज्यों क चयनित इकलन क प्राथमिक माजवान हतर पध(*Litsea monopetala* – Soalu; *Persea bombycina* - Som) सम्ग पारिस्थिति तंत्र कसथ जुड़ कीट जीव कसंग्रह करनक्लिए सर्वेक्षण कियगय।
- भरत क उत्तर-पूर्वी रज्यों क चयनित इलक्षों प्राथमिक भौज्य पौधों अर्थात (*Litsea monopetala* – Soalu; *Persea bombycina* - Som) सम्ग पारिस्थितिकी तंत्र कसथ जुड़ कीट जीव क संग्रह क लिए सर्वेक्षण कियगय। कीट क चर समूहों अर्थात Coleoptera, Lepidoptera, Hemiptera, Hymenoptera एकत्र किए गए। मूग पारिस्थितिकी तंत्र कसथ जुड़कीट जीव क970 नमूनों की तस्वीर प्रविष्टि तैयर की गई। प्रजतियों और जीनस स्तर तक सौ और तीन प्रजतियों की पहचान की गई और इसक परिवर और जीनस स्तर पर अन्य नमूनों पहचान की गई।
- 800 सअधिक कृसकों की उपस्थिति में जगरूकत कुशल प्रशिक्षण प्रर्शनी तथ समूह चर्च परिचर्च जैसक्रयक्रमों क जरिए एरी सी 2 कअधिक जनप्रियकरण तथ इसअपनाक्रयक्रम यजन कर 1 लख सअधिक सी2 नस्ल करग मुक्त चकत पूर्तित कियगय।
- मूगरक्षामकीट कसंक्रमण करनवलतीन तीन बैक्टीरियल रग ज़नक़ों क 16SrDNA क अनुक्रमण कमध्यम सपहचान की गई। *Lysinibacillus shaericus, Serrtia marcescens* और उर casseliflavus करग जनक करूप में पहचान की गई।
- मूग खाद्य पौध तथ मूगरक्षामकीट क पीड़क व रगों क लिए पूर्वानुमान और पूर्व चवानी लवानी प्रणली विकसित कियगयहै। इस संध में वर्ष 2015-2016 कौरान 71030 रक्षाम कृषकों कअसमीय भषमें 20 और अंग्रजी भषमें- 8 संश भजज चुकहैं।
- पकएरी रक्षाम कीटों कचढ़नक्लिए लकड़ी कसिमटनमट्टी कप्रकर कमटज तैयर किय गयहै ज जनी की तुलनमें एक मिनट में मिनट कखिलफ 100 कक्रून/मिनट) कम समय

लक्षण है।इस मॉडल का आकार 90 x 60 सी.एम. है। इस 99% कारगर प्राप्ति के साथ 500 पके कीटों का उत्पादन के लिए मॉडल किया जा सकता है। इस मॉडल का प्रति 5-6 खाद्य पौधा के लिए उपयोग किया जा सकता है।

- मूंग रोग कीटों का आनुवंशिक संसाधनों के लिए जी.सी.सी., अलग-थलग, वांछित गुण हिल्स, मणिपुर में स्वस्थाने ठ वन्य आनुवंशिक संसाधनों अनुरक्षण किया जा रहा है।

रोग उत्पादन विस्तार

- वर्ष 2015-2016 के दौरान मूंग और एरी संवर्धन की प्रौद्योगिकियों का प्रसार के लिए मूंग का 4 (चार) और एरी का 4 (चार) एस.एम.वी. की स्थापना की गई तथा प्रत्यक्ष एस.एम.वी में 100 लाभार्थियों शामिल किए गए। इसके अतिरिक्त 62 लाभार्थियों का शामिल करते हुए एक पीसीटी एस.एम.वी स्थापित किया गया। इससे किसान का बीच कारगर उत्पादन,कच्चा रोग उत्पादन और आय प्राप्त करने के संबंध में सुधार देखा गया। वर्ष 2015-16 के दौरान कीटपालन का कार्य में हुए संचयी प्रभाव आकलन से पता चला कि कारगर उत्पादन का स्तर पर मूंग एस.एम.वी. में 28.0% और एरी एस.एम.वी. में 40.8% कारगर उत्पादन में बढ़ोतरी हुई है।
- मूंग संवर्धन का एकीकृत प्रौद्योगिकी पैकेज का प्रौद्योगिकी स्थानांतरण कार्यक्रम (टीओटी) का अधीन 508 किसानों का शामिल किया गया। मूंग संवर्धन का एकीकृत प्रौद्योगिकी पैकेज तथा भिन्न-भिन्न मूंग एफ.एफएस. में प्रक्षेत्र स्तर पर प्रमुख कृषकों का जीविका व्यावहारिक प्रशिक्षण पर प्रदर्शनी कार्यक्रम आयोजित किया गया। प्रभाव आकलन परिणाम से पता चला कि कृषकों द्वारा नवीनतम प्रौद्योगिकियों का अपनाने पर <u>प्रति</u> रोग मुक्त चकत्ते से 50-61 मूंग का से उत्पादन में वृद्धि परिलक्षित हुई है।
- एरी संवर्धन का एकीकृत प्रौद्योगिकी पैकेज का 3 (तीन) भिन्न-भिन्न एरी एफ.एफएस. में प्रक्षेत्र स्तर पर 300 प्रमुख कृषकों का जीविका व्यावहारिक प्रशिक्षण पर प्रदर्शनी कार्यक्रम आयोजन किया गया। प्रभाव आकलन परिणाम से पता चला कि कृषकों द्वारा नवीनतम प्रौद्योगिकियों का अपनाने पर प्रति 100 रोग मुक्त चकत्ते 7.5 कि.ग्रा. से 9.50 कि.ग्रा. औसत एरी कारगर (भार) उत्पादन में वृद्धि अर्जित किया गया है।
- संस्थान में 4143 किसानों प्रौद्योगिकियों सही मॉडल गांवों और संस्थान में आयोजित विभिन्न प्रशिक्षण कार्यक्रमों का कार्यान्वयन का माध्यम मूंग और इरी संस्कृति पर संस्थान द्वारा विकसित का साथ अवगत था।
- संस्थान द्वारा मूंग व एरी संवर्धन पर का जरिए 4143 किसानों प्रौद्योगिकियों सही मॉडल गांवों और संस्थान में आयोजित विभिन्न प्रशिक्षण कार्यक्रमों का कार्यान्वयन का माध्यम मूंग और इरी संस्कृति पर संस्थान द्वारा विकसित का साथ अवगत था।

- संस्थान द्वारा वर्ष 2016 के दौरान ई ईई, गुवाहाटी में दिनांक 25 व 26 फरवरी, 2016 को 'मूंग और एरी रोग की समस्याओं तथा उसकी की संभावनाओं' पर अंतरराष्ट्रीय सिम्पोजियम का आयोजन किया गया।

- संस्थान में एक कृषिमहा, 12 प्रौद्योगिकी जागरूकता कार्यक्रम, 12 क्षेत्र दिवस तथा ग्रामवगों के साथ 10 समूह वार्ता चर्चा का आयोजन किया गया।

मानव संसाधन विकास

- 480 लाभार्थियों का शामिल कर 6 दिवस का कृषक कुशल प्रशिक्षण, 100 लाभार्थियों का शामिल कर 3 दिवस का कृषक कुशल प्रशिक्षण, 30 किसानों का शामिल कर एन.ई.ए.एम. द्वारा प्रायोजित प्रशिक्षण कार्यक्रम, सी.एस.एस.-सी.आई.टी. का अन्तर्गत 24 कृषकों का लिए तकनीकी अभिविन्यास प्रशिक्षण कार्यक्रम तथा 16 एस.ओ/एस.ए. का अभिविन्यास प्रशिक्षक्षण कार्यक्रम आयोजित किया गया। इसका अतिरिक्त संस्थान द्वारा एस.एम.वी. व एफ.एफ.एस.का अन्तर्गत लाभार्थियों का लिए प्रशिक्षण कार्यक्रम का आयोजन किया गया। ग्राम उत्पादन विभाग, उत्तर प्रदेश द्वारा प्रायोजित कृषक प्रशिक्षण कार्यक्रम, आर.एस.पी. का पुनश्चर्या प्रशिक्षण तथा केन्द्रीय ग्राम आयोग का युवक वैज्ञानिकों का नींव प्रशिक्षण प्रदान किया गया।
- संस्थान में दिनांक 21 से 23 मार्च, 2016 तक "कीटों में संक्रामक रोगों का नियंत्रण का लिए उन्नत तकनीक" पर एक राष्ट्रीय स्तर की कार्यशाला-सह-प्रशिक्षण कार्यक्रम आयोजित किया जहां 31 वैज्ञानिकों/ विद्वानों/विभिन्न संगठनों से छात्रों ने भाग लिया।
- संस्थागत आयातित हा परियोजना का तहत "विविधता, अन्वेषण, वर्गीकरण और प्रबंधन पर एक कार्यशाला शल्कपंखी कीड़ों का लिए उन्नत उपकरणों और तकनीक कार्यक्रम आयोजन किया गया। एक प्रदर्शन और एक जागरूकता कार्यक्रम का आयोजन किया जिसमें संस्थान का निकट स्थित सकूल और कॉलेज का 225 छात्रों ने भाग लिया।

भूमि उपयोग कार्यक्रमों -

- मांग का अनुसार 6000 साम और 6400 का सार नवाभि पौधा पूर्तित किए गए।
- वाणिज्यिक उद्देश्य का लिए 1497 मूगा राग मुक्त चकता तथा बीज फसलों उद्देश्य का लिए 2384 राग मुक्त चकता कीटपालन किया गया जिससा 39,918 वाणिज्यिक का सा और 61,501 बीज का सा का उत्पादन हुआ।
- 441 एरी राग मुक्त चकता का कीटपालन किया और इस तरह 33.6 कि.ग्रा. एरी का सा उत्पादन हुआ।
- 19,917 मूगा व एरी राग मुक्त चकता और 3915 एरी राग मुक्त चकता उत्पादित और आपूर्तित किए गए।

बुनियादी ढांचा का विकास और दूसरों-

- कीट भंडार का रखरखाव किया जा रहा है।
- वीडियो कॉन्फ्रेंस रूम स्थापित किया गया।

- संस्थान में हाई स्पीड नेशनल नॉलेज नेटवर्क (एन.के.एन.) इंटरनेट कनेक्शन संस्थान में प्रदान किया गया है।
- मुख्य कार्यालय तथा प्रशिक्षण भवन में 5 सी.सी.टी.वी. कैमरा संस्थापित किया गया ताकि सुरक्षा कार्मिक का समय का घटाया जा सकता है।
- केन्द्रीय राजभाषा कार्यान्वयन समिति की सभी कर्मचारियों तथा इसके परिवार के सदस्यों के लिए ब्लड ग्रूप कार्ड तैयार किया गया है।
- एम किसान पार्टेल के लिए 1000 किसान कार्ड तैयार किया गया है।
- अक्टूबर, 2015 के दौरान ई.एस.ओ **ISO 9001: 2008 प्रमाण पत्र** का नवीकरण किया गया।
- नवम्बर, 2015 के दौरान क्षेत्रीय मूग अनुसंधान केन्द्र, बोको ई.एस.ओ **ISO 9001: 2008 प्रमाण पत्र** प्राप्त किया है।

प्रकाशन:

- संस्थान द्वारा सी.एम.ई. आर.टी. ई. सीकॉल्चर न्यूज (अंग्रेजी), हिन्दी न्यूज लेटर (दो अंक), वार्षिक प्रतिवेदन 2014-2015, 2 (दो) इक्स्टेंशन मैन्यूअल, 11 (ग्यारह) लीफलट/टेक्निकल बुलेटिन तथा 3 (तीन) पुस्तक/मैन्युअल प्रकाशित किया गया। इसके अलावा, संस्थान के वैज्ञानिकों ने प्रतिष्ठित पत्रिकाओं में 7 (सात) शोध लेख और 32 शोध लेख विभिन्न सेमिनार /सम्मेलन कार्यशाला की कार्यवाही में 32 अनुसंधान शोध प्रकाशित किया है।

क्षेत्रीय राजभाषा उत्पादन अनुसंधान केन्द्रों में उपलब्धियां

क्षेत्रीय मूगा अनुसंधान केन्द्र, बोको, असम

- क्षेत्रीय मूग अनुसंधान केन्द्र, बोको में साल साल की S3 और S6 मारफोटाइप को बड़ापैमाना में गुणन किया जा रहा है ताकि उसा प्रक्षेत्र में पूर्ति की जा सकें। वर्ष के दौरान साल का S3 और S6 के 25600 नन्हे पौधो की पूर्ति की गई है।
- केन्द्र में एक कृषिमेला, 3 (तीन) प्रौद्योगिकी जागरूकता कार्यक्रम, 3 (तीन) प्रक्षेत्र दिवस और राजभाषा विभाग के साथ 10 समूह चर्चा/वार्ताए आयोजित किया गया।
- 314 किसानों को शामिल कर 6 दिन के लिए किसान कौशल प्रशिक्षण आयोजन किया गया।
- 760 वाणिज्यिक मूग बीएफएलएस और 2576 बीज फसलों के कीटपालन किया गया जिससे 28557 वाणिज्यिक कोसे और 8955 बीज कोसे उत्पादित हुए ।
- 11240 मूग बीएफएलएस उत्पादित कर मांग के अनुसार 8974 बीएफएलएस की पूर्ति की।

क्षेत्रीय एरी अनुसंधान केन्द्र, मेन्दिपथार, मेघालय

- "एरी संवर्धन में □हतर तकनीकों और कौशल विकास अपन□कर किसानों की सामाजिक-□ थिक स्थिति में उत्थान" नामक अनुसंधान परियोजन□की मंजूरी अनुसंधान सलाहकार समिति द्वार□ □ान□क□□ उस□ गा□क□अनुमो□न हा□ु ी.एस.टी., नई □ि□ल्ली क□भाज□गय□।
- क□न्द्र में एक कृषिमा□□, 4 प्रौद्य□गिकी जा□गरूकत□कार्यक्रम, 4 क्षा□ क□ि□वस और रा□ामवि□ों क□ सा□थ 7 समूह चर्चा/ वार्ता□ए □ य□जित किय□गय□।
- 240 किसानों क□शा□मिल कर 6 □ि□न क□किसान कौशल प्रशिक्षण □ य□जन किय□गय□।
- 7500 क□सारू पौधा□उगा□ए गए तथ□मांग क□अनुसार 43 किल□अरंी □ीज और 7100 क□सारू क□ पौधा□□ पूर्तित किय□गय□।
- 500 एरी □ीएफएलएस कीटपा□न कर उससा□3.7 किल□एरी क□स□उत्पा□ित हु□ ।
- 9845 एरी □ीएफएलएस उत्पा□न कर मांग क□अनुसार 9345 □ीएफएलएस □ पूर्तित किय□गय□।
- क□न्द्र क□ प्रौद्य□गिकी अपना□ा□क□कार्यक्रम क□ जरिए एरी संवर्धन पर संस्था□न द्वार□ विकसित की गई प्रौद्य□गिकिया□ क□सन□र्भ में 100 कृषकों क□अवगत किय□गय□।

क्षा□ीय एरी अनुसंधान क□न्द्र ,शादनगर ,आन्ध्र प्रदश

- क□न्द्र में " अर्द्ध शुष्क क्षा□ में □ारिश सा□सिंचित स्थिति में एरी रा□ाम क□कीड़ों (सा□मिय□ रिसिनी □ा□ान) कीटपा□न तथ□ क□स्तर खाद्य पौध□ जीनाटाइप (***Ricinus communis*** **Linn.)** सं□ंधी का□स□निर्मा□ण" नामक परियोजन□समा□प्त ह□गयी तथ□इसक□निष्कर्ष निका□ल□गय□और और इसकी अंतिम रिपार्ट केंद्रीय कार्या□लय क□भाजी गई। भविष्य में इसकी □ गा□की कार्रवाई क□ सं□ंध में,

  चयनित अरंी जीनाटाइप क□मल्टीलाकेशन (**multilocational**) परीक्षण हा□ु सुझाव □िय□गय□ है।
- □ ंध्र प्रा□ा क□अर्द्ध शुष्क परिस्थितियों में एरी पारिस्थितिक प्रजा□ति एस.□ र. 025 क□क्षा□ परीक्षण क□लिए यो□जन□□नाई है।
- 50 कृषकों क□शा□मिल कर 3 □ि□न की अवधि क□लिए कृषक कौशल प्रशिक्षण □ य□जन किय□ गय□।
- क□न्द्र में 2 प्रौद्य□गिकी जा□गरूकत□कार्यक्रम, 3 प्रक्षा□ □िवस और रा□ामवि□ों क□सा□थ 6 समूह चर्चा/ वार्ता□ए □ य□जित किय□गय□।
- 200 रा□ा मुक्त चकत□ाकीटपा□न किय□गय□और उससा□35 किल□एरी क□स□उत्पा□ित हु□ ।
- 200 एरी रा□ा मुक्त चकत□ाकीटपा□न किय□गय□तथ□मांग क□अनुसार इसकी □ पूर्ति की गई।

अनुसंधान एवं विस्तार क□न्द्रों की उपलब्धियाः

अनुसंधान एवं विस्तार केंद्र, कूचबिहार

- अनुसंधान एवं विस्तार केंद्र,कूच□िहार में एक कृषिमा□□, 4 प्रौद्य□गिकी जा□गरूकत□कार्यक्रम, 4 क्षा□ □िवस और रा□ामवि□ों क□□ीच 8 समूह चर्चा□की गई।

- 150 कृषकों क□ श□मिल कर 6 □न अवधि क□ लिए किस□न कौशल प्रशिक्षण □ य□जित किय□ गय□।
- 5000 स□म /स□व□लू नव□ □भि□ पौध□/ पौध□□गए गए और 3000 स□म नव□ □भि□ पौध□□ पूर्ति की गई।
- 530 व□णिज्यिक मूग□ □ी.एफ.एल. और 600 □ीज फसलों कीटप□लन किय□ गय□ तथ□ जिसस□ 5600 व□णिज्यिक क□स□और 6538 □ीज क□कून क□उत्प□□त हु□ ।
- 1400 मूग□□ी.एफ.एल. उत्प□□त किय□गय□तथ□मां□ग क□अनुस□र 1320 □ी.एफ.एल □ पूर्ति की गई।

अनुसंधान एवं विस्तार केंद्र,तुरा

- क□न्द्र में 2 प्रौद्य□गिकी ज□गरूकत□ कार्यक्रम, 2 क्ष□व □वस और और रश्□ामवि□ों क□स□थ 7समूह चर्च□/ व□र्ल□ए □ य□जित किय□गय□।
- 51 कृषकों क□ श□मिल कर 6 □न की अवधि क□ लिए कृषक कौशल प्रशिक्षण □ य□जित किय□ गय□।
- 5000 स□म स□म / स□व□लू नव□ □भि□ पौध□/फौध□□गए गए तथ□ उसस□3000 स□म नव□ □भि□ पौध□ □ पूर्तित किए गए।
- □ीज फसल क□ लिए 1000 मूग□ □ी.एफ.एल.कीटप□लन किय□ तथ□ इसस□27,064 □ीज क□स□ उत्प□□त हु□ ।
- 2145 मूग□□ी.एफ.एल उत्प□□त किय□गय□तथ□यथ□मां□ग 2045 □ी.एफ.एल □ पूर्ति की गई।

अनुसंधान एवं विस्तार केंद्र,लखीमपुर

- क□न्द्र में 2 प्रौद्य□गिकी ज□गरूकत□ कार्यक्रम, 3 क्ष□व □वस और रश्□ामवि□ों क□स□थ 5 समूह चर्च□/ व□र्ल□ए □ य□जित किय□गय□।
- 90 किस□नों क□ श□मिल करत□हूए 6 □न की अवधि क□लिए कृ□यक कौशल प्रशिक्षण क□□ य□जन किय□गय□।
- 5000 स□म/स□व□लू क□नव□ □भिध पौध□/मौध□□गए गए और यथ□मां□ग 263 □ी.एफ.एल □ पूर्ति की गई।
- 320 व□णिज्यिक मूग□ □ी.एफ.एल. और □ीज फसल क□ लिए 297 □ी.एफ.एल कीटप□लन किय□ गय□। इस स□1295 व□णिज्यिक □ी.एफ.एल 2352 □ीज क□स□□ी.एफ.एल क□उत्प□□न हु□ ।
- □ वश्यकत□क□अनुस□र 553 मूग□□ी.एफ.एल .उत्प□□त किय□गय□।

अनुसंधान एवं विस्तार केंद्र,कोकराझार

- 1 प्रौद्य□गिकी ज□गरूकत□ कार्यक्रम,1 क्ष□व □वस और रश्□ामवि□ों क□स□थ 6 समूह चर्च□/ व□र्ल□ए □ य□जित किय□गय□।
- 200मूग□व□णिज्यिक □ी.एफ.एल .कीटप□लन किय□और उसस□3903 व□णिज्यिक क□स□उत्प□□त हु□ ।

अनुसंधान एवं विस्तार केंद्र,फतहपुर

- 3 प्रौद्यगिकी जागरूकत कार्यक्रम, 2 क्षत्र दवस और रशामवदों क साथ 7 समूह चर्चा/ वार्साए य जित कय गय।

अनुसंधान एवं विस्तार केंद्र,दिफू

- 2 प्रौद्यगिकी जागरूकत कार्यक्रम, 1 क्षत्र दवस और रशामवदों क साथ 4 समूह चर्चा/ वार्साए य जित कय गय।
- यथ मांग 18 किल अरंडी क बीज पूर्ति की गई।
- 150 डी.एफ.एल. कीटपालन किय गय तथ इससे 7.9 किल एरी क स उत्पादन किय गय।
- 2000 एरी डी.एफ.एल. उत्पादित किय गय तथ यथ मांग 1398 डी.एफ.एल पूर्ति की गई।

HIGHLIGHTS OF ACHIEVEMENTS (2015-16)

The Central Muga and Eri Research & Training Institute, Lahdoigarh, Jorhat along with its network of nested Research stations & units viz., RMRS, Boko; RERS, Shadnagar; RERS, Mendipathar and RECs located at Lakhimpur, Coochbehar, Tura, Diphu, Kokrajhar and Fatehpur provides R& D support in muga and eri sectors for the development of the industries. During 2015-16, 4 CSB funded, 4 DBT funded and 5 DST funded research projects under different categories viz., environmental challenges and global warming, drudgery reduction & women friendly technologies and eco-friendly & organic farming were undertaken at the institute and its regional stations, out of which 8 projects were concluded, and 5 projects are being continued. Moreover, 2 projects have been newly approved by CSB and 1 by DBT. In addition, 2 regular programmes, extension communication programmes like Field day, Krishi mela, Awareness programmes, Transfer of Technologies programmes and Training programmes were conducted at the institute during the period under report. The major achievements in Research at CMER&TI, Lahdoigarh are as follows:

Host Plant Improvement, Production and Protection

- A consortium of rhizobacteria isolated from rhizospheric soil of castor growing in wild condition at different parts of Assam were identified as potential biofertilizer. From this consortium, an INM formulation /package has been developed which can reduce 50% of the recommended inorganic NPK dose in castor cultivation.
- *Ailanthus grandis* (Borpat) has been identified as the best perennial host plant based on biomass production, bioassay, biochemical and nutritional analysis of leaves for eri silkworm rearing. *A. excelsa* (Borkesseru) is also performing well and can be utilized. Field trials have been conducted in Borpathar (Golaghat), Nagajangka & Morangial (Jorhat) and Barekuri (Tinsukia) covering 250 farmers for popularization of *Ailanthus grandis* in eri silkworm rearing. The average cocoon shell yield recorded as 11.83 kg /100 dfls with single shell weight of 0.51g and single cocoon weight of 3.47g.

- Three Kissan nurseries have been developed in three SMVs namely Dadhara, Tamulisiga, Barekuri for mass multiplication of *Ailanthus grandis*. Mising Autonomous Council has initiated mass plantation of Borpat for utilization in ericulture.
- Castor genotypes were evaluated based on growth parameters, physiological parameters, chemoassay and bioassay at RERS, Shadnagar and identified suitable genotype for semi-arid conditions of Andhra Pradesh.

Silkworm improvement, Production and Protection

- Muga egg preservation schedule has been developed by which 48 hr old embryos can be preserved at low temperature (7 ˚C) for 20 days without any adverse effects on hatching. Eggs of mix ages (24-72 hr) can also be preserved at 7^{o} C and 75-85 % R.H. up to 15 days without any adverse effect on hatching and rearing performance. Developed technology will facilitate large scale commercial grainage for bulk supply of eggs and synchronized hatching.
- Developed high yielding breed of muga silkworm, CMR-1 showed average fecundity (nos.) of 166 and hatching (%) of 72.28 against 155 and 68.38 respectively, in control. The breed, CMR-2 showed average fecundity (nos.) of 164 and hatching (%) of 70.12 against 155 and 68.38, respectively in control. Multilocational trials of the breeds are under progress.
- Muga silkworm gut-microflora were morphologically and biochemically characterized. The most efficient cellulase, lipase and antagonistic gut-bacteria were identified as *Bacillus cereus* strain MGB011, *Bacillus stratosphericus* strain MGB05 and *Bacillus atrophaeus* strain MGB14, respectively. Treatment of beneficial gut bacteria consortia increased average larval weight by 10.3 %, male cocoon weight by 5.9 %, female cocoon weight by 14.35 %, male shell weight by 10.34 %, female shell weight by 17.34 %, male SR by 5.62 %, female SR by 3.43 % and ERR by 27.2% in comparison to the control (untreated silkworms).
- The selected localities of North-eastern states of India were surveyed for collection of Insect Fauna associated with muga ecosystem from two primary host plants (Som-*Persea bombycina*, Soalu - *Litsea monopetala*). Four groups of insect's *viz*., Coleoptera, Lepidoptera, Hemiptera, Hymenoptera were collected. Database entry was made for 970 specimens of Insect fauna associated with muga ecosystem. Two hundred and three species were identified up to species and genus level. Other specimens were identified upto family and genus level.
- Large scale popularization and adoption of eri C2 breed was conducted among more than 800 farmers through Awareness programme, Skill training, Demonstration and Group discussion and supplied more than 1 lakh quality C2 breed dfls. The eri silk production and productivity has been improved by 32 %
- Three bacterial pathogens were identified causing diseases of muga silkworm through sequencing of the 16SrDNA. Pathogens are identified to be *Lysinibacillus shaericus*, *Serrtia marcescens* and *Enterococcus casseliflavus.*
- Forecasting and forewarning system for pests and diseases of muga host plants and silkworm have been developed. During 2015-16, 28 messages (20 Assamese and 8 English) have been sent to 71030 farmers.
- A new wooden collapsible strip type mountage for mounting ripened eri silkworm. It takes very less time for harvesting (100 cocoons / minute against 10 cocoons /minute in jali). In 90 x 60 cm size montage, around 500 ripened worms can be mounted for cocoon formation with 99% cocoon recovery. The mountage can be used for 5-6 plants.
- For conservation of genetic resources of muga silkworm, eight wild genetic resources are being maintained under e*x-situ* condition at GCC, Damalgre, West Garo Hills, Meghalaya.

Sericulture Extension

- For dissemination of technologies in muga and eri culture, 4 muga and 4 eri SMV with 100 beneficiaries in each SMV and one PCT SMV covering 62 beneficiaries were implemented during 2015-16. Improvement was noticed in respect of cocoon production, raw silk production and income generation among the farmers. Cumulative impact assessment from the rearing performance during 2015-16, revealed that level of cocoon production is enhanced by 28.0 % in Muga SMV and 40.8% in Eri SMVs.
- Under Transfer of Technology (TOT) programme on Integrated Technology Package of muga culture, 508 farmers were covered. Demonstration programmes on integrated technology package of muga culture and on job practical training at the field of Lead farmers in 4 different muga FFS were conducted. Impact assessment result showed that adopting the latest technologies by the farmers, average muga cocoon yield was increased from 50 to 61 cocoons per dfl.
- 300 farmers were covered in the demonstration programmes on Integrated Technology Package of eri culture and on job practical training at the field of Lead farmers in 3 different eri FFS. Impact assessment result showed that adopting the latest technologies by the farmers, average eri cocoon (shell) yield was increased from 7.5 kg to 9.50 kg per 100 dfls.
- 4143 farmers were sensitized with the technologies developed by the institute on muga and eri culture through implementation of Seri Model villages and different training programmes organized at the institute.
- Institute organized a National Seminar 'Problems & prospects of muga and eri silk sectors' at IIE, Guwahati during 25-26th February, 2016.
- Institute conducted one Krishimela, 12 Technology Awareness Programmes, 12 Field day and 10 Group Discussions among the sericulturists.

Human Resource Development

- A total of 3571 beneficiaries were trained on different seri- technologies under different Training Programmes. Organized Farmers skill training of 6 days duration covering 480 farmers, Farmers skill training of 3 days duration covering 100 farmers, NIAM sponsored training programme covering 30 farmers, Tech. Orientation Programme for 24 farmers under CSS-CBT and conducted Orientation training to 16 SOs/SAs. Further, the institute organized training for the beneficiaries under SMVs & FFS, Farmers Training Programme sponsored by DOS-UP, Refresher Training Programme to RSPs and Foundation Training to CSB Young Scientists.
- Organized one national level workshop cum training programme on "Advanced diagnostic techniques of infectious diseases in insects" was organized at the institute during 21st -23rd March, 2016 where 31 scientists / scholars/ students from different organizations participated.
- Under Institutional Biotech Hub project, one workshop on "Diversity, exploration, Taxonomy and management: Advanced tools and techniques for Lepidopteran insects was organized Two demonstration and one awareness programmes were conducted and 225 nos. of students from nearby School and Colleges participated

Land utilization programmes

- Supplied 6000 Som and 6400 nos. of kesseru seedlings as per demand.
- Reared 1497 muga dfls as commercial and 2384 dfls as seed crops. Thereby produced 39918 commercial cocoons and 61501 seed cocoons.
- Reared 441 eri dfls and thereby produced 33.6 kg eri cocoons.
- Produced and supplied 19917 muga and 3915 eri dfls

Infrastructure development & others

- Insect Repository is being maintained.
- Video conference room has been established

- High speed National Knowledge Network (NKN) internet connection has been provided in the institute.
- Five CCTV camera have been installed in the main office & training campus to bring down the no. of security guards.
- Data base on the Blood Group of all CSB employees and their family members has been prepared.
- Created 1000 farmers database for m-Kisan Portal
- Renewed ISO 9001: 2008 certificate for the institute during October, 2015
- Received ISO 9001: 2008 certificate for RMRS, Boko during November, 2015

Publications:

- The institute published 2 issues of CMERTI Sericulture News (English) and 2 issues of Hindi newsletters, Annual Report for 2014-15, 2 extension manual, 11 nos. of leaflets / technical bulletins and 3 nos. of books / manuals. Besides, the scientists of the institute published seven research articles in reputed journals and 32 research articles in the proceedings of various seminar/conference/workshop.

Achievements of Regional Sericultural Research Stations

Regional Muga Research Station, Boko, Assam

- S3 and S6 morphotypes of som are being multiplied in large scale at RMRS, Boko for supply to the field. 25600 saplings of S3 and S6 morphotypes of som have been supplied during the year.
- Conducted one Krishimela, 3 Technology Awareness Programmes, 3 Field day and 10 Group Discussions among the sericulturists.
- Organized Farmers skill training of 6 days duration covering 314 farmers.
- Reared 760 muga dfls as commercial and 2576 dfls as seed crops. Thereby produced 28557 commercial cocoons and 8955 seed cocoons.
- Produced 11240 muga dfls and supplied 8974 dfls as per demand.

Regional Eri Research Station, Mendipathar, Meghalaya

- One Research Project entitled “Socio-economic upliftment of farmers through adoption of improved technologies and skill development in eri culture” was approved by RAC and sent to DST, New Delhi for approval.
- Conducted one Krishimela, 4 Technology Awareness Programmes, 4 Field day and 7 Group Discussions among the sericulturists.
- Organized Farmers skill training of 6 days duration covering 240 farmers.
- Raised 7500 kesseru seedlings supplied 43 kg castor seeds and 7100 nos. of kesseru seedlings as per demand.
- Reared 500 eri dfls and thereby produced 33.7 kg eri cocoons
- Produced 9845 eri dfls and supplied 9345 dfls as per demand.
- 100 farmers were sensitized with the technologies developed by the institute on eri culture through technology adoption programme of the station.

Regional Eri Research Station, Shadnagar, AndhraPradesh

- One Research Project entitled “Eri silkworm (*Samia ricini* Donovan) rearing and cocoon production in relation to host plant castor genotypes (*Ricinus communis* Linn.) raised under rain-fed conditions in semi-arid region” was concluded and Final report was sent to Central Office. As a future course of Action, multilocational trials of the selected castor genotypes have been suggested.
- Planned for field trial of eri eco race SR-025 at semi-arid conditions of Andhra Pradesh.
- Organized Farmers skill training of 3 days duration covering 50 farmers
- Conducted 2 Technology Awareness Programmes, 3 Field day and 6 Group Discussions among the sericulturists.

- Reared 200 eri dfls and thereby produced 35 kg eri cocoons.
- Produced and supplied 200 eri dfls as per demand

Achievements of Research & Extension Centres

Research & Extension Centre, Coochbehar
- Conducted one Krishimela, 4 Technology Awareness Programmes, 4 Field day and 8 Group Discussions among the sericulturists.
- Organized Farmers skill training of 6 days duration covering 150 farmers.
- Raised 5000 som / soalu seedling /sapling and supplied 3000 nos. of som seedlings
- Reared 530 muga dfls as commercial and 600 dfls as seed crops. Thereby produced 5600 commercial cocoons and 6538 seed cocoons.
- Produced 1400 muga dfls and supplied 1320 dfls as per demand.

Research & Extension Centre, Tura
- Conducted 2 Technology Awareness Programmes, 2 Field day and 7 Group Discussions among the sericulturists.
- Organized Farmers skill training of 6 days duration covering 51 farmers.
- Raised 5000 som / soalu seedling /sapling and supplied 3000 nos. of som seedlings
- Reared 1000 muga dfls as seed crop and produced 27064 seed cocoons.
- Produced 2145 muga dfls and supplied 2045 dfls as per demand.

Research & Extension Centre, Lakhimpur
- Conducted 2 Technology Awareness Programmes, 3 Field day and 5 Group Discussions among the sericulturists.
- Organized Farmers skill training of 6 days duration covering 90 farmers.
- Raised 5000 som / soalu seedling /sapling and supplied 263 nos. of som seedlings
- Reared 320 muga dfls as commercial and 297 dfls seed crop and thereby produced 1295 commercial 2352 seed cocoons.
- Produced 553 muga dfls as per requirement

Research & Extension Centre, Kokrajhar
- Conducted 1 Technology Awareness Programmes, 1 Field day and 6 Group Discussions among the sericulturists.
- Reared 200 muga dfls as commercial and thereby produced 3903 commercial cocoons.

Research & Extension Centre, Fatehpur
- Conducted 3 Technology Awareness Programmes, 2 Field day and 7 Group Discussions among the sericulturists.

Research & Extension Centre, Diphu
- Conducted 2 Technology Awareness Programmes, 1 Field day and 4 Group Discussions among the sericulturists.
- Supplied 18 kg Castor seeds as per demand.
- Reared 150 eri dfls and thereby produced 7.9 kg eri cocoons.
- Produced 2000 eri dfls and supplied 1398 dfls as per demand.

Achievement in infrastructure development
- Insect Repository is established at the institute and tried to maintain in coordination with the Biodiversity Board.
- Orders have been placed with CPWD for muga grainage building.
- Video conference room has been established
- For NKN internet connection, computer and other accessories have been procured

- CCTV has been installed in the campus
- Digital EPBX has been installed

Others

- Renewed ISO 9001: 2008 certificate for the institute during November, 2015.
- Received ISO 9001: 2008 certificate for RMRS, Boko during December, 2015

FINANCIAL TARGET AND EXPENDITURE

(Rupees in lakhs)

Particulars	Consolidated provision							
	Estimated budget				Actual expenditure			
	Recurring	Capital assets	Salary	Total	Recurring	Capital assets	Salary	Total
	GIA-31	GIA-35	GIA-36		GIA-31	GIA-35	GIA-36	
Non-plan	0.00	0.00	1125.53	1125.53	0.00	0.00	1125.53	1125.53
Normal plan NE	342.61	756.30	0.00	1098.91	342.61	756.30	0.00	1098.91
Plan	21.46	6.80	0.00	28.26	21.46	6.80	0.00	28.26

Total	364.07	763.10	1125.53	2252.70	364.07	763.10	1125.53	2252.70

Research Advisory Committee of CMER&TI, Lahdoigarh

Chairman

Prof. Bolin Kr. Konwar
Vice Chancellor, Nagaland University, Lumami – 798 627, Nagaland

Members

Dr. N. Muraleedharan
Director, Tocklai Tea Research Institute, Jorhat - 785008
Prof. D.K. Jha
Head, Dept. of Botany, Gauhati University, Guwahati
Dr. T.C. Bora
Scientist-G & Head,
Biotechnology Division, North East Institute of Science & Technology, Jorhat
Prof. S.K. Dutta
Dept. of Entomology, Assam Agriculture University, Jorhat, Assam.
Dr. Kailas Chandra
Scientist 'F' & Additional Director, Zoological Survey of India,
New Alipore, Kolkata-700 053
Director (HQ)
Central Silk Board, CSB, Bangalore
Director
CSTRI, Bangalore
Director of Sericulture
Govt. of Assam, Khanapara, Guwahati-781 004, Assam
Director of Sericulture
Govt. of Nagaland, Kohima
Director of Sericulture
BTAD, Bodoland Territorial Council, Kokrajhar, Assam.
Director of Sericulture
Govt. of Manipur, Project Management Complex,
Sangaipat, Imphal East, Manipur, Imphal-795 0048
Director of Sericulture
Govt. of Mizoram, Aizawl – 796 001.
Scientist – D
Muga Silkworm Seed Organization, Central Silk Board,
Dargah Road, Near Sijubari Mazar,
Hatigaon, Guwahati-781 038
Joint Secretary (Tech)
Regional Office, Central Silk Board,
Dargah Road, Near Sijubari Mazar, Hatigaon, Guwahati-781 038
Conservator of Forests
Jorhat, Assam
Sri Hema Gogoi
Muga Farmer, Bogorijeng, P.O. Pulibor, Golaghat, Assam.
Smt. Lakhimai Lahon
Eri Farmer, Borholla Grant, Titabar, Assam

Member Convener

Director, CMER&TI, Lahdoigarh, Jorhat.

ACHIEVEMENT OF THE RESULT FRAMEWORK DOCUMENT (2015-16)

#	Objectives	Wt.	#	Actions	#	Success Indicator	Unit	Rel. Wt.	Target/Criteria Value					Achievement during the quarter	Progressive total
									Excellent 100 %	Very Good 90%	Good 80%	Fair 70%	Poor 60%		
1	Conduct scientific, technical and economic research to enhance production, productivity and quality of Indian silk.	22	1	Research Projects-coded by CO	i	Total on- going Projects	No.	1	15	13	12	11	10	15	15[a]
					ii	Projects Concluded	No.	2	6	5	4	3	2	3	7[a]
					iii	Projects Initiated	No.	1	3	2	1	0	0	3	4[a]
					iv	New Projects taken up at RMRS's/RERSs	No.	2	**3**	2	1	0	0	0	0[a]
					v	No of technologies/ innovations developed	No	2	2	1	0	0	0	0	5[a]
					vi	New technologies for field testing	No	2	2	1	0	0	0	0	3[a]
					vii	Equipment / machinery newly developed for sericulture mechanization	No	2	1	0	0	0	0	1	1[a]
			2	Evaluation of improved varieties of muga and eri host plants and its disseminating to field	i	Progress of the research projects based on the pre-determined milestones	%	0.5	100	90	80	70	60	12.5	102.5[a]
					ii	High yielding / new host plant varieties evaluated	No.	2	2	1	0	0	0	0	2[a]
			3	Developing improved breeds and its dissemination to field	i	Progress of the research projects based on the pre-determined milestones	%	0.5	100	90	80	70	60	0	100[a]
					ii	Improved breeds developed	No.	2	1	0	0	0	0	0	2[a]
			4	Improvement in the productivity and quality of muga and eri silkworms	i	Progress of the research projects based on the pre-determined milestones	%	0.5	100	90	80	70	60	20.56	100[a]
					ii	Productivity improvement	%	2	12	10	8	6	4	0	32.45[b]

			5	Integrated Pest and Disease Management and its dissemination to field	i	Progress of the research projects based on the pre-determined milestones	%	0.5	100	90	80	70	60	5	100 [a]
					ii	Technologies / solutions developed	No.	2	2	1	0	0	0	0	4 [a]
2	Commercialization of products and Technologies	6	6	Sericulture technologies including chemical taken up for commercialization /patenting	i	Technologies commercialized/popularized	No.	3	14	12	10	8	6	18	18 [b]
					ii	No. of technologies patented	No.	3	1	0	0	0	0	0	0 [a]
3	Field level Interventions for Quality and productivity Improvement through Information, Education and Communication	**28**	7	Interventions through main Institutes level	i	Number of Seri-model Village identified	Number	**1**	9	8	7	6	5	9	9 [b]
					ii	No. of farmers adopted	No	**2**	850	800	750	700	650	862	862 [b]
					iii	Expected raw silk Output	MT	**2**	5.0	4.5	4.0	3.5	3.0	1.017	6.317 [a]
			8	Large scale popularization of C2 breeds	i	No. of dfls proposed for large scale popularization	Nos.	2	100000	80000	70000	60000	50000	28490	106572 [a]
			9	Interventions through RMRS/ RERS/REC level	i	Number of Blocks/Districts adopted	Number	1	7	6	5	4	3	9	9 [b]
					ii	No of farmers covered	No.	2	625	600	575	550	525	259	1442 [b]
					iii	Raw silk Output	MT	2	2.5	2.0	1.8	1.6	1.4	0.68	3.12 [a]
			10	New plantation with improved varieties	i	Popularization of improved host plant varieties among the farmers	Acres	2	200	150	125	100	90	72.3	181.13 [a]
				100 % Adoption of Technologies amongst different stake holders	**ii**	Number of farmers covers under 100% adoption of technology	Number	3	1400	1300	1250	1200	1100	451	2498 [a]
					iii	No of farmers covered under DBT	No	3	1400	1300	1200	1100	1000	415	2238 [a]
					iv	Number of FFS	Number	2	7	6	5	4	3	7	7 [b]

				Krishi Melas	v	No. of programmes conducted	No	**2**	4*	3	2	1	0	3	4[a]
					vi	No. of farmers covered	No	**2**	1250*	1050	900	800	700	1309	1709[a]
					vii	Post programme follow up	%	**2**	90	80	70	55	50	90	90[c]
	IT Initiatives	**4**	11	Development of data base and technology under IT initiatives	**i**	No. of Farmers database created for m-Kisan Portal	Number	2	1400	1300	1250	1200	1150	1000	2406[b]
					ii	Preparation of Technology descriptor adoption document	Date	2	15-05-2015	01-06-2015	15-06-2015	01-07-2015	15-07-2015	15-05-2015	15-05-2015
	Capacity Building among the stake holders	4	12	Capacity building	i	Beneficiaries trained under structured programmes, need based programme etc.	No	2	2000	1800	1600	1400	1200	1016	3571[a]
					ii	Beneficiaries placed in silk sector after training	No	2	400	350	300	250	200	0	740[a]
	Revenue Generation	4	13	Generation of funds as per XII Plan guidelines	i	Revenue generation	Rs. in lakh	4	30	28	26	24	22	15.16	28.22[a]
4	Strengthening institutional framework to support ongoing research and related programmes	5	14	Utilization of existing land holdings	i	Effective utilization of cultivable land for assigned mandates	Acres	1	45	40	35	30	25	0	55.69[a]
			15	Utilization of service buildings (laboratory, rearing house, grainages, staff quarters, hostels, guest house etc)	ii	Extent of utilization of facilities for the core purpose of assigned mandates	%	1	100	98	95	90	85	100	100[c]
			16	Optimum utilization of manpower	iii	Utilization of scientific manpower for research activities	%	1	100	98	95	90	85	100	100[c]
			17	Utilization of Grants	iv	Expenditure under Central Sector Schemes	Rs. In Crore	2	6.0	5.5	5	4.5	4	9.300	11.272[a]

5	Maintenance of breeders stock	2	18	Production & supply of nucleus seeds to basic seed farms of CSB & States for further multiplication	i	Dfls production and supply	Number of dfls	2	3200	3000	2500	2400	2300	5175	20568[a]
6	Publication of R&D innovations and package of practices for knowledge dissemination	5	19	Facilitating the scientists and the technologists to publish innovations and package of practices for wider use	i	Publication of research articles by the Institute (first author)	Number	2	30	28	26	24	22	18	34[a]
					ii	Printing and circulation of books/ manuals by the Institute (only one claimant)	Number	1	4	3	2	1	0	3	5[a]
					iii	Printing and publication of extension manuals	Number	1	2	1	0	0	0	1	2[a]
					iv	Publication of technical bulletins / leaflets	Number	1	7	5	4	3	2	11	14[a]
7	Disease forecasting & forewarning	2	20	Identify the disease occurrence in advance & forewarn the beneficiaries with remedial measures	i	Instances where such activities were undertaken	Number	2	11	10	9	8	7	0	17[a]
8	Improvement in Post Cocoon Technology	4	21	To undertake programmes for improving the post cocoon technologies of muga and eri silkworm cocoons	i	Machineries and technologies demonstrated in the field	Number	2	4	3	2	1	0	0	4[a]
					ii	Stakeholders covered for field testing	Number	2	25	20	18	15	12	0	30[a]
9	Collaborative Research Programmes with other R&D organizations in	4	22	Identifying potential R&D institutes in India and abroad and undertakes collaborati	i	Projects taken up for collaborative research	No.	4	2	1	0	0	0	1	4[a]

	India and abroad			ve research programmes for the benefit of both the countries											
10	Efficient functioning of RFD system	2	23	Timely submission of draft RFD for 2015-16	i	On time submission	Date	1	22-Apr-15	23-Apr-15	24-Apr-15	25-Apr-15	26-Apr-15	22-Apr-15	22-Apr-15
			24	Timely submission of results of 2014-15	i	On time submission	Date	1	01-May-15	02-May-15	03-May-15	04-May-15	05-May-15	4-Apr-15	4-Apr-15
11	Administrative Reform	4	25	Implement mitigating strategies for reducing potential risk of corruption	i	% of implementation	%	1	100	98	95	90	85	100	100 [c]
			26	Implement ISO 9001 as per the approved action plan.	i	Target date for renewal of ISO 9001 at Institute	Date	1	13-Oct-15	28-Oct-15	13-Nov-15	28-Nov-15	13-Dec-15	8-Oct-5	8-Oct-15
					ii	Action Plan for renewal of ISO 9001 at RMRS Boko	Date	1	22-Nov-15	07-Dec-15	22-Dec-15	07-Jan-16	22-Jan-16	16-Nov-15	16-Nov-15
			27	Identify, design and implement major innovations	i	Implementation of identified innovations	Date	1	01-May-15	02-May-15	03-May-15	04-May-15	05-May-15	01-May-15	01-May-15
12	Improving internal efficiency / responsive- ness / service delivery of the organization	2	28	Implementation of Sevottam	i	Independent audit of implementation of Citizen's charter	%	1	100	98	95	90	85	100	100
					ii	Independent audit of implementation of public grievances redressal system.	%	1	100	98	95	90	85	100	100
13	Ensuring compliance of the Financial Accountability Framework	2	29	Timely submission of ATNs on Audit paras of AG & Internal Audit	i	Percentage of ATNs submitted within due date (4 months) from date of presentation of report	%	0.5	100	98	95	90	85	100	100

			30	Timely submission of ATRs to AG & CSB, HQ.	i	Percentage of ATRs submitted within due date (6 months) from date of presentation of report	%	0.5	100	98	95	90	85	100	100
			31	Early disposal of pending ATNs on Audit paras of AG reports.	i	Percentage of outstanding ATNs disposed off during the year	%	0.5	100	98	95	90	85	100	100
			32	Early disposal of pending ATRs on AG reports.	i	Percentage of outstanding ATRs disposed off during the year	%	0.5	100	98	95	90	85	100	100
		100						**100.00**							

a-cumulative total of all the quarter; b-highest among the quarter, c-average of all quarters, * Revised target as per order issued by CBT Division, CSB, Bangalore

**** Excluding two delegated units RERS, Shadnagar and RMRS, Boko**

LIST OF THE R&D PROJECTS

Sl. No.	Project code	Title of the project	Duration	Scientists involved
CONCLUDED PROJECTS				
1.	APS - 5856	Development of egg preservation schedule in muga silkworm, *Antheraea assamensis* Helfer	April, 2011 - June, 2015	D. Goswami, N.I Singh, M.D. Senapati
2.	ARC-5864	Studies on the insect fauna associated with muga ecosystem in North East India with emphasis on the illustrated diagnostics	August, 2012 - July, 2015	R. Kumar, G. Rajkhowa
3.	AIP-5861	Molecular approaches in characterization and utilization of gut microflora from muga silkworm *Antheraea assamensis* for enhancing productivity of muga culture in North Eastern India (In collaboration with IARI, New Delhi)	June, 2012 – Oct. 2015	D.K. Gogoi, R. Kumar
4.	PRP-5862	Screening of microbial flora (potential bio-fertilizer) of castor rhizosphere and development of INM package in ericulture (DST-FTYS, New Delhi)	July, 2012 – June., 2015	D.K. Gogoi
5.	AIB - 5851	Development of high yielding muga silkworm breed through population improvement	Feb., 2011 – Dec., 2015	N.I. Singh, D. Goswami
6.	PIN-5871	Development of Bio-intensive Module for Organic Muga Silk Production	January 2015- December 2015	Maitry Daimari and S. A. Ahmed
7.	AIB- 5869	Popularization of new eri breed C2 at farmers' field	October 2014- September 2015	S.A. Ahmed, MC Sarmah
ONGOING PROJECTS				
1		Establishment of Institutional Biotech Hub (Phase-II)	Dec. 2010 – Nov., 2015	M. Chutia, R. Das
2	ARP-5867	Characterization, transmission and cyto-pathology of infectious flacherie and cytoplasmic polyhedrosis virus in muga silkworm *Antheraea assamensis* Helfer	July, 2013 – June, 2016	M. Chutia, R. Kumar
3	APR-5865	Etiology of bacterial diseases and molecular characterization of the pathogens of muga silkworm in	March, 2013-Feb., 2016	M. Chutia, R. Das

		NE India		
4	APR-5866	Sustainable eri silkworm rearing: evaluation of *Ailanthus* species	March, 2013 – June, 2016	S.A. Ahmed, M.C. Sarmah, P.K. Handique, B.N. Sarkar
5	ARP-5868	Isolation and characterization of antifungal peptides from Muga Silkworm *Antheraeaassamensis* Helfer	May, 2014 – June 2017	K. Neog, B. G. Unni, A. K. Ghosh, S. C. Kundu
6	AIT 5872	Whole Genome Sequencing and functional genomics of Golden Silk Moth *Antheraea assamensis (*collaborative project).	2015-2018	K. Neog (From CMER&TI)
7	AIB-5879	Development of suitable combinations/hybrids of eri silkworm with sustainable performance for commercial exploitation	November, 2014 - October, 2017	B.N. Sarkar, M.C. Sarmah, S.A. Ahmed
8	ARP 5874	Development of Decision Support System for Early Warning of Selected Muga Silkworm Diseases & Pests with Geospatial Technique	March 2016-February 2019	SA Ahmed, Ranjana Das,
9	MOE 5873	Enhancement of rural economy through technology intervention for sustainable muga culture in Upper Brahmaputra Valley of Assam	March 2016-February 2019	Ranjana Das, D Goswami, D Mech, M. Chutia
REGULAR PROGRAMMES				
1	CMERTI- RP1	Induction of Indoor rearing technique for *Antheraea assamensis* Helfer through field trials.	Jan. 2011 onwards	K. Neog
2	CMERTI- RP4	Forecasting and forwarning for pest and disease of muga host plants and silkworm	Jan. 2014 onwards	R. Das

ACHIEVEMENTS IN CONCLUDED PROJECTS

Project code: APS-5856
Project Title: Development of egg preservation schedule in muga silkworm, *Antheraea assamensis* Helfer.
Total Project Cost (Rs) : 7.96 lakhs
Project Period : April 2011-June 2015
Investigators : D. Goswami, Principal Investigator
N.I.Singh, Co- Investigator
M.D.Senapati, Co- Investigator

Objective:

To develop suitable technology for short and long term preservation of eggs of muga silkworm

Progress/ Achievements

Isolation of embryo of muga silkworm eggs and preparation of embryo chart

Muga silkworm eggs were collected from the Muga Silkworm Improvement Section, Central Muga Eri Research and Training Institute, Central Silk Board, Jorhat, India. To isolate the different embryonic developmental stages of muga silkworm in different ages, the standard technique developed by Vemananda Reddy et al. (2003) for mulberry silkworm was followed with slight modification as the eggs of muga silkworm has thick chorionic layer covered with thick gummy substances.

The zero age eggs of muga silkworm, *A. assamensis* were collected and incubated at 26 ± 2 ˚C and relative humidity of 75-85 % for different durations from 24 hr to till hatching and the stages of embryonic development at the different ages were studied at an interval of 12 hr. The egg samples of different age groups were boiled in 3 – 4 % KOH solution for 2-3 minutes and then washed in 60 ˚C warm water. Care was taken so that KOH does not dissolve the embryo. The embryo was then kept in distilled water maintained at room temperature in a transparent glass petridish and kept under the dissecting stereo zoom microscope. The water was squirted by using a Pasteur pipette over the eggs to release embryos. The egg shell was removed from the micropylar end using a sharp surgery blade. With the help of a pointed needle and soft brush, the embryo was freed from the yolk material. After isolation of different stages, embryos were preserved in 70 % alcohol in the small glass vial for preparation of permanent slide. The photographs of different ages of embryos were taken under the stereo zoom microscope.

Like in most other insects, life of muga silkworm begins as an independent egg. Each egg is manufactured within the female's genital system and is eventually released from her body through an ovipositor, a component of her external genitalia. The cell's cytoplasm is usually distributed in a thin band just inside the vitelline membrane and in diffuse strands that run throughout the yolk. The egg cell's haploid nucleus lies within the yolk, usually close to one end of the egg. The egg's anterior/posterior polarity is determined by the relative positions of the nucleus and the oosome. The egg is covered by a protective "shell" called the chorion made of protein secreted before oviposition by accessory glands in the female's

reproductive system. The chorion is perforated by microscopic pores called aeropyles that allow respiratory exchange of oxygen and carbon dioxide with relatively little loss of water. The micropyle, a special opening near the anterior end of the chorion, serves as a gateway for entry of sperm during fertilization.

Embryogenesis is a developmental process that usually begins once the egg has been fertilized. After two hours of oviposition, male and female pronuclei unite at a definite position near the anterior pole to form zygote (Takami, 1969). The zygote yields about 5000 daughter nuclei through 12-13 cycles of mitosis without cytokinesis. The cleavage nuclei migrate through the yolk toward the perimeter of the egg. They settle in the band of periplasm where they engineer the construction of membranes to form individual cells and a one-cell-thick layer, the blastoderm is formed. Blastoderm cells on one side of the egg begin to enlarge and multiply. This region, known as the germ band is where the embryo's body will develop. The rest of the cells in the blastoderm become part of a membrane that forms the yolk sac. Cells from the serosa grow around the germ band, enclosing the embryo in an amniotic membrane.

At the cellular blastoderm stage, when secondary membrane is formed between blastoderm cells and the yolk system, some cleavage nuclei migrating towards egg periphery are prevented from entering into the periplasm and they remain attached to the secondary yolk membrane. These become vitellophages. Cleavage nuclei remaining in yolk becomes the centers of yolk granules to supply nutrition to the developing embryo. Yolk membrane folds during late germ band stage after which the yolk system divided into masses each enclosing one or several nuclei and yolk organelles. This process is known as yolk segmentation (Miya, 1984).

The embryonic developmental stages in *Bombyx mori* were serially numbered from 1-30 (Takami & Kitazawa, 1960). The embryonic developmental stages in eri silkworm, *Samia ricini* has been studied and identified the suitable stage for cold preservation (Sarkar *et al*., 2012). The fertilization is considered as stage-1, Cleavage is stage -2 and Blastoderm is stage -3. The earliest embryonic stage that can be isolated and removed is from stage 4, i.e. germ band onwards.

The chronological variations during embryonic development of normal eggs were recorded from 24 h to till hatching. Thirteen different embryonic stages were detected and among these stages the longest stage viz. Hei - B stage was observed at 68 hr to 72 hr old embryo.

Stage-4: This stage is called germ band, which develops to an embryo. A group of cells attaches to the inside at a specific region of the germ band. The cytoplasm of these cells appears denser than that of germ band cells. These are primordial germ cells. The germ band is concave on the inner side and the shape is of an oval plate. In muga silkworm, it forms within 24 hr of oviposition. Throughout 22-28 hr, the germ band becomes slender and elongated and by 28-34 hr, a long narrow depression called the primitive groove or streak or median plate is formed along the mid portion of the germ band on upper side. By 24-36 hr, the development of embryo was well differentiated into head and trunk region.

Stage-5, 6 & 7: The embryo gradually contracts to the shape of Dharuma (Japanese doll). Gradually the head and tail region can be identified. After 48 hr, segmentation of the body is clearly visible. The head end is called the protocephalon and the tail end is called caudal lobe. This stage is continued from 36 hr to 60 hr in muga silkworm egg.

Stage-15: In 68 hr to 72 hr of age, the embryo reaches this stage wherein the metamerism of mesoderm is completed and mesoderm is arranged segmentally. In 72 hr,

embryo showed three well differentiated distinct regions of the body i.e. head, thorax and abdomen. The segmentations with enough length and the amniotic fold covering the embryo were clear and serosa was completely covered with the yolk. The embryo was slender with a well-defined head and caudal region. The head has a clear cut depression in the middle. Mesoderm segments are clearly visible.

Stage-16-20: In 84-96 hr, rudiments of appendages appear in thoracic region and cephalic region formed by the beginning of stomodaeum.

Stage-21: The process of blastokinesis begins in 108-120 hr after oviposition. Embryo starts to move around. Blastokinesis first start in the abdominal region and extend toward heads. Posterior abdominal segments are first turned vertically so that the abdominal region as a whole forms a straight line. The abdominal region then turns towards anterior side and reaches the level of prothorax. The anterior and posterior ectodermal invaginations extends to form the fore gut and hind gut respectively.

Stage-22: The head capsule formation was completed after 132 hr and mouthparts got matured. Three segmented antennae with antennal setae, the mandibles and labrum are well developed. Yolk mass inside the eggs serves as a source of nutrients for the developing embryo and also help in holding the embryo on its surface as a necessary foundation.

Stage-23: After 144 hr lateral walls complete and tips of labrum and labium become segmented. Thoracic legs become segmented with claws at distal end. Rudiments of the setae develop on the body surface.

Stage-24: At about 156 hr, entire body of embryo is covered by strong setae and embryonic moult occurs in this stage. The caudal horns also occur in this stage.

Stage-25-29: After about 168 hr, mandible become sclerotised and pigmented at distal ends larval eyes (*i.e.* ocelli) appear as six brown spot on either side of head. The spiracles are clearly visible on the sides of the body. Head capsule and mouth appendages are sclerotised and well pigmented. The amnion and serosa disappear by fragmentation. Embryo ingests the embryonic membranes and sensitive for adverse environmental condition. Entire body of embryo becomes sclerotised.

Stage-30 (Newly born muga larvae): Fully developed muga silkworm larva comes out from the egg cell on the 8th day of oviposition rupturing the anterior part of egg shell by the mandibles and swallowing the portion of the chorion in the early morning of exposure to light. Newly born larvae are generally blackish or brownish in colour. Generally healthy larvae are blackish brown in colour with distinct yellow lines at the intersegment region. Head portion is shining black with elongated spot and larval body is yellowish with blackish tubercle.

Present finding indicates that, the embryonic development starts within a few hours of egg laying and it requires proper incubation for healthy development of embryos. Any change in temperature can hamper the development, hatching and rearing performance. Embryonic development and hatching were hampered at the stressed temperature and humidity condition because high temperature and low humidity were unfavorable condition for embryonic development (Dinesh *et al*., 2012). Due to global warming, this type of condition prevails during seed crop grainages of summer seasons of *A. assamensis*. Higher temperature and low humidity during embryonic development leads to death of embryo during early age. Temperature stress caused poor egg laying, delay and poor hatching, depression of eggs and death of fully formed larvae inside egg. The result of the present study help to find out the particular embryonic stage suitable for long term egg preservation which will help to skip the unfavourable season and can synchronize rearing with availability of leave.

Effect of refrigeration on the hatchability

Muga silkworm eggs of different embryonic ages (24hr, 36hr, 48hr, 60hr, and 72hr and mix ages from 24hr to 72 hr) were preserved at 5^0C for different durations to observe their hatching performance after long term preservation.

In 10 days of preservation at 5^0C, embryo of 24 hr showed 67.83% hatching against 75.32% of control which was significantly lower than that of control (P≤0.01& P≤0.05). Similarly, in 10 days of preservation at 5^0C, embryos of 36hr showed 71.32% hatching which was not significantly different to that of control (P≤0.01& P≤0.05).). Hatching performance of 69.37% of embryos of 48hr was not significantly different than that of control (P≤0.01&P≤0.05). Embryos of 60hr, 72 hr and mixed ages of 24hr to 72hr showed hatching of 65.27%, 61.87% and 63.27% respectively which were significantly lower than that of control (P≤0.01&P≤0.05).

In 20 days of preservation at 5^0C of embryos of 24hr, 36hr, 48hr, 60hr, 72hr and mix ages, hatching were recorded as 65.42, 69.78, 69.95, 65.3, 64.72 and 65.07 respectively which were significantly lower than that of control (P≤0.01 & P≤0.05). However, hatching performance of embryos of 36hr and 48hr was at par to that of control (P≤0.01& P≤0.05).

However, from 30 days of preservation onward at 5^0C, hatching performance of embryos of different ages and mixed ages (24hr to 72hr) were significantly lower than that of control (P≤0.01 & P≤0.05).

Table: Hatching performance of different aged embryos preserved at 5^0C

Duration of preservation	Embryonic age							CD	
	24hr	36hr	48hr	60hr	72hr	Mixed	Control	5%	1%
10 days	67.82	71.32	69.37	65.27	61.87	63.27	75.32	4.76	6.45
20 days	65.42	69.78	69.95	65.3	64.72	65.07	75.32	3.54	4.62
30 days	34.47	41.2	31.75	32.87	29.5	32.9	75.32	4.41	5.77
40 days	25.87	31.02	30.4	28	25.12	25.25	75.32	3.66	4.78

Observing the extremely low hatching performance of the eggs beyond 20 days of preservation at 5^0C, the unhatched eggs of the preserved lots were dissected after releasing from the BOD incubator and observed under the microscope. It was found that embryos were fully developed inside the egg shell but could not emerge out of the egg shell. In view of the industries' need for preserving eggs of mix ages (24hr to 72hr), the experiment was modified by preserving eggs of mix ages at three different temperature ranges i.e. 5^0C, 7^0C and 10^0C for different durations. Muga silkworm eggs are generally harvested after 72hr of egg laying.

The result of the hatching performances of the different durations of the preservation of the eggs of mixed ages at three different temperature viz. 5°C, 7°C and 10°C are presented in table-2. As evidenced from the table, at 5°C the eggs of the mixed ages can be preserved up to 5 days without affecting the hatching performance. At 7°C, the eggs can be preserved for a maximum period of 15 days with hatching of 71.85% which is not significantly different from that of control (P≤ 0.05). Similarly at 10°C, the eggs of mixed ages can be preserved for a maximum duration of 6 days with hatching of 70.00% without significant difference from that of control (P≤ 0.05). It was observed that, while preserving the eggs at 10°C beyond 6 days the embryos developed inside the BOD incubator and some of the embryos hatched

from the eggs after about 15 days of preservation. The embryos, though developed fully inside the egg shell at 10°C could not break the egg shell and cannot be hatched which may be due to weakness of the developed embryo at 10°C. Another reason for unsuccessful preservation of eggs for longer duration may be due to the low relative humidity (<60%) inside the BOD incubator at low temperature which affected the development of the young embryos. Thus, from the analysis of the table, it is found that among the three different temperatures of preservation of the eggs of mixed ages, 7°C is the most effective temperature for preservation.

Table: Hatching performance in different days of preservation of muga silkworm eggs (mixed) at different temperature and duration

Temperature	Hatching performance in different days of preservation (%)						CD	
	0	4	8	12	16	20	5%	1%
5^0C	75	71	53.5	52.75	44.5	29.75	3.75	2.82
7^0C	75	73.25	72.25	72.25	69	57.25	3.20	2.41
10^0C	75	71	65	51.25			4.56	3.41
Control	75	75	75	75	75	75		
CD 1%		2.51	4.24	3.55	3.27	3.75		
CD 5%		1.81	3.06	2.56	2.32	2.66		

After confirming the suitable temperature and duration of preservation of the eggs of mixed ages, 400 dfls were preserved at 7°C for 15 days and bioassay of the preserved eggs was conducted in four different locations by rearing 100 dfls per location during 'Chatua' crop'2015 and the rearing performances were compared with that of control.

Table: Bioassay result of preserved egg during Chatua Crop, 2015

Location	Nos. of dfl		Hatching %		E. R. R. %		Cocoon weight (g)	
	T	C	T	C	T	C	T	C
I	100	100	72.00	75.00	54.60	54.65	5.42	5.45
II	100	100	73.00	74.00	51.60	52.00	5.7	5.65
III	100	100	70.00	71.42	53.97	54.5	5.65	5.55
IV	100	100	72.00	75.00	52.72	52.05	5.55	5.65
Average			71.75	73.86	53.22	53.3	5.58	5.57
CD (P≤0.05)			1.73		0.63		0.16	
CD (P≤ 0.01)			1.83		0.93		0.24	

T: Treatment, C: Control

It is observed from the above table-3 that hatching percentage in the different locations was not significantly different from that of control (P≤ 0.05). In effective rate of rearing (ERR), significant differences were not observed between the preserved and the control eggs in the different locations (P≤0.05 & P≤ 0.01). Similarly, in cocoon weight also there was no significant difference between the preserved and the control lots. The above result of the bioassay showed that preservation of eggs at 7°C did not affect the survivability and cocoon weight of the muga silkworm. Therefore, it is deduced that muga silkworm eggs of mixed ages (24hr to 72hr) can be effectively preserved at 7°C up to 15 days in BOD incubator.

Project Code: ARC 5864

Project Title: Studies on the insect fauna associated with Muga-ecosystem in North East India with emphasis on the illustrated diagnostics

Total Project Cost (Rs.) : Rs. 19.25 Lakhs

Project Period : August, 2012-July 2015

Investigators : Dr. Rajesh Kumar Principal Investigator
Mr. Girin Rajkhowa Co-investigator

Objectives:

1. Exploration, collection and preservation of insect fauna associated with Muga-ecosystem in North East India.
2. Identification, morphological characterization and documentation.
3. Development of computerized diagnostic tools and inventorization of insect fauna

Objective – I: Exploration, collection and preservation of insect fauna associated with muga ecosystem in North East India

Methodology adopted:

The standard methodology was used for sampling and data collection of insects in muga ecosystem (Oldroyd, 1958; Ross, 1949). The collection was made by visiting selected localities with the help of portable light traps at night, net sweeping and other methods during day time. Field photographs were taken before collecting the insects. Mature and immature stages were collected from the selected localities in muga ecosystem for studying the life cycle in the laboratory. The collection was made through the following methods:

a) *Net Collection:* A sweep net collection methods was adopted to collect the adults of four group of insects.
b) *Aspirator:* Aspirator methods were adopted to collect small insects (micro moths, weevils and other sucking pests).
c) *Handpicking:* The larval stages were collected by Handpicking method in vials and jars.
d) *Butter paper envelope:* Lepidopteran insects were collected through this method.
e) *Light Trap collection (black light, UV light, Mercury vapour lamps):* All three types of light traps were installed in the field during night time to collect the four group of insects. Two light traps are battery operated (black light and UV light) and one is DC power operated.
f) *Pit fall trap*: Pit fall trap methodology was adopted to collect different type of ants available in the field.
g) *Yellow sticky traps*: Yellow sticky trap methodology was adopted to collect the sucking pests.
h) *Leaf litter sampling*: Leaf liter was observed to collect the mature and immature stages of pests.

Forty four localities were surveyed to collect insect pests from August, 2012 to July, 2015 in six states *viz*., Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram and Nagaland.

Table: Localities surveyed in six states of North Eastern India

Sl. No.	States	Location of collection
1	Arunachal Pradesh	Pashighat, Roing, Itanagar, Nirjuli, Ziro
2	Assam	Udalguri (BTC), Tamulpur (BTC), Lakhimpur, Tejpur, Tinisukia, Jorhat, Golaghat, Bogori, Bokaghat, Moran, Sivasgar, Nazira, Dibrugarh, Goalpara, Sadiya, Khwong, Jungle Block, Titabar, Mariani, Mangaldoi, Tupia,
3	Manipur	Imphal, Urkhul
4	Meghalaya	Barapani, Shillong, Mawflong, Nongpoh (Khasi Hills); Tura, Damalgiri, Silsela, Balpakram National Park, Bagmara, Kanai, Dalu (Garo Hills), Mawsentei, Mergner
5	Mizoram	Aizawl
6	Nagaland	Mokockchung, Zuniboto

Objective – II: Identification, morphological characterization and documentation

- Database entry was made for 970 specimens
- 203 species was identified upto genus and species level.
- Other specimens identified upto family and genus level.
- The selected localities of North-eastern states of India were surveyed for Insect Fauna associated with muga ecosystem from two primary host plants (Som-*Persea bombycina*, Soalu - *Litsea monopetala*) (Family : Lauraceae).
- The four insects groups were focussed to study the faunal biodiversity, because these are economically important groups in Seri-ecosystem.
- Four groups of insects were collected *viz*., Coleoptera, Lepidoptera, Hemiptera, Hymenoptera. Other group (Diptera, Mantodea, Neuroptera, Odonata) of insects were also collected and reported, because other insects were found more destructive.
- 1500 photographs had been taken from Microscope.
- A 3045 field photograph was taken for all insect pests, predators.

Table: Total number of identified species order and state wise

Order	Assam	Mizoram	Arunachal Pradesh	Meghalaya	Manipur	Nagaland
Coleoptera	48	12	7	41	6	11
Lepidoptera	81	60	52	73	49	55
Diptera	3	1	1	1	1	1
Hemiptera	35	11	9	32	8	8
Hymenoptera	19	9	9	13	9	9
Isoptera	1	0	0	0	0	0
Odonata	1	0	0	0	0	0
Neuroptera	4	0	0	0	0	0
Mantodea	2	0	0	2	0	0
Total species	174	84	69	149	64	75

Objective III: Development of illustrated diagnostic tools and inventorization of insect fauna

All identified insect is being maintained at CMERTI, Lahdoigarh

- A sucking pest, *Pyrops candalaris* (Fulgoridae : Hemiptera) – first report feeding on soalu (*Litsea monoptetala*) –manuscript accepted in Munis Entomology and Zoology
- Three parasites have been observed belongs to genus *Brachymeria*. Upto species level is under process.
- Tortricid, geometrid and noctuid caterpillar collected and reared in laboratory and identification is in under process.
- First report of *Radhica elisabethae* (Lepidoptera: Lasiocampidae) feeding on som plantations from India (Meghalaya and Nagaland) in muga ecosystem – Manuscript Submitted.
- Five new pests, predator, and parasites reported.
- One cerambycid borer, *Oberea* sp. (Cerambycidae: Coleoptera) has been reported for the first time feeding inside the branches of som plantations (*Persea bombycina*) and identified by Russian Scientist Dr. Mikhail Danilevsky. This species similar to *Oberea oculta*, which is found in India, but head and antenna are black in *O. oculta* and yellow in collected species. The final identification is under process. This pest's adults available during April to June on Som plantations. This pest is compared and found new and will be published as new species.
- *Lamprolabus pseudobispinosus* (Coleoptera: Atellabidae) reported for the first time from India and identified by Dr. Andrei Legalov, Russian Scientist. He reported *L. pseudobiospinosus* as new species from China in 2005. In 2011, It has been reported from Meghalaya feeding on soalu plantations (host plant of muga silkworm) and published Rajesh Kumar, G. Rajkhowa and A. B. Barapatre, 2012.
- Some new pests have been observed, among them one pest is identified as Stem Gall making weevil on som (*Persea bombycina*) and material was supplied to Dr. V.V. Ramamurthy, which was published as new species. This type of gall making weevil has been reported for the first time by *Synorchestes indicus Ayri & Ramamurthy, sp. nov. (*2012). This is the first substantiated gall-making habit reported in this tribe. (Reference: Shaloo Ayri, Hiroaki Kojima & V.V. Ramamurthy, 2012. Flea weevils of the genus *Synorchestes* Voss (Coleoptera, Curculionidae, Curculioninae, Rhamphini), with description of a second species from India. *Zootaxa,* 3568: 74–80 (2012).
- *A new record of Xylotrupes gideon* (Linnaeus) (Coleoptera: Scarabaeidae) on *Persia bombycina*, Kost. from India
- Reported for the first time dipteran parasite for *Zezura multistrigata* (Lepidoptera: Cossidae) (borer of som and soalu) and developed field diagnostic keys.

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Project Code: AIP - 5861

Project title: Molecular approaches in characterization and utilization of gut microflora from muga silkworm *Antheraea assamensis* for enhancing productivity of muga culture in North Eastern India (in collaboration with IARI, New Delhi)

Project Period : June 2012 – Oct. 2015

Funding Agency : DBT, New Delhi

Total Budget allocation : Rs. 30.73 Lakhs
Project Investigators : D.K. Gogoi, Principal Investigator
R. Kumar, Co- investigator

Objectives

1. Enumeration of gut microbial diversity in different morphotypes and accessions of muga silkworm *A. assamensis.*
2. Characterization of gut microbial isolates using 16s rRNA probes and culture dependent techniques.
3. Evaluation of positive influence of consortium of gut microbial isolates on the growth, development and economic parameters of *A. assamensis.*
4. Assessing the antagonistic activity of gut microbial isolates against entomopathogens of *A. assamensis*.

Highlights of achievements

Survey and collection of Muga silkworm larvae

Periodical survey and collection of muga silkworm eco-races was carried out during the different muga crop seasons (both commercial & seed crop) throughout Assam and its neighbor states. Collection was done as per the standard methodology and immediately brought to the laboratory for further study. Muga silkworm larval samples were collected in 3rd, 4th and 5th instar from different government farm, farmer's field and wild natural habitats. All the relevant data like source of seed, races, date of brushing, host plant and meteorological data of the collection site were recorded during the collection.

The 4th and 5th instar larvae of Muga silkworm were dissected and the gut-microflora was isolated as per the method described by Khyade and Marathe (2012) with a little modification, in the laboratory. The larval samples were kept under starvation for 24 h so that no faecal particle remains in the alimentary tract. The larvae were anesthetized with a chloroform soaked cotton pad and surface sterilized with 70 % ethanol. The entire alimentary canal of the larvae was dissected out aseptically in a UV laminar flow chamber (Labotech, India). The isolated digestive tract was washed with sterile, cold 0.9 % NaCl solution and cut into small pieces with a sterile scalpel, homogenized in 0.1 M Potassium Phosphate buffer and incubated at 37 ^{0}C for 1 h. The sterile homogenate was centrifuged at 10,000 rpm (REMI, C24-BL) for 10 minutes and the supernatant was taken as stock for preparation of dilution up to 10^{-5}.

The gut bacteria was isolated by pour plate method using Nutrient agar (Hi-media Ltd., Mumbai) and Brain heart infusion agar (Hi-media Ltd., Mumbai) containing different substrate. The plates were incubated (OVFU, O-CIS-4D) at 32 ^{0}C for 24 to 48 h. Enumeration was done by total viable colony count and expressed as the number of colony forming units (CFU) in 1 ml of homogenate sample.

Morphological and biochemical characterization:

The isolates were tested in terms of Gram reaction and biochemical characteristics (Holt *et al*., 1994) and further identified on the basis of pigment, colony form, elevation, margin, texture and opacity (Smibert and Krieg, 1981). Biochemical tests performed for both Gram positive and negative bacteria were Citrate utilization, Lysine utilization, Ornithine utilization, Urease, Phenylalanine deamination, Nitrate reduction, H_2S production, Glucose, Adonitol, Lactose, Arabinose, Sorbitol, Malonate, Voges proskaur, ONPG, Catalase, Arginine, Sucrose, Mannitol and Trehalose by using Biochemical Test Kit (Hi-media Ltd., Mumbai) as per the methodology of Bergey's Manual of Determinative Bacteriology.

Altogether, 360 bacterial strains were isolated from the Muga silkworm gut homogenates prepared from the collected larval samples. Out of them, 240 nos. were gram positive rods, 60 gram negative rods, 34 gram positive coccus and 26 gram negative coccus. They were found to be arranged in different orientations under microscope..

All the bacterial isolates exhibited diverse biochemical properties during the analysis for the biochemical tests as per qualitative biochemical tests..

Screening for enzymatic activity

Amylase

Amylase test was carried out by inoculating/streaking the gut-bacteria into medium containing starch 20 g, $(NH_4)_2SO_4$ 1 g, glucose 1 g, NaCl 1g, $MgSO_4.7H_2O$ 1 g, sodium thiosulphate 1 g, K_2HPO_4 2 g, Agar 20 g and H_2O 1 l. The plates were incubated at 32 ^{0}C for 5 days and a few drops of iodine solution (iodine 1 g, KI 2 g and H_2O 300 ml) poured over the colonies. Destaining of blue colour around the colonies indicated positive test for amylase. Qualitative estimation of amylase producing bacteria was calculated as hydrolysis capacity (HC) i.e. the ratio of diameter of clearing zone and colony (Hendricks *et al*., 1995).

Cellulase

Cellulose degrading ability of the isolated gut bacteria was performed by streaking on the Cellulose Congo-red agar media (KH_2PO_4 0.5 g, $MgSO_4$ 0.25 g, CMC 2 g, agar 15 g, Congo-red 0.2 g and Gelatin 2 g, distilled water 1 l ; pH 6.8-7.2). Colonies showing discolouration of the Congo-red were considered as positive cellulose-degrading bacteria. Hydrolysis capacity was calculated as per the method mentioned above.

Xylanase

The test for xylanase activity was carried out by streaking the bacteria on NA medium plate supplemented with 0.01 % xylan. The plates were incubated for 24 h and 10 ml of Congo-Red (1mg/ml H_2O) was added followed by incubation at 32 ^{0}C for 15 minutes. The Congo-red was poured off and added 10 ml of 1M NaCl solution and again incubated for 15 minutes. Appearance of clear zone around the colonies indicated positive test for xylanase.

Pectinase

Screening for pectinase was performed by using Pectinase Screening Agar Medium (PSAM) with the composition of pectin 10 g, $(NH_4)_2HPO_4$ 3 g, KH_2PO_4 2 g, K_2HPO_4 3 g, $MgSO_4$ 0.1 g, Agar 15 g, H_2O 1 l; pH 4.5. The cultures were incubated at 37 ^{0}C for 24 h and then flooded with 50 mM iodine solution. After incubation for 15 min., appearance of clear zone around the growth of the bacteria confirmed positive pectinase test.

Lipase

Lipase test was carried out by inoculating the isolates in tributyrin agar medium (pH 6.0) containing peptone 5 g, yeast extract 3 g, tributyrin 10 ml, agar 15 g and H_2O 15 ml. The plates were inoculated at 32 ^{0}C for 48 h. A clear zone developed around the colonies of fat-splitting organisms indicated lipase positive reaction. Lipase HC was calculated as the ratio of diameter of clearing zone and colony.

Further, the results of the tests for amylase, cellulase, xylanase, pectinase and lipase are represented below. Isolate no. MGS-5 showed positive results for all the enzymatic tests, whereas isolate nos. MGB-10 and MGB-12 exhibited prominent cellulolytic activity.

Table: Enzymatic activities of the gut-bacteria isolated from the digestive tract of *A. assamensis*.

Isolate	Hydrolysis Capacity									
	Amylase		Cellulase		Xylanase		Pectinase		Lipase	
	+/-	HC	+/-	HC	+/-	HC	+/-	HC	+/-	HC
MGBS2	+	1.125	-	NA	-	NA	+	1.049	+	1.013
MGBS3	+	1.206	-	NA	-	NA	-	NA	+	1.087
MGS4	+	1.023	+	1.021	+	1.018	-	NA	+	1.048
MGS5	+	1.217	+	1.226	+	1.261	+	1.112	+	1.067
MGS6	+	1.184	-	NA	-	NA	-	NA	+	1.091
MGB8	-	NA	-	NA	+	1.214	-	NA	+	1.214
MGS9	+	1.321	-	NA	+	1.118	+	1.034	+	1.143
MGS13	+	1.162	+	1.014	-	NA	-	NA	+	1.031
MGBS6	+	1.084	-	NA	-	NA	-	NA	-	NA

MGB10	-	NA	+	1.012	-	NA	-	NA	+	1.333
MGB12	-	NA	+	1.157	+	1.164	-	NA	-	NA
MGB14	+	1.114	-	NA	-	NA	-	NA	-	NA
MGB1	++	1.416	+	NA	-	NA	-	NA	+	1.051
MGB2	-	NA	-	NA	-	NA	-	NA	++	1.416
MGBS2	-	NA	-	NA	-	NA	+	1.048	-	NA
MGS3	-	NA	-	NA	++	1.25	+	1.14	++	1.6
MGB5	++	3.529	++	1.5	-	NA	++	1.2	+	1.06
MGS9	++	1.81	-	NA	++	1.25	++	1.56	++	1.142
MGBS10	-	NA	-	NA	-	NA	+	1.2	++	1.461
MGB10	-	NA	-	NA	++	1.33	+++	2.45	++	1.46
MGS13	-	NA	++	1.07	-	NA	+	1.36	+	1.03
MGS17	-	NA	+	1.086	-	NA	-	NA	+	1.375
MGS18	++	2	-	NA	-	NA	-	NA	+	1.153
MGB19	-	NA	-	NA	-	NA	-	NA	-	NA
MGB01	-	NA	++	2.4	-	NA	+	1.16	-	NA
MGB02	-	NA	++	1.22	-	NA	-	NA	-	NA
MGB05	++	1.272	++	2	-	NA	+	1.16	-	NA
MGB06	-	NA	++	2	-	NA	++	1.22	++	1.6
MGB09	-	NA	++	1.22	-	NA	-	NA	+	1.230
MGB22	-	NA	-	NA	-	NA	+	1.06	-	NA
MGB30	-	NA	-	NA	-	NA	+	1.10	-	NA
MGB43	+	1.026	++	1.20	-	NA	-	NA	-	NA
MGB58	-	NA	-	NA	-	NA	-	NA	+	1.23
MGB83	-	NA	-	NA	-	NA	+	1.24	-	NA
MGB107	-	NA	-	NA	+	1.148	-	NA	-	NA
MGB134	+	0.982	-	NA	-	NA	-	NA	+	1.11
MGB146	-	NA	+	1.010	-	NA	-	NA	-	NA
MGB168	+	1.210	-	NA	-	NA	-	NA	-	NA
MGB190	-	NA	-	NA	-	NA	+	1.18	-	NA
MGB195	++	1.310	-	NA	-	NA	-	NA	+	1.15
MGB215	+	1.114	+	1.000	-	NA	-	NA	-	NA
MGB265	-	NA	-	NA	+	1.153	-	NA	-	NA
MGB274	++	1.234	-	NA	-	NA	-	NA	+	1.20
MGB330	-	NA	-	NA	-	NA	++	1.02	-	NA
MGB341	++	1.260	-	NA	-	NA	-	NA	+	1.14

HC = Hydrolysis capacity - the ratio of diameter of clearing zone and colony

Quantitative assay of gut-bacteria of *A. assamensis* for cellulolytic activity

Pure cultures of cellulolytic bacteria were individually maintained on CMC supplemented minimal agar slants at 4^0C. The cultures were inoculated in a broth containing 0.03% $MgSO_4$, 0.2% K_2HPO_4, 1% glucose, 0.25% $(NH_4)_2SO_4$ and 1% peptone at pH 7 for 24h of fermentation period, these vegetative cells were used as inoculum source.

For cellulase enzyme production, fermentation medium was prepared using sucrose 1%, K_2HPO_4 0.2%, $MgSO_4$ 0.03%, Peptone 1% and $(NH_4)_2SO_4$ 0.25%. The medium was inoculated with 1ml of inoculum incubated in shaker at 35^0C temperature for 24 hrs. with agitation speed 140 rpm. The fermented broth was centrifuged at 14,000xg for 10 min. at 4^0C.The clear supernatant obtained used as crude enzyme source.

Estimation of cellulase activity

Cellulase activity was assayed using dinitrosalisic acid (DNS) reagent by estimation of reducing sugars released from solubilised in 0.05 M phosphate buffer at pH 8.Crude enzyme was added to 0.5 ml of 1% CMC in 0.05 M phosphate buffer and incubated at 50^0 C for 30 min. Reaction was stopped by addition of 1.5ml of DNS reagent and boiled at 100^0C in

water bath for 10min. Sugars liberated were determined by measuring absorbance at 540 nm. Calibration curve was prepared from different serial concentration of glucose. Cellulase production was estimated by using glucose calibration curve. Cellulase activity is expressed as the quantity of enzyme, which is required to release 1µmol of glucose per minute under standard assay conditions.

The results showed that isolate no. MGB011 has released highest cellulase (0.0821) during *in-vitro* assay. In addition, isolate no. MGB03 (0.07) and MGB06 (0.067) showed considerably higher cellulolytic activity.

Quantitative assay of gut-bacteria of *A. assamensis* for lipase activity

Quantitative lipase assay of gut-bacteria of *A. assamensis* was done as per the standard method of Winkler & Stuckman, (1979). The pure culture of lipase producing gut-bacteria were inoculated into the culture broth with the composition (g), peptone 0.2, $NH_4H_2PO_4$ 0.1, NaCl 0.25, $MgSO_4.7H_2O$ 0.04, $CaCl_2.2H_2O$ 0.04, olive oil 2 ml, Tween-80 1/2 drops, distilled water 100 ml and pH 7.

Overnight seed cultures were inoculated into the 250 ml Erlenmeyer flasks containing 100 ml media and incubated at 32^0C in rotary shaker for 150 rpm. Culture broth were collected after 24 hrs and centrifuged at 10,000 rpm for 10 min at 4^0C. The cell filtrate/supernatant was used as a source of extra cellular lipase.

The stock solution of substrate (20 mM) i.e. *p*-nitrophenyl pulmitate (*p*-NPP) was prepared in HPLC grade iso-propanol. The reaction mixture contained 75 µl of *p*-NPP stock-solution, 5-50 µl of test sample (crude enzyme of gut-bacteria) and Tris buffer (0.05 M, pH 8.5) to make final volume 3 ml. The reaction mixture was incubated at 45^0C for 20 minutes in a water bath. Then, the reaction was stopped by adding 1 ml of chilled (-20^0C) acetone:ethanol (1:1). Control tube was taken, which contained heat-inactivated enzyme (boiled for 5 minutes in water bath) and incubated simultaneously with the assay.

The absorbance of the heat-inactivated lipase was subtracted from the absorbance of corresponding test samples. The absorbance of the *p*-nitrophenol released was measured spectrophotometrically (Systronic *uv-vis*) at 410 nm. The unknown concentration of *p*-nitrophenol released was determined from a previously prepared reference curve of *p*-nitrophenol (2-20 µl/ml in 0.05 M Tris buffer, pH 8.5). Each of the assays was performed in triplicate and one unit (IU) of lipase activity was defined as micromole(s) of *p*-nitrophenol release by hydrolysis of *p*-NPP by one ml of enzyme at 45^0C under assay condition.

The results revealed that isolate no. MGB14 has got maximum lipolytic activity (19.21) during *in-vitro* assay. In addition, isolate no. MGB02 (17.85) and MGS19 (11.97) also showed considerably higher lipase activity. Accordingly, isolate no. MGB14 has been selected for formulation of the probiotic consortia and its genomic DNA was sent for 16S rDNA sequencing for species level identification.

Quantitative assay of gut-bacteria of *A. assamensis* for pectinase activity

Pectinase activity of the gut bacteria was assayed quantitatively by following the method of Kashyap *et al* 2000. The isolates that showed pectinase activity during qualitative screening were inoculated into 50 ml of YEP medium (Yeast extract 10g/L and pectin 2.5 g/L & pH 7.2) then incubated at 37^0 C in rotary shaker (150 rev/min). Culture broth were collected after 36 hrs and centrifuged at 10,000 rpm for 10 min at 4^0 C. The cell filtrate/supernatant was used as a source of extra cellular Pectinase. Polygalacturonic acid was used as substrate for pectinase assay by the colorimetric method of Miller (1959). From the supernatant 100 µl is taken in a test tube and was incubated with polygalacturonic acid (1% w/v) in triplicate at 40^0 C for 10 minutes under static condition. Then added 400 µl of DNSA [2 gm DNSA + 40 ml 2 N NaOH (diluted in 100 ml distilled water) + 60 gm potassium sodium tartrate (made up the volume to 200 ml) and the mixture was boiled for 15 minutes. Mixture was finally diluted to 5 ml with deionized water]. Then the colour developed was measured by colorimeter at 530 nm. Pectinase activity was determined in unitml^{-1}min.$^{-1}$ by calibrating a standard curve prepared from the serial dilution of galacturonic acid (20 mg in 20 ml H_2O).

Based on the *in-vitro* assay result, isolate no. MGS09 has got highest (0.21) pectinase activity. However, isolate no. MGBS02 (0.198), MGS05 (0.196), MGB10 (0.196).196), MGB05 (0.197) and MGB01 (0.190) also have got considerably higher pectinolytic activity. Accordingly, isolate no. MGB09 has been selected for formulation of the probiotic consortia and its genomic DNA was sent for 16S rDNA sequencing for species level identification.

Quantitative assay of gut-bacteria of *A. assamensis* for xylanase activity

The muga silkworm gut-bacteria with xylanase activity were inoculated to the 50 ml activation medium (Xylan 20.0 g/L, peptone 5.0 g/L, NaCl 5.0 g/L, Yeast extract 2.0 g/L, beef extract 1.0 g/L, pH 7) and incubated in an orbital shaker at 32^{0}C and 120 rpm for 24 hours. After required incubation, 1 ml culture broth was inoculated into the 50 ml fermentation media (Xylan 20.0 g/L, peptone 2.0 g/L, yeast extract 2.5 g/L, $CaCl_2.2H_2O$ 0.005 g/L, $MgCl_2.6H_2O$ 0.005 g/L, $FeCl_3$ 0.005 g/L, K_2HPO_4 2.5 g/L, KH_2PO_4 1.0 g/L, NaCl 0.10 g/L, $(NH_4)2SO_4$ 2.0 g/L) and again incubated at 32^o C and 120 rpm in orbital shaker for 24 hours. Then, the broth culture was centrifuged at 10,000 rpm for 10 min at 4^o C. The cell filtrate/supernatant was used as a source of crude enzyme for xylanase assay (Mahilranjan *et. al*., 2012).

The stock solution of substrate (0.6%) i.e. xylan was prepared in distilled water. The reaction mixture contained xylan, distilled water and the enzyme solution. At first 0.5 ml xylan was taken in a test tube with equal volume of distilled water. Then, 1 ml of crude enzyme (i.e. culture filtrate) was added to the mixture and incubated at 30^o C for 30 minutes. The reaction mixture was allowed to cool and 2 ml of DNS was added to it. Then the test tubes were boiled in water bath for 5 minutes and the absorbance of the reddish colour developed was measured in 550 nm against blank as reference. In the blank tubes crude microbial enzyme was added in the final step after stopping the reaction by DNS solution. The enzyme released in units per ml per minutes was calculated by calibrating a standard curve prepared from the serial dilution of xylose sugar.

The results revealed that isolate no. MGS01 has got maximum (0.041) xylanase activity during *in-vitro* assay. In addition, isolate no. MG03 (0.033), MGS10 (0.032) and MG02 (0.025) also showed considerably higher xylanase activity. Accordingly, isolate no. MGS01 has been selected for formulation of the probiotic consortia and its genomic DNA was sent for 16S rDNA sequencing for species level identification.

Screening of gut-bacteria for antimicrobial activity:

The muga silkworm gut-microflora was screened for their antagonistic properties against three pathogenic microorganisms: *Escherichia coli*, *Bacillus subtilis* and *Pseudomonas aeruginosa*. The gut-bacteria were cultured on Nutrient broth medium for 48 hrs. at 32^0 C in shaking incubator and centrifuged at 10000 rpm. The culture filtrate was used for antibacterial bioassay by Agar well diffusion method. Zone of inhibition (mm) was recorded by measuring the clear zone produced around agar well/cup.

Table: Antimicrobial activity of muga silkworm gut-bacteria against pathogenic microorganisms.

Isolate No	Inhibition Zone Diameter (mm)		
	E. coli	***B. subtilis***	***P. aeruginosa***
MGB01	27	30	-
MGB03	-	15	-
MGB05	17	40	19
MGB06	-	-	30
MGB07	-	25	-
MGB09	-	24	-
MGB12	15	20	-
MGS03	30	25	-
MGB24	-	-	18

MGB47	-	20	-
MGB78	19	-	-
MGB118	20	-	-
MGB136	-	18	-
MGB163	-	24	-
MGB182	17	19	-
MGB231	19	-	-
MGB236	-	20	-
MGB248	-	21	-
MGB252	19	-	-
MGB264	-	22	-

Extraction of crude bioactive compound

The muga gut bacteria which showed good anti-microbial screening activity were further studied for extraction of crude bio-active molecule by ethyl acetate extraction method of Bordoloi *et al* 2001. Culture broth and ethyl acetate were mixed thoroughly in 1:1 ratio using a separating funnel by vigorous manual shaking. The aqueous layer was discarded and solvent layer was allowed to dry in-vacuo. A thin film of desired compound will be left and was dissolved in Dimethyl sulfoxide (DMSO) and made ready for filling up Agar well to observe the antimicrobial activity of the isolates.

In-vitro antimicrobial bioassay screening showed that 20 isolates of *A. assamensis* gut-bacteria have got antagonistic property against the three entomo-pathogens. Among the isolates, MGB05 produced inhibition zone in agar well assay against *E. coli* (17 mm), *B. subtilis* (40 mm) and *P. aeruginosa* (19 mm). Simultaneously, isolate no MGB05 was screened for its antimicrobial activity against the selected gut-bacterial isolates. The isolate did not show antagonistic property against the selected beneficial gut-bacteria.

Identification of beneficial gut bacteria

The identification of the beneficial gut-bacteria selected for formulation of probiotic consortium was carried out by polyphasic approach, i.e. based on morphological, biochemical and molecular characterization.

Cultural characters of the pure isolates was studied on the basis of colony elevation, margin, form, texture and opacity (Smibert and Kreig, 1981).The morphological study was conducted by Gram staining microscopy method using Gram staining kit (Hi-media K001) as per the method described by Holt *et al* (1994). The stained bacterial cells were observed under Phase contrast microscope (Olympus, CKX41) to monitor the Gram reaction, shape, orientation etc. Biochemical characterization was carried out by culture depended techniques as per the Bergey's Manual of Determinative Bacteriology and by using Biochemical Test Kit (Hi-media Ltd., Mumbai, India).

Molecular identification

Molecular identification of the selected potential gut-bacteria was carried out by 16S rDNA homology analysis. Isolation of the genomic DNA of the potential A. assamensis gut-bacteria was done by standard methodology (Marmur, 1961) by using Genomic DNA extraction kit manufactured by SRL Pvt. Ltd., Mumbai (India). The DNA purity and quantity were checked by spectrophotometer at 260 and 280 nm. PCR amplification of 16S rDNA was done with bacterial universal forward primer 16SF and reverse primer 16SR as described earlier by Weisberg *et al*, 1991. The PCR for the 16S rRNA gene was performed with initial denaturation at 95°C for 2 min followed by 35 cycles consisting of 95^{0}C for 1min, 55 ^{0}C for 1min and 72 ^{0}C for 1.5 min, followed by a final extension step of 5 min at 72 ^{0}C. The PCR products were purified by using a QIAquick PCR purification kit (Qiagen) according to the manufacturer's instructions. The partial sequencing of the 16S rDNA gene was carried out

through the courtesy of DNA sequencing service, Merck Millipore (Bangalore GeNei™), Bangalore, India.

The partial 16S rDNA sequence was aligned against representative reference sequences of the most closely related members obtained from the National Centre for Biotechnology Information database (http://www.ncbi.nlm.nih.gov/BLAST). By using CLUSTLW, a phylogenetic tree was also constructed by the Neighbour Joining method (Saitou and Nie, 1987). The gene sequences identified were submitted to NCBI GenBank and accession numbers were obtained.

Based on morphology, biochemical properties, closest homology (%) of 16S rDNA and phylogenetic tree, the potential *A. assamensis* gut-bacteria selected for probiotic consortium are identified as follows:-

Culture dependent Gut Bacteria

DNA was extracted from pure cultures of gut bacterial isolates from muga silkworm *A. assamensis* and PCR was performed using 16s rRNA primers (27F-"AGAGTTTGATCCTGGCTCAG" and 1492R"AAGGAGGTGATCCAGCCGCA"). The sequence data were edited to retain only high-quality sequences and were compared with the BLAST algorithm to 16S rDNA sequences as compiled and implemented in NCBI (Searches employed both ends of the 16S molecule when available; bacterial species were identified based on their similarity with existing sequences). Generic identity of about 86 gut bacterial isolates was established through 16srRNA primers submitted to GenBank vide accession numbers, KJ672302 –KJ672387. Out of the 86 isolates, 46 isolates were identified based on rDNA sequence were comprise of genus Bacillus and is the most dominant group present in muga silkworm gut. An additional 21 isolates were identified to genus *Serratia* sp. i.e. Enterobacteriaceae, from the sequence data; only four isolates of genus Alcaligens were found.

Culture independent gut bacteria

Gut bacterial diversity of muga silkworm was also assessed through next generation sequencing approaches. Amplicon sequencing of V3 region of 16s rRNA genes was done on Illumina MiSeq platform. Bioinformatics analysis has revealed that Actinobacteria, Firmicutes and Proteobacteria being the dominant gut bacterial phyla with the identification of over >1000 Operational Taxonomic Units (OTUs) of gut bacterial strains.

Culture and preparation of the consortium:

The selected gut-bacteria of *A. assamensis* were cultured separately on nutrient broth medium for 48 hrs. in shaking incubator at 32° C. Then, the 48 hrs. old culture broth were centrifuged and cells were collected separately. The cells of the five different gut-bacteria were resuspended on sterile distilled water with final microbial load 10^8 cfu and utilized for feeding to silkworm (CMERTI-I).

Treatment of beneficial gut-bacteria (CMERTI-I) on *A. assamensis*:

Altogether 300 nos. of 2nd instar *A. assamensis* larvae were taken and reared on *Persea bombycina* (host) plants in 3 replications (100 each on different host plants). Simultaneously, 100 worms were also reared as control without treatment. Consortium of 5 selected gut-bacteria solution with a microbial load 10^8 cfu was sprayed on *P. bombycina* leaf during 3rd instar of rearing. Second round of spraying was also performed in 10 days of intervals. Relevant rearing data were recorded during the growing period of the larvae.

Nos of worms brushed, Larval weight (matured silkworm), nos. of cocoon harvested, ERR%, average cocoon weight (♂ &♀), shell weight (♂ &♀) and SR% (♂ &♀) etc. The first field trial to asses the impact of the gut-bacteria consortium (CMERTI-I) was conducted during the month of October-November' 2014 at Field Laboratory of CMER&TI located at Titabar.

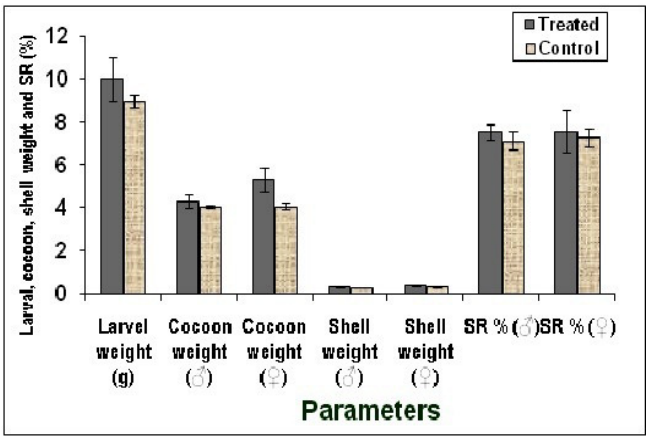


Fig.: Rearing and cocoon parameters of *A. assamensis* treated with CMERTI-

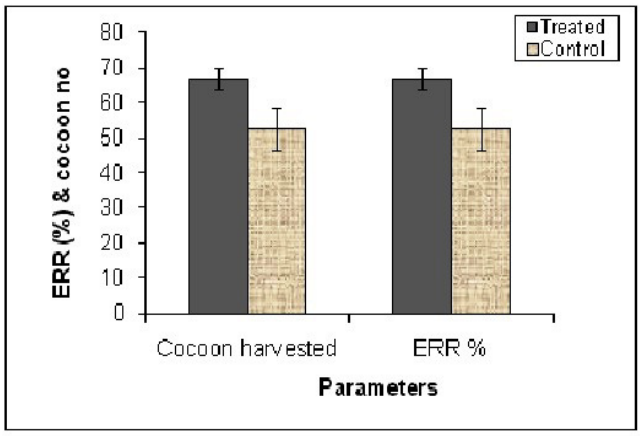


Fig.: Nos. of cocoon harvested and ERR% *A. assamensis* treated with

The average larval weight was recorded higher (10 gm) in the *A. assamensis* silkworms treated with beneficial gut-bacteria combinations (*Bacillus cereus* MGB011+ *Bacillus atrophaeus* MGB14 + *Bacillus cereus* MGS09 + *Bacillus stratosphericus* MGB05 + MGS01) then the control (8.97 gm). As such, average cocoon weight (♂4.3 gm & ♀5.34 gm), shell weight (♂0.32 gm & ♀0.40 gm) and silk ratio (♂7.52% & ♀7.53%) were also found higher in the treated silkworms in comparison to control i.e. in untreated silkworm rearing. The effective rate of rearing (ERR) was calculated, where it was recorded higher (67%) in the *A. assamensis* silkworms treated with beneficial gut-bacteria combinations then the control (52.67%). The first field trial results revealed that the ERR% of *A. assamensis* has been increased by 27.2% against the control. Accordingly, the average larval weight (10.3%), cocoon weight (♂5.9% & ♀14.35%), shell weight (♂10.34% & ♀17.34%) and SR% (♂5.62% & ♀3.43%) also increased in the treated in comparison to the untreated silkworms.

Second field trial to asses the impact of the gut-bacteria consortium (CMERTI-I) was conducted during the month of January-February' 2015' at Field Laboratory of CMER&TI located at Titabar.

The average larval weight increased (9.79 gm) when treated the beneficial gut-bacterial consortium CMERTI-I against control (8.69 gm). Similarly, average cocoon weight (♂3.56 gm & ♀4.94 gm), shell weight (♂0.31 gm & ♀0.39 gm) and silk ratio (♂8.74% & ♀6.93%) were also enhanced while treated with the same consortium. The effective rate of rearing (ERR) was calculated, where it was recorded higher (76%) in the *A. assamensis* silkworms treated with CMERTI-I then the control (56%). The results revealed that the ERR% of *A. assamensis* has been increased by 35.7% against the control. Accordingly, the percentage of increase over control was determined for average larval weight (12.5%), cocoon weight (♂6.6% & ♀10%), shell weight (♂13.5% & ♀5.4%) and SR% (♂6.6% & ♀2.36%).

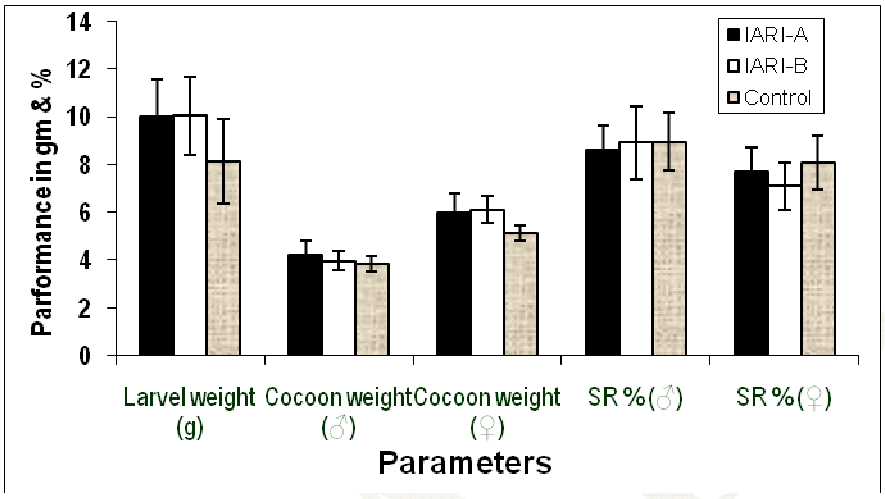
Third field trial to asses the impact of the gut-bacteria consortium (CMERTI-I) was conducted during the month of June-July' 2015' at Farm no. 3 of CMER&TI, Lahdoigarh.

The feeding of the beneficial gut-bacteria consortium CMERTI-I enhanced average larval weight (9.08 gm) of muga silkworm over the control (8.35 gm). As such, average cocoon weight (♂4.72 gm & ♀5.61 gm), shell weight (♂0.36 gm & ♀0.48 gm) and silk ratio (♂9.07% & ♀8.87%) were also recorded higher in the treated silkworms in comparison to the control i.e. in untreated silkworm rearing. The effective rate of rearing (ERR) was also found higher (71.6%) in the *A. assamensis* silkworms fed with CMERTI-I then the control (61.7%). Supplementation of CMERTI-I enhanced the ERR% of *A. assamensis* by 8.98% against the

control. Likewise, percentage of enhancement in different parameter are, average larval weight (8.74%), cocoon weight (♂7.76% & ♀33.25%), shell weight (♂21.21% & ♀23.07%) and SR% (♂20.93% & ♀2.90%) against the untreated silkworms.

Assessment of the consortia developed by IARI, New Delhi

The collaborating institute, IARI, New Delhi has developed to consortia (IARI-I & IARI-II) of beneficial gut-bacteria of *A. assamensis*. The field trials were conducted by the same procedure at Field Laboratory, Titabar. First field trial to assess the impact of consortia IARI-I and IARI-II was carried out at Field Laboratory of CMER&TI located at Titabar during the month of April-May' 2015.



The average larval weight was increased in the *A. assamensis* silkworms treated with both the beneficial gut-bacteria consortia IARI-I (9.97 gm) and IARI-II (10.02 gm) in comparison to the untreated silkworm (8.13 gm). As such, average cocoon weight and shell weight were recorded higher both in the IARI-I and IARI treated silkworms then the control. On the contrary, the absolute silk ration (%) was found lower in the IARI-I and IARI-II treated silkworms than the control. The ERR% of the crop was highest (91%) in the IARI-I treated silkworms, which has been followed by IARI-II (78%) and control (65%), respectively. The percentage of increase in ERR% over control was 40% and 20% while treated with IARI-I and IARI-II consortia. IARI-I and IARI-II improved the silkworm larval weight during experimental rearing by 22.63% and 23.25% respectively.

Similarly, percentage of increase over control for other parameter are cocoon weight (IARI-I ♂15.40% & ♀17.38%; IARI-II ♂3.66% & ♀19.34%) and shell weight (IARI-I ♂6.12% & ♀12.35%; IARI-II ♂3.21% & ♀5.08%) found to be significant.

Subsequent trial to assess the impact of consortia IARI-I and IARI-II was carried out at Farm no. 3 of CMER&TI, Lahdoigarh during August-September' 2015.

Larval weight was recorded higher (8.94 gm) in the *A. assamensis* silkworms treated with IARI-II then the control (8.54 gm), whereas no significant increase over control was recorded in the IARI-I treated larvae. Similarly, both the consortia did not exhibit significant impact on the male cocoon weight, but the female cocoon weight was increased while treated with IARI-I (5.11 gm) and IARI-II (4.88 gm). As such, male silk ratio was higher (8.22%) in the IARI-II treated *A. assamensis* silkworm then control. However, in female cocoon the absolute silk ratio was increased while treat with IARI-I (9.5%) and IARI-II (9.43%).

The percentage of increase in ERR% over control was 19.44% and 6.94% while treated with IARI-I and IARI-II consortia.

Similarly, for other parameter percentage of increase over control was cocoon weight (IARI-I ♂2.27% & ♀18.84%; IARI-II ♂5.0% & ♀13.49%) and shell weight (IARI-I ♂14.48% & ♀25.64%; IARI-II ♂17.95% & ♀17.95%) found to be significant.

Project Code: PRP-5862

Project Title: Screening of microbial flora (potential bio-fertilizer) of castor rhizosphere and development of INM package in Ericulture

Total Project Cost (Rs.) : Rs. 18.80 (lakhs)

Project Period : July 2012-June 2015

Investigators : Dr. Dip Kumar Gogoi, Principal Investigator
Dr. Kartik Neog, Co-investigator

Objectives:

i) Benchmark survey for microorganisms with biofertilizer potentialities prevalent to castor rhizosphere and experimental virgin plot.
ii) Analysis of soil biological properties of experimental virgin plot.
iii) Selection and identification of potential strains by polyphasic approach.
iv) Formulation and application of biofertilizer package with different treatment combinations in RBD for field trial.
v) Study of various growth parameters in specific time period of the growing castor plant.
vi) Post record survey of the microbial status in the experimental field.

Achievements

Analysis of soil biological properties of experimental plots (Pre-experiment)

The soil pH of the collected samples from two plots was recorded within the range of 6.3 to 6.7. The average soil respiration activity in both Plot no.8 and 10, per 100 gm of soil was found more during summer in comparison to that of the others at different time intervals i.e. 24 hrs. (18.28 mg/100g), 48 hrs. (18.97 mg/100g) and 72 hrs. (19.54 mg/100g), respectively. Similarly, the amount of carbon released calculated out from the evolved CO_2 in different time interval for both the plots was also higher (4.72 mg/100g) in summer and followed by winter (4.14 mg/100g), spring (3.84 mg/100g) and autumn (3.59 mg/100g), respectively. Irrespective to the season, the results revealed that the amount of CO_2 evolution increases with prolonged incubation period. Plot wise evaluation of soil respiration showed better activity in Plot no.8 than Plot no. 10. The soil respiration was positively correlated with environmental parameters like temperature, humidity etc. in different seasons.

Table : Correlation of soil respiration and amount of released carbon with environmental parameters in various seasons of the year.

Parameter	Correlation/ Significance	CO_2 evolution (mg/100g)		Carbon released (mg/100g)	
		Plot 8	Plot 10	Plot 8	Plot 10
Temperature (^{0}C)	Correlation	0.043	0.062	0.043	0.058
	Significance (Level: 0.01)	0.957	0.938	0.957	0.942

Humidity (%)	Correlation	0.241	0.274	0.245	0.267
	Significance (Level: 0.01)	0.759	0.726	0.755	0.733

The average soil dehydrogenase activity (DH) in both the experimental plots was found more during summer season which has been followed during autumn, spring and winter season, respectively. The comparative study showed better DH activity in Plot 10 than that of Plot 8 throughout the year. Significantly, highest DH activity in Plot no 10 (0.796 µg/10 ml) and 8 (0.535 µg/10 ml) was recorded during summer season, whereas the lowest activity was found in winter season both in Plot no 10 (0.553 µg/10 ml) and Plot 8 (0.315 µg/10 ml). The statistical analysis showed positive co-relation between the environmental parameters (temperature and humidity) and soil DH activity in various seasons for both the plots.

Acid phosphatase (AP) activity was also estimated in spring, summer, autumn and winter seasons for the soil samples of Plot no.10 and 8. Although AP activity is more during summer season, no significant ($p > 0.05$) difference was observed in all the seasons for both the plots. However, the AP activity in Plot no.10 (35.06 µg/ml) is significantly more than Plot no. 8 (32.45 µg/ml), especially in summer. Lowest AP activity was found in Plot no. 10 (30.16 µg/ml) and Plot no. 8 (28.63 µg/ml) was found in autumn season. So far as statistical analysis is concerned, positive co-relation was observed between the environmental parameter and AP activity.

Table: Correlation of soil dehydrogenase and acid phosphatase activity with environmental parameters in various seasons of the year

Parameter	Correlation/ Significance	Soil dehydrogenase (µg/10ml)		Acid phosphatase (µg/ml)	
		Plot 8	Plot 10	Plot 8	Plot 10
Temperature (^{0}C)	Correlation	0.835	0.904	0.258	0.136
	Significance	0.165	0.096	0.742	0.864
Humidity (%)	Correlation	0.566	0.221	0.322	0.241
	Significance	0.434	0.779	0.678	0.759

Significant level: 0.05

Isolation of biofertilizer potential castor rhizobacteria

Altogether, one hundred twenty two (122) nos. of rhizosphere soil samples of castor plant were collected from different locations of Assam such as Kazhiranga, Majuli, Sivasagar, Jorhat, Golaghat, Sodiya, Digboi, Tinsukia, Tingrai and foothills of Nagaland.

Pure culture of fourteen *Azospirillum sp.*, twenty *Azotobacter/Achromobacter sp.*, twenty two phosphate solubilizing bacteria (PSB) and fifteen *Pseudomonas* sp. were isolated from the collected castor rhizosphere samples by standard Serial Dilution Technique using Okon's, Ashby's, Pikovskaya and King's B/Pseudomonas isolation agar media, respectively.

Population of *Azospirillum sp.*, *Azotbacter sp.* and *Achromobacter sp.* was higher in the castor rhizosphere samples collected from Kaziranga National Park. On the other hand, majority of PSB and Pseudomonas sp. were isolated from the soil samples of Majuli river

island, Jorhat. In addition, significantly higher population of PSB was found in the castor rhizosphere collected from Sodiya, foothills of Nagaland and Digboi.

The *Azospirillum* and *Azotobacter/Achromobacter* isolates were observed under microscope as Gram negative, small-rod and oval shaped bacteria. All the isolates exhibited diverse array of biochemical reactions during biochemical characterization.

Among the PSB, most of the isolates were Gram positive rod shaped bacteria of different sizes. Very few are found to be Gram negative, coccus shaped phosphate solubilizing bacteria arranged in different orientations. As such, *Pseudomonas* isolates were found to be Gram negative small rod shaped bacteria having different biochemical properties.

Qualitative Screening of microflora

Screening of the biofertilizer potential castor rhizobacteria revealed that most of the isolates have got nitrate reductase, phosphate solubilization and PGPR activity. The *Azosprillum*, *Azotobacter*, *Achromobacter*, *Pseudomonas* and PSB isolates, which have significantly positive screening results, were selected for subsequent quantitative assay.

PSB isolate no. MAJ PSB 12 showed highest phosphatase activity with solubilization index 3.0 and 3.66 at 48 and 96 hrs. of incubation, respectively. Similarly, isolate no. KAZ AZP 01, MAJ AZB 07, MAJ AZB09, MAJ AZB 13 and KAZ AZB 01, 05 showed better nitrate reductase activity than the rest of the isolates in qualitative screening. *Pseudomonas* isolate no. MAJ PIA3 produced highest inhibition zone (mm) while tested for their *in-vitro* antifungal activity against five common plant pathogens. Besides, rest of the Pseudomonads also have got considerable amount of antifungal property against five test organisms viz. *F. monoliformes*, *F. oxysporum* NCIM 1281, *R. solani*, *F. oxysporum* Ciceri and *F. oxysporum lycopersicum.*

Table: Screening of nitrate reductase activity of the isolates

Sl. No.	*Azospirillum sp.*	Activity	Sl. No.	*Azotobacter sp.*	Activity
01	KAZ AZP01	+++	01	KAZ AZB01	+++
02	KAZ AZP02	+	02	KAZ AZB02	++
03	KAZ AZP03	++	03	KAZ AZB03	++
04	KAZ AZP04	+	04	KAZ AZB04	+
05	KAZ AZP05	+	05	KAZ AZB05	+++
06	KAZ AZP06	+	06	KAZ AZB06	++
07	KAZ AZP07	+	07	MAJ AZB07	+++
08	KAZ AZP08	+	08	MAJ AZB08	++
09	MAJ AZP09	++	09	MAJ AZB09	+++
10	MAJ AZP10	+	10	MAJ AZB10	++
11	MAJ AZP11	+	11	MAJ AZB11	+
12	SOD AZP12	+	12	MAJ AZB12	+
13	NGL AZP13	++	13	MAJ AZB13	+++
14	ARN AZP14	+	14	MAJ AZB14	+
			15	ARN AZB15	+
			16	ARN AZB16	+
			17	ARN AZB17	+
			18	DGB AZB18	+

			19	DGB AZB19	+
			20	NGL AZB20	+

*+++ High, ++ Moderate, + Low

Table : Screening for Antifungal activity of the *Pseudomonas* isolates.

Pseudomonas isolates	Inhibition zone diameter (mm)				
	F. monoliformes	*F. oxysporum* NCIM 1281	*F. oxysporum ciceri*	*R. solani*	*F. oxysporum lycopersicum*
Control	NA	NA	NA	NA	NA
MAJ PIA01	13	00	00	12	14
MAJ PIA02	00	15	00	12	19
MAJ PIA03	26	35	31	28	30
MAJ PIA04	18	20	14	16	15
MAJ PIA05	10	00	08	15	12
MAJ PIA06	00	12	00	16	00
MAJ PIA07	00	18	18	12	00
MAJ PIA08	21	00	00	15	00

Quantitative assay of the castor rhizobacteria

Nitrate reductase activity was assayed among the selected *Azospirillum*, *Azotobacter* and *Achromobacter* isolates. Among the *Azospirillum* sps., isolate no. KAZ AZP01 released highest nitrate reductase (37.05 units/ml), followed by KAZ AZP02 (24.90 units/ml) and KAZ AZP07 (20.7 units/ml) respectively. Accordingly, translation of nitrite formed by *Azospirillum* sps. could be expressed as KAZ AZP01> KAZ AZP02> KAZ AZP07> ARN AZP14> MAJ AZP09> KAZ AZP05> KAZ AZP03> NGL AZP13> SOD AZP12> MAJ AZP10.

So far as, nitrate reductase activity among the *Azotobacter* and *Achromobacter* isolates is concern, activity was highest (17.70 units/ml) in KAZ AZB05, followed by KAZ AZB01 (16.65 units/ml) and KAZ AZB03 (15.45 units/ml), respectively. The translation of nitrite formed by *Azotobacter/Achromobacter* sps. could be expressed as KAZ AZB05> KAZ AZB01> KAZ AZB03> DGB AZB19> MAJ AZB14> DGB AZB18> MAJ AZB07> KAZ AZB04> MAJ AZB08> MAJ AZB09.

Based on the above results, the most efficient nitrate reducer KAZ AZP01 and KAZ AZB05 were selected for species level identification and utilized for subsequent formulation of INM package in castor cultivation.

In-vitro phosphate solubilization by the PSB isolates was assessed based on available PO_4 concentration in broth culture on different time interval. The soluble P concentration in the NBRIP medium after 96 h of incubation was estimated ranging between 30.6 ± 0.78 mg/L and 9.10 ± 0.67 mg/L. Simultaneously, significant decrease of pH of the medium up to 5.4 from an initial pH of 7.0 was observed after 96 h. Out of the fifteen PSB isolates, isolate no. MAJ PSB12 showed highest P solubilization (30.6 ± 0.78 mg/L) with maximum drop in pH to 5.4, followed by KAZ PSB03 with soluble P concentration 21.10 ± 0.44 mg/L. Minimum concentration of soluble P (9.10 ± 0.67 mg/L) was recorded in the culture of MAJ PSB03 with culture medium pH 7 after 96 h of incubation at 30^0 C. Based on

the assay result MAJ PSB12 was identified through rDNA homology and further considered for implementation in field trial.

Plant growth promoting activity

Most of the isolates taken under consideration were found to be positive against IAA, GA_3 and ACC deaminase activity test. Among the *Azospirillum* isolates highest PGP activity of the above three parameters were found in KAZ AZP01 as 26.51 mg/l, 5.990 mg/l and 0.011 µg/10ml/min., respectively. Besides, KAZ AZP03 for IAA (18.50 mg/l) and GA_3 (4.07 mg/l) production and KAZ AZP02 for ACC deaminase activity (0.010 µg/10ml/min.). also have got considerably higher plant growth promoting ability in comparison to others. Highest amount of IAA (27.87 mg/l), GA_3 (7.0 mg/l) and ACC deaminase (0.027 µg/10ml/min) was produced by KAZ AZB05 among the *Azotobacter/Achromobacter* isolates followed by the isolate KAZ AZB03 for IAA (22.58 mg/l), KAZ AZB01 for GA_3 (3.30 mg/l) and KAZ AZB02 & MAJ AZB08 for ACC deaminase activity (0.005 µg/10ml/min.) Similarly, among the PSB isolates MAJ PSB12 synthesized highest amount of IAA (24.60 mg/l), GA_3 (3.921 mg/l) and ACC deaminase (0.015 µg/10ml/min.) followed by MAJ PSB05 for IAA (21.19 mg/l), KAZ PSB01 for GA_3 (3.417 mg/l) and MAJ PSB11 for ACC deaminase activity (0.011 µg/10ml/min.). Accordingly, among the Pseudomonads, isolate no. MAJ PIA03 showed highest IAA (27.84 mg/l), GA_3 (8.21 mg/l) and ACC deaminase activity (0.014 µg/10ml/min.) which was followed by MAJ PIA07 for IAA (22.49 mg/l) and GA_3 (5.88 mg/l). MAJ PIA01 also found to have considerably better ACC deaminase activity (0.011 µg/10ml/min.)

Selection and identification of potential isolates

Most efficient *Azospirillum* isolate KAZ AZP01 is a small rod-shaped, size (length 2.5-2.8 µM × width 1.1-1.3 µM), gram-negative bacteria. A total of 1446 bp of 16S rRNA gene of the strain KAZ AZP01 was amplified and sequenced by using their respective primers. Comparison of these test sequences against NCBI GenBank database was performed with BLAST. As per the BLAST result the 16S rDNA sequence of isolate KAZ AZP01 has 99% sequence similarity with *Azospirillum brasilense* strain SP245. Hence, the N_2 reducing isolate no. KAZ AZP01 was finally identified as *Azospirillum brasilense* strain KAZ AZP01. Similarly, isolate no. KAZ AZB05 is also a gram negative, rod shaped aerobic bacteria, which had 99% 16S rDNA sequence homology with *Achromobacter xylosoxidans* strain M66. Based on morphology, biochemical properties and rDNA homology result, the isolate was identified as *Achromobacter xylosoxidans* strain KAZ AZB05. Subsequently, phylogenetic tree were constructed, which shows the relationship between the individual query isolates and closely homologous group of bacteria.

Based on biochemical characterization the most efficient PSB isolate was positive in hydrolysis of starch, urease, catalase, nitrate reductase, phosphatase, methyl red, gelatin liquefaction, indole, and arginine whereas showed negative VP test, citrate, H_2S production and ONPG test. The bacterium, MAJ PSB12 assimilated glucose, arabinose, maltose, mannitol, glycerol, sucrose, and trehalose however did not utilized xylose, adonitol, galactose, gluconate, lactose, melibiose, rhamnose, ribose, sorbitol and xylitol.

A total of 1404 bp of 16S rRNA gene of the strain MAJ PSB12 was amplified and sequenced by using their respective primers. Comparison of these test sequences against NCBI GenBank database was performed with BLAST. As per the BLAST result the 16S rDNA sequence of isolate MAJ PSB12 has 99% sequence similarity having highest score i.e. 2514 bits with *Bacillus firmus* NBRC 15306. Subsequently, a 16S rDNA gene sequence was

aligned and phylogenetic tree were constructed, which shows the relationship between the isolate MAJ PSB12 and closely homologous group of bacteria. Based on the 16S rDNA homology to *B. firmus,* the isolate MAJ PSB12 was referred as *Bacillus firmus* strain MAJ PSB12 with NCBI Gene Bank accession no. KM068057. The DNA G+C content of strain MAJ PSB12 was determined as 41.0 mol %.

Based on the assay results, the most efficient *Pseudomonas* isolate MAJ PIA03 was identified upto species level through 16S rRNA gene homology. The genomic DNA of MAJ PIA03 was sent and 16S rDNA sequence has been obtained through the courtesy to Bangalore Gen[ei], Bangalore, India. The sequence has been aligned with the closest homology by using the BLAST tool of NCBI (National Centre for Biotechnology Information). The phylogenetic tree showed closest homology of the strain with *Pseudomonas aeruginosa* NBRC 12689 and hence identified as *Pseudomonas aeruginosa* strain MAJ PIA03. The 16S rDNA sequence was finally online submitted to NCBI with accession no. KM875456.

The selected biofertilizer potential castor rhizobacteria were identified by polyphasic approach for further field trial and formulation of INM package as follows:

Sl. No.	Isolate number	Source	Location	Scientific name	NCBI accession no.
01	KAZ AZP01	Castor rhizosphere	Kaziranga National Park	*Azospirillum brasilense* strain KAZ AZP01	Under progress
02	KAZ AZB05	Castor rhizosphere	Kaziranga National Park	*Achromobacter xylosoxidans* strain KAZ AZB05	KP298705
03	MAJ PSB12	Castor rhizosphere	Majuli	*Bacillus firmus strain* MAJ PSB12	KM068057
04	MAJ PIA03	Castor rhizosphere	Majuli	*Pseudomonas aeruginosa* strain MAJ PIA03	KM875456

Field trial

The selected biofertilizer potential rhizobacteria viz. *Azospirillum brasilense* strain KAZ AZP01, *Achromobacter sp*. strain KAZ AZB05, *Bacillus firmus strain* MAJ PSB12 and *Pseudomonas aeruginosa* strain MAJ PIA03 were mass cultured in liquid culture broth. Ten different treatment combinations were prepared and applied in the castor plants as mentioned in the methodology section.

Two consecutive field trials under optimum growing conditions were conducted which resulted significant enhancement on various growth parameters over control while treated with biofertilizer potential microbial consortia.

In plot 8, maximum (59.9 ± 22.51) castor leaves yield per plant was recorded while treated with T_8, whereas in plot 10 leaf number was highest (77.90 ± 14.20) in treatment no T_9. Nos. of leaf production per plant was significantly higher in T_{10} (P8:55 ± 12.01; P10: 49.10 ± 13.33), T_8 (P8: 59.9 ± 22.51; T10: 61.2±17.67) and T_9 (P8: 57.4 ± 5.1; P10: 77.9 ± 14.20) as compared to control (T1) in both the plots. The nos. of leaves were 45.5 and 43.7 in plot

no 8 and 10, respectively, while the castor plants were treated with organic manure/FYM (1 Kg/plant).

Fresh leaf weight in gm per plant was recorded highest while treated with T_9 in both the plots (P8: 485 ± 47.67; P10: 707 ± 81.28), followed by T_{10} (P8: 484 ± 76.48; P10: 615 ± 54.47) and T_8 (P8: 469 ± 66.47; P10: 518 ± 97.07). The treatment 1, i.e. existing recommended dose produced slightly in lower side (P8: 239 ± 13.9; P10: 491.5 ±113.48) so far as fresh leaf weight is concerned. The castor leaf moisture content (in gm) was higher in the plants supplemented with T_9 (P8: 421.80 ± 50.96; P10: 612.70 ± 68.32) on both the plots, which have been followed by T_{10} (P8: 420.90 ± 71.73; P10: 543.20 ± 62.46) and T_8 (P8: 409.90 ± 61.47; P10: 489.40 ± 58.65), respectively.

The leaf biomass (in gm) per plant has also been enhanced significantly due to application of biofertilizer consortia. The plants with T_9 input produced maximum biomass (dry weight) in plot 8 (74.10 ± 35.44) as well as plot 10 (113.30 ± 25.16) in comparison to other treatments including control). Significantly, the average percentage leaf biomass increase over control in plot 8 was 152.04%, 114.96%, 114.62%, 101.02% and 98.20% when T_9, T_8, T_{10}, T_5 and T_4 were applied, respectively. In plot no. 10, leaf biomass (%) increased over control was recorded as 78.57%, 71.40%, 67.01%, 26.77% and 24.65% while supplemented with T_9, T_8, T_{10}, T_5 and T_7, respectively.

Accordingly, the average stem base diameter (in cm) of castor plant was also more in T_8 (2.79±0.23) and T_9 (4.17±0.42) of plot 8 & 10, respectively in comparison to the control (P8: 1.97 ± 0.35; P10: 3.56 ± 0.55). However, there was no significant difference between the treatment applications and control was observed in terms of stem base diameter.

Besides, castor stems were also recorded to be longer (in meter) while treated with T_{10} (2.23 ± 0.31) and T_9 (2.66 ± 0.32) at plot nos. 8 and 10, respectively in comparison to other treatments. Result showed that the stems are stronger in castor plants treated with biofertilizer potential microflora.

In both the experimental plots, the primary root length (in cm) was found to be longest in T_9 (P8: 56.30 ± 26.73; P10: 70.40 ± 21.46), which have been followed by T_{10} (P8: 55.20 ± 21.77; P10: 56.60 ± 15.77). Root biomass per plant was highest in T_8 (65.30 ± 33.57) at plot 8 whereas in plot 10 it was found maximum (172.70 ± 65.31) in T_9.

From the above results, it has been observed that biofertilizer potential microbial consortia in combination with reduced dose (30-50%) of inorganic NPK, significantly enhanced the growth and leaf yield in castor plant.

Post record survey of the microbial status in the experimental field

The results revealed that the amount of CO_2 evolution increases with prolonged incubation period. Plot wise evaluation of soil respiration showed better activity in Plot 8 than Plot 10 per 100 g of soil at different time intervals i.e. 24 h (20.24 mg/100g), 48 hrs. (23.39 mg/100g) and 72 hrs. (27.72 mg/100g), respectively. The soil respiration activity in the experimental plots has been increased in post experimental analysis in comparison to benchmark survey. It reflects that, soil microbial population was increased due to application of biofertilizer input on castor plants.

During post experimental analysis, the comparative study showed better DH activity in Plot 10 than that of Plot 8. Significantly, highest DH activity in Plot no 10 (0.878 µg/ml/hr) and in Plot 8 (0.775 µg/ml/hr) was recorded, whereas the lowest activity in Plot no 10 was found (0.841 µg/ml/hr) and in Plot 8 it was 0.688 µg/ml/hr.

Acid phosphatase (AP) activity was also estimated for the soil samples of Plot no.10 and 8 after completion of field trial. However, in Plot no.10 (33.64 µg/ml/min.) the AP activity is significantly more in comparison to Plot no. 8 (31.79 µg/ml/min.). Lowest AP activity in Plot no. 10 was found to be 32.70 µg/ml/min. and in Plot no. 8 it was 29.30 µg/ml/min.

The soil dehydrogenase activity has been enhanced in both the experimental plots treated with of biofertilizer consortia. On the contrary, no significance difference was observed between pre and post experimental acid phosphatase activity in plot 8 and 10.

Development of INM package

Based on the qualitative and quantitative assay, four most efficient biofertilizer potential rhizobacteria namely *Azospirillum brasilense* strain KAZ AZP01, *Achromobacter xylosoxidans* strain KAZ AZB05, *Bacillus firmus strain* MAJ PSB12, *Pseudomonas aeruginosa* strain MAJ PIA03 were considered for formulation of INM package in ericulture. These bacteria were isolated from the rhizosphere soil of native castor plants growing naturally in Northeast India.

Among ten different treatment combinations, application of T_9 has got significant impact on growth and yield of castor plant in comparison to control and other combinations. Normal recommended dose (FYM/Cowdung-1000g + Urea-13g + SSP-25g + MOP-3g) for castor plant in ericulture was considered as control. Soil treatment through input of biofertilizers can enhance the crop yield and reduces soil pollution by curtailing the chemical fertilizer dose and eventually lead to sustainable agriculture. Hence, based on findings of the field trial, Treatment-9 i.e. the combinations of four selected rhizobacteria with 50% reduced dose of inorganic fertilizer is recommended as eco-friendly and effective Integrated Nutrition Package for systematic castor cultivation in sustainable eri sericulture.

The recommended INM package for systematic castor cultivation in ericulture under the project is as follows:

S/N	Constituent	Fertilizer type	Formulation	Quantity per plant
01	*Azospirillum brasilense* strain KAZ AZP01	Biofertilizer	In carrier (e.g. vermicompost) and inert material (e.g. Charcoal) in 1:1 ratio with final microbial load 10^8 cfu.	500 gm
02	*Achromobacter xylosoxidans* strain KAZ AZB05			
03	*Bacillus firmus strain* MAJ PSB12			
04	*Pseudomonas aeruginosa* strain MAJ PIA03			
05	FYM (Cow-dung)	Organic fertilizer	Compost	500 gm
06	Urea	Inorganic fertilizer	Pure	6.5 gm
07	SSP		Pure	12.5 gm
08	MOP		Pure	1.50 gm

Project Code: AIB 5851

Project Title: Development of high yielding muga silkworm breed through population improvement
Total Project Cost (Rs) : 7.05 lakh
Project Period : February, 2011-December, 2015
Investigators : Dr. N. I. Singh, Principal Investigator
D. Goswami, Co –Investigator

Objective

To develop new breeds of muga silkworm with high survivability and high shell weight

Progress /achievements

In order to develop high yielding muga silkworm breeds with high survivability and high cocoon shell weight, wild seed cocoons of muga silkworm were collected from different places viz. Mendipathar, South Garo Hills and West Garo Hills, Tura, Imphal Manipur, Kaccharipathar, Golaghat and conserved in *ex situ* in the GPB of the Institute for utilization in the breeding programme. Eight Germplasm accessions were collected and the rearing performances of these accessions were evaluated in the different seasons to select the best Genotype to utilize in further selection breeding. Among the eight Genotypes, the average fecundity ranged from 135 to 172 eggs with the highest shown by the Genotype Aa-MM. Average hatching percentage ranged from 69.87% to 83.33% with the highest recorded in the Genotype Aa-TM. Average cocoon yield per dfl in the Genotype ranged from 90 cocoons per dfl in the Aa-KA to 110 per dfl in the Genotype Aa-MM while the highest effective rate of rearing was registered by the Genotype Aa-SD (92.85%) and the lowest by the Genotype Aa-TM (77.14). Average cocoon weight in the female ranged from 6.28g to 7.22g with the highest recorded by the Genotype Aa-MM while the male cocoon weight ranged from 4.13g to 5.05g with the highest recorded by the Genotype Aa-TM. The highest average female cocoon shell weight of 0.75g was registered by the Genotype Aa-TM and the lowest of 0.47g by the Genotype Aa-IM while in the male highest cocoon shell weight of 0.52g was shown by the biotype Aa-TM with the lowest of 0.35g by the by the Genotype Aa-SD. The average filament length ranged from 289m to 411m in the different Genotype with the highest recorded by Aa-TM and lowest by the Genotype Aa-SD.

Besides, three Germplasm accessions viz. Aa-01, Aa-02 and Aa-03 were obtained from RMRS, Boko for utilization in the breeding programme. The rearing of these three muga silkworm accessions was evaluated during Jarua and Chatua crops.

The analysis of variance revealed significant differences among the genotypes in all the important economic characters studied.

The components of genetic variation such as variances of genotype and phenotype together with genotypic coefficient of variation (GCV), Phenotypic coefficient of variation (PCV), heritability in broad sense (h2) and genetic advancement are studied. The single cocoon shell weight in the female showed highest PCV (19.252%) and GCV (20.795%) and high estimated heritability (86%) followed by cocoon shell weight of the male with PCV (13.669%), GCV (15.89%) and heritability (67%) and in fecundity, PCV of 10.282%, GCV of 10.695% and highest heritability 92% were recorded. The GCV was near to PCV for most of the characters, indicating a highly significant effect of genotype on phenotypic expression with very little effect of environment. In the present study, heritability of the different characters ranged from 0.63(number of cocoons per dfl) to 0.93(male cocoon weight). High heritability estimates indicate the presence of large number of fixable additive factors and hence these characters may be improved by selection.

The phenotypic (r_p) and genotypic (r_g) correlations among the different characters are analysed. It is observed from the table that r_g are generally higher than the r_p values in most of the characters. Fecundity showed significant positive correlation with number of cocoons per dfl and female cocoon weight while negative correlation with ERR which indicated that simultaneous selection of fecundity and cocoon weight would be effective for improvement of cocoon yield. Hatching percentage exhibited significant positive correlation with number of cocoons per dfl. Significant positive correlations were observed between the characters, number of cocoons per dfl and ERR. Female and male cocoon weights were found to have significant positive correlation with shell weight and filament length. Cocoon shell weight of both sexes showed significant positive correlation with filament length. Thus for improvement of filament length, cocoon weight and shell weight in both the sexes should be simultaneously selected.

Table: Performance of different economic characters in muga silkworm Genotypes

Genotype	Fecundity	Hatching %	No.of cocoons Per dfl	E.R.R. %	Female Cocoon weight (g)	Female Cocoon Shell Weight (g)	Male cocoon Weight (g)	Male cocoon Shell Weight (g)	Single Cocoon Filament Length (m)
Aa-SD	138	76.05	97	92.85	6.71	0.50	4.28	0.35	289
Aa-Blue	140	75.75	96	91.20	6.30	0.54	4.13	0.35	302
Aa-MM	172	80.20	110	80.55	6.80	0.48	4.70	0.49	388
Aa-GA	135	77.77	92	87.73	6.28	0.52	4.50	0.46	350
Aa-TM	168	83.33	108	77.14	6.54	0.75	5.05	0.52	411
Aa-IM	165	69.87	98	85	6.54	0.47	4.39	0.47	328
Aa-KA	145	74.53	90	83.42	7.22	0.72	4.86	0.47	393
Aa-SM	170	70.05	94	78.94	6.99	0.57	4.39	0.45	343
CD (5%)	2.75	1.96	12.80	5.45	0.008	0.02	0.007	0.008	35.72
CD (1%)	4.03	2.87	23.30	9.36	0.011	0.03	0.01	0.013	52.315

Table: Components of genetic variability in respect of 9 characters in muga silkworm, *A. assamensis*

Parameters	Genotypic variance	Phenotypic Variance	Genotypic Coefficient of Variation	Phenotypic Coefficient of Variation	Heritability (Broad Sense)	Genetic Advance as % of mean
Fecundity	250.71	271.27	9.314	9.688	0.92	17.32
Hatching %	18.77	29.2	6.184	7.713	0.64	8.01
Cocoons per dfl	45.09	71.58	7.143	9.00	0.63	9.57

E.R.R. %	32.69	42.51	7.243	8.259	0.77	10.60
Female Cocoon weight	0.105	0.115	4.635	4.851	0.91	8.19
Female shell weight	0.012	0.014	19.218	20.758	0.86	31.38
Male Cocoon weight	0.093	0.10	6.946	7.203	0.93	11.40
Male Cocoon shell weight	0.0037	0.005	19.218	20.758	0.74	20.78
Filament length	1788.95	2650.87	12.331	15.018	0.67	17.34

Table : Genotypic and phenotypic co-relation of the different traits in Muga silkworm

Character		Hatching %	No. of cocoon /dfl	ERR%	Female cocoon weight	Female shell weight	Male cocoon weight	Male shell weight	Filament length
Fecundity	r_p	-0.07	0.75*	-0.78*	0.78*	0.07	0.37	0.54	0.40
	r_g	0.39	0.845**	-0.89**	0.837**	0.08	0.40	0.66	0.54
Hatching %	r_p		0.74*	0.24	0.23	0.24	0.50	0.26	0.38
	r_g		0.85**	0.25	0.29	0.39	0.61	0.27	0.56
No. of cocoon /dfl	r_p			0.77*	-0.16	-0.072	0.33	0.29	0.27
	r_g			0.75*	-0.15	-0.004	0.42	0.40	0.43
ERR%	r_p				-0.38	-0.42	-0.65	-0.71	-0.64
	r_g				-0.42	-0.48	-0.76*	-0.89**	-0.92**
Female cocoon weight	r_p					0.78*	0.363	-0.24	0.32
	r_g					0.74*	0.374	0.25	0.37
Female shell weight	r_p						0.675	-0.75*	0.77*
	r_g						0.757*	0.83*	0.84**
Male cocoon weight	r_p							0.82*	0.832*
	r_g							0.84**	0.905**
Male shell weight	r_p								0.765*
	r_g								0.842**

r_p : phenotypic
r_g : genotypic

*Significant at 1% level
**Significant at 5% level

Development of High Yielding Recombinant Inbred Lines(RIL): Two Genotypes *viz*. Aa-SD and Aa-TM possessing high values of the desired traits viz. Survivability and cocoon shell weight along with high heritability (broad sense) and high genetic advance in percent over

mean of the traits to be selected have been identified as parents for evolution of high yielding breeds. The Genotype Aa-SD possessing highest ERR of 92.85% was crossed with the Genotype Aa-TM possessing highest values of cocoon shell weight (0.75g in female and 0.52g in male).

In the F1 hybrid of the selected parents Aa-SD and Aa-TM, fecundity, ERR, cocoon weight and shell weight were recorded as 160 eggs, 82.68%, 7.67g in female and 5.47g in male with 0.75g in shell weight in female and with 0.58g in shell weight in male respectively. Segregating Progenies of the F2 hybrid Aa-SD X Aa-TM were raised. High segregation was observed in the F2 generation. It was observed that in F2, the Effective Rate of Rearing (ERR %) ranged from 67.74 to 90.26 % with 18.67% CV, cocoon shell weight in female, ranged from 0.58 to 0.85 g with 18.30 % CV and in male, it ranged from 0.44-0.68 g with 20.75% CV showing that there is wide scope for selection of improved breeds. From the analysis of the rearing data of hybrid, it was observed that the selected hybrid progenies showed higher survivability and higher shell weight than the other lines.

Table: Rearing performance of F2 hybrid in 9 important characters.

PARENT/ HYBRID		Fec.	Hat. %	Cocoon yield /DFL	E.R.R. %	Fem. Coc. Wt.(g)	Fem. Shell Wt.(g)	Male Coc. Wt.(g)	Male Shell Wt.(g)
Aa-SD XAa-TM (F1)		160	76.48	101	82.68	7.67	0.75	5.47	0.55
Aa-SD		138	76.05	97	92.85	6.71	0.50	4.28	0.35
Aa-TM		168	83.33	108	77.14	6.54	0.75	5.05	0.52
Aa-SD X Aa-TM (F2)	Average	156	71.63	91	80.31	7.24	0.71	5.15	0.53
	Range	140-175	64.81-79.73	81-105	67.74-90.26	6.29-8.38	0.58-0.85	4.58-6.23	0.44-0.68
	SD	17.45	10.96	7.61	9.49	1.36	0.14	0.99	0.11
	CV (%)	11.18	15.30	8.36	11,82	18.67	18.30	19.22	20.75

From the segregating F2 generation, progenies possessing high ERR and high cocoon shell weight were selected and reared cellularly in the subsequent generations followed by directional selection of superior recombinant inbred lines(RIL) having high cocoon shell weight and high survivability. Directional selection was employed primarily based on high survivability and high shell weight while keeping the other yield contributing parameters above the average standard value in each generation. The rearing performances of the subsequent generations of the recombinant inbred lines (RILs) during the different generations and seasons were analyzed. In each generation, data like fecundity, hatching percentage, cocoon yield, effective rate of rearing (ERR %) cocoon weight and cocoon shell weight were recorded.

Data were analyzed and compared with that of control. In the selected breed, fecundity ranged from 150 eggs during chotua crop to 220 eggs during Jarua crop, hatching ranged from 55.86 % in Aherua crop to 79.74% during Kotia Crop, lowest ERR of 36.72 % was recorded during Jarua crop while it was > 50% in all the seasons and generations with highest of 62.59 % during Jethua crop. Similarly, in single cocoon shell weight, lowest of 0.55 g in female and 0.42 g in male were recorded during Jarua crop while it was > 0.60 g in

female and > 0.48 g in male during all the seasons and generations. The selected breed performed best during the two commercial crops (Jethua and Kotia). In the 18th generation, the breed showed average cocoon yield of 86 per dfl against 65 cocoons per dfl of the control (33.87% improvement) and similarly, it showed improvement of 14.54 % in female cocoon shell weight and 17.78 % improvement in male cocoon shell weight. As observed, rearing performance of the selected Breed (CMR-1) were significantly better than that of control during all the seasons in most of the parameters (P<0.01).

Table: Rearing Performance of Selected Breed (CMR-1) in different Generations and seasons

Season	Breed/Control	Fecundity	Hatching %	Cocoon yield/DFl	ERR %	Female Cocoon weight	Female Shell Weight	Male Cocoon weight	Male Shell weight
Jethua	CMR F3	191	78.13	93	62.15	7.29	0.62	5.25	0.50
	Control	159	73.45	69	58.78	6.80	0.60	4.76	0.48
Aherua	F4	180	78.71	87	62.02	7.14	0.62	5.20	0.50
	Control	162	71.28	52	44.54	6.80	0.60	4.69	0.48
Bhodia	F5	168	71.34	73	60.67	7.55	0.66	5.27	0.54
	Control	152	68.37	45	42.70	6.54	0.58	4.75	0.48
Kotia	F6	178	76.26	83	61.63	7.96	0.67	4.94	0.55
	Control	162	69.54	61	53.88	6.80	0.61	4.64	0.51
Jarua	F7	220	70.74	95	61.21	6.48	0.55	3.96	0.44
	Control	170	70.89	66	54.78	5.70	0.47	3.67	0.37
Chotua	F8	156	70.81	61	55.16	6.48	0.61	4.37	0.48
	Control	145	72.29	47	45.04	6.23	0.54	3.76	0.44
Jethua	F9	178	72.61	81	62.59	6.82	0.66	4.60	0.54
	Control	166	72.14	65	53.98	6.55	0.59	4.54	0.54
Aherua	F10	165	67.89	67	59.83	7.02	0.65	4.86	0.50
	Control	152	59.55	49	54.47	6.40	0.56	4.58	0.45
Bhodia	F11	156	61.16	49	51.15	7.08	0.64	4.93	0.53
	Control	140	53.00	31	41.63	6.51	0.55	4.53	0.44
Kotia	F12	168	65.26	67	61.44	6.74	0.61	4.65	0.48
	control	142	61.03	43	50.14	6.37	0.54	4.44	0.44
Jarua	F13	209	70.95	54	36.72	6.38	0.55	4.14	0.42
	control	163	71.50	26	22.16	5.93	0.48	3.93	0.37
Chotua	F14	150	71.67	59	54.55	6.57	0.62	4.57	0.50
	Control	142	70.38	44	44.95	6.11	0.54	4.08	0.42
Jethua	F15	170	73.71	63	51.07	6.93	0.64	4.72	0.54
	Control	157	70.33	46	41.80	6.40	0.55	4.46	0.46
Aherua	F16	166	55.86	51	55.04	6.82	0.64	4.85	0.53
	Control	149	50.08	31	40.96	6.45	0.56	4.56	0.45
Bhodia	F17	165	62.06	53	51.85	7.25	0.65	4.95	0.52
	Control	146	54.35	37	47.57	6.52	0.57	4.56	0.45
Kotia	F18	205	79.74	86	52.38	6.86	0.63	4.82	0.50
	Control	175	74.78	65	49.65	6.51	0.55	4.53	0.45

CD	(P<0.05)	3.22	1.482	2.620	2.268	0.122	0.016	0.095	0.013
	(P<0.01)	4.23	1.947	3.444	2.980	0.185	0.021	0.125	0.017

Development of Superior Recurrent Backcross Line (RBL): Recurrent backcrossing of the hybrid Aa-SD X Aa-TM was done with the parent Aa-TM for introgression of high shell weight genes in the subsequent backcrosses. The backcrossing was repeated for 6th successive generations to introgress the high shell weight genes into the Recurrent Backcross Line and develop a Congenic Line with maximum homozygocity like the receptor parent. From 7th to 17th generations, directional selection was employed primarily based on high survivability and high shell weight while keeping the other yield contributing parameters above the average standard value in each generation. In each generation, data like fecundity, hatching percentage, cocoon yield cocoon weight and cocoon shell weight were recorded. Data were analyzed and compared with that of control.

In Backcross (BC1) the fecundity, ERR, female cocoon weight, male cocoon weight and shell weight in both female and male were recorded as 158, 80.75%, 7.14g, 4.98g, 0.68g and 0.50g respectively. Highest fecundity of 215 eggs was observed at BC6 and lowest fecundity of 150 eggs were recorded at BC10 and BC13. It recorded the lowest ERR of 19.49 % BC12 during Jarua Crop while in all the other generations and seasons the ERR % was recorded > 50%. The single cocoon shell weight in commercial crops were > 0.60 g in female cocoons and >0.50 g in male cocoons. Cocoon Shell weight was lowest in Jarua crops. In the 17th generation, the breed showed average cocoon yield of 73 per dfl against 65 cocoons per dfl of the control (12.31 % improvement) and similarly, it showed improvement of 10.00 % in both female and male cocoon shell weight. As observed, the selected backcrossed line performed significantly better than that of control in all the seasons in most of the parameters (P<0.01).

Table: Rearing Performance of Selected Backcrossed Line (CMR2) in different Generations and seasons

Season	Breed/Control	Fecundity	Hatching %	Cocoon yield/DFl	ERR %	Female Cocoon weight	Female Shell Weight	Male Cocoon weight	Male Shell weight
Chotua	BC1	158	70.42	70	63.06	6.95	0.72	4.95	0.51
	Control	155	68.47	41	38.44	6.57	0.57	4.84	0.47
Jethua	BC2	172	75.06	85	64.84	6.86	0.61	4.65	0.50
	Control	159	73.45	69	58.78	6.80	0.62	4.76	0.48
Aherua	BC3	169	74.22	74	59.22	7.01	0.61	4.97	0.52
	Control	170	75.29	69	41.17	7.25	0.64	4.92	0.51
Bhodia	BC4	165	71.77	73	61.81	7.00	0.62	5.00	0.50
	Control	152	68.36	45	42.69	6.54	0.57	4.75	0.48
Kotia	BC5	175	72.93	77	60.38	7.28	0.70	4.89	0.58
	Control	162	69.54	60	53.88	6.80	0.61	4.64	0.51
Jarua	BC6	215	71.45	84	54.54	6.51	0.54	4.00	0.45
	Control	170	70.88	66	54.78	5.70	0.47	3.66	0.37
Chotua	BC7	155	70.90	61	55.17	6.50	0.61	4.24	0.47
	Control	145	72.30	47	45.04	6.23	0.54	3.76	0.45
Jethua	BC8	180	73.30	82	61.72	7.20	0.76	4.60	0.59
	Control	166	72.14	65	53.98	6.55	0.59	4.54	0.50
Aherua	BC9	165	67.88	68	61.08	6.70	0.63	4.96	0.52

	Control	152	49.20	54	54.47	6.40	0.56	4.58	0.45
Bhodia	BC10	150	60.46	47	51.74	7.14	0.66	5.00	0.54
	Control	140	53.00	31	41.63	6.51	0.55	4.53	0.45
Kotia	BC11	166	65.82	67	61.60	6.94	0.64	4.70	0.51
	Control	142	61.03	43	50.14	6.37	0.54	4.44	0.44
Jarua	BC12	190	73.88	27	19.49	6.33	0.52	4.03	0.42
	Control	163	71.49	25	22.16	5.93	0.48	3.93	0.37
Chotua	BC13	150	71.06	54	50.46	6.39	0.60	4.19	0.47
	Control	142	70.38	44	49.95	6.11	0.54	4.08	0.42
Jethua	BC14	165	77.68	67	52.34	6.96	0.64	4.67	0.51
	Control	157	70.33	46	41.80	6.40	0.55	4.46	0.46
Aherua	BC15	166	53.82	46	51.25	6.77	0.63	4.89	0.52
	Control	150	50.10	31	40.96	6.45	0.56	4.56	0.45
Bhodia	BC16	162	55.39	46	51.50	6.89	0.63	4.87	0.52
	Control	146	54.35	37	47.57	6.52	0.57	4.56	0.45
Kotia	BC17	179	75.42	73	54.07	6.75	0.60	4.78	0.50
	Control	175	74.78	65	49.65	6.51	0.55	4.54	0.45
CD	(P<0.05)	3.117	1.382	2.442	2.310	0.108	0.016	0.085	0.123
	(P<0.01)	4.097	1.816	3.310	3.036	0.142	0.021	0.112	0.016

Trial rearing: Preliminary trial rearing of the breed conducted at different places showed better rearing performance than that of control during Jethua, Bhodia and Aherua Crops.

However, field trial rearing of 50 dfls of each of the Muga Breed CMR1 and CMR2 during Jarua Crop, 2013-14 at MSSO Tura showed poor yield of only 19 cocoons per dfl and 17 cocoons per dfl respectively.

Table: Result of preliminary trial rearing of muga breed (CMR-1) during 2013-14.

Place	Breed/ Control	Crop	No. Of dfls/g	Fecundity	Hat. %	No. Of coc. per dfl /g	ERR %	Fem. Coc. Wt. (g)	Fem Shell Wt. (g)	Male coc. wt. (g)	Male shell wt.(g)
Lahdoigah	Breed	Jethua 2013	50 dfls	179	72.72	80	61.53	6.80	0.66	4.70	0.56
P4 unit-Mendipathar	Breed	-do-	50 dfls	160	85.00	80	59.05	7.66	0.64	4.62	0.44
P4- Tura-	Breed	-do-	50 dfls	160	60.00	70	73.43	8.24	0.68	4.82	
	Control	-do-	50 dfls	165	70.30	64	55.17	6.50	0.58	4.50	0.50
Lahdoigarh	Breed	Aherua 13	50 dfls	166	67.71	67	60.19	6.93	0.64	4.86	0.51
P4- Tura	Breed	-do-	50 dfls	173	90.00	78	50.40	7.62	0.72	4.48	0.50
Control	Control	-do-	50 dfls	152	69.58	49	54.46	6.38	0.56	4.64	0.46
P4-Tura	Breed	Bhodia	450	182	93.00	35	30.48	8.20	0.71	4.22	0.42

			gm dfls	(127/g)							
Lahdoigarh	Breed	-do-	50 dfls	155	61.30	49	51.20	7.05	0.64	4.90	0.52
	Control	-do-	50 dfls	140	53.00	34	45.82	6.65	0.55	4.60	0.44
Aosendang Nag.	Breed	Jethua, 2014	80 dfl (100 g)	170/ 135 eggs/g	71.85	52 dfl (42 g)	43.81	7.75	0.66	4.70	0.50
CMER&TI	Breed	Jethua, 2014	100 dfls	170	75.00	65	50.94	6.85	0.64	4.68	0.53
	Control	Jethua, 2014	100 dfl	160	70.62	48	42.47	6.45	0.56	4.45	0.45

Project Code: PIN-5871

Title of the Project: Development of Bio-intensive Module for Organic Muga Silk Production (KIRAN- Societal Research Fellowship)

Project period : January 2015 to December 2016

Total Cost of the Project : Rs 3.3 Lakhs

Investigators : Maitry Daimari, Investigator
Dr. S A Ahmed, Mentor

Objectives

1. Identification of reliable and actual factors of muga production decline through field survey.
2. Identification of strategies to alleviate the field problems of muga silk production and productivity.
3. Development of bio-intensive organic silk production module to overcome large scale dependence of inorganic inputs in muga eco-system and to reduce mortality of muga silk.

Summary/ achievements

Survey, collection of samples (Larvae, soil and leaves)

Survey was conducted in three muga potential district of Assam i.e., Dibrugarh, Sivasagar and Jorhat during January 2015 to April 2015. A questionnaire was prepared to collect primary information and interviewed personally to know the indigenous practices adopted during rearing, seed production diseases and pest management. From each district two villages were selected. From Sivasagar district Sukafa Nagar and Mathurapur, from Dibrugarh district, Khawang and Tinkang and from Jorhat district Kochari gaon and Madhabpur were selected. Information was collected covering 132 i.e., 44 farmers in each district. Most of the farmers surveyed were associated with more than 25 years with muga culture. Collected the sample of soil, larvae and leaves and sent the samples of larvae to IIT, Guwahati for residual analysis

Documentation of ITK

Documentation of Indigenous Knowledge Practices (ITKs) in respect of muga silkworm rearing, host plant management, pest, diseases and predator management have been done. Plant extract of *Ageratum conyzoides (Gandhali bon),Mentha arvensis (Podina) and Cymbopogon citrates (Gadh birina)* are used to control uzy fly , *Tapor tanga* (*Garcinia xanthochymus)* for degumming process, *Azadirechta indica* as anti- flacherie , turmeric powder is used as red ant repellent etc.

Muga silkworm rearing

The experimental rearing was carried out during Bhodia (Aug-Sep) crop season. Out of 50 DFL, 25 DFL were reared adjacent to the tea garden and 25 DFL were 300 meter apart from tea garden to find out the affect of pesticide used in tea gardens on muga larvae. From the experiment it was observed that the larvae perform same schedule up to 4th moult. When pesticide was sprayed at the tea garden the larvae which are reared nearby tea garden was instantly stopped feeding , after 3 hours black colored fluid secrete from mouth and the body of larvae turn black within 4-5 hours. After 7-8 hours larvae were died. Rest of the larvae performed late moulting and emerge abnormal moth. Larvae which are apart from the tea garden (control) had no any symptom and they have normal development.

Preparation of organic module

Application of the ITKs in CSB Experimental farm (farm no 3) with suitable refinement along with improved technologies has been done. Rearing of 75 DFL has been been conducted during *Kotia* crop (Oct-Nov) .The rearing plot was prepared by applying organic inputs, viz., vermi-compost and bio-pesticides .During rearing two phyto-chemicals namely,T1(20% solution of the extract of *Ocimum sanctum*) and T2 (20% solution of the extract of *Azadirechta indica*) were used to control disease. The results indicated that the performance of T1 treated lot shows better results (ERR 61.65%) as compared to T2 (ERR 49.47%) against 46.99% ERR in the control.

Project Area

Dibrugarh district

Tingkhang: Tingkhang is a taluk and assembly constituency of Dibrugarh district of Assam and is today an important tea cultivation and oil exploration area of Assam. It belongs to the block –Tingkhang and the village covers 2km breadth and 4.5 km length. Total 850 families lives in this village.

Khawng: It belongs to the block Tilai Nagar and area covers 5 km length and 4 km breadth. Total 800 families lives in the village.

Sivasagar district

Sukafa: It is a village panchayat located in the Sivsagar district of Assam state. The latitude 26.11 and longitude 91.83 are the geo-coordinate of the Sukafa. Sukafa Nagar belongs to the block Najira Chang-moni and covers 300 families. Total area of the village is 1km breadth and 1.5km in length.

Mathurapur: Mathurapur is a village few kilometers apart from Sukafa Nagar. It belongs to the block Lakua and cover 500 families. Total area of the village is 2km breadth and 3.5km in length.

Jorhat district

Kachari Gaon: It is an Indian village located in Titabor Tehsil and belongs to the Jorhat district of Assam. Kochari Gaon covers 2km length and 2km breadth and 174 families.

Madhabpur: Madhabpur belongs to the block Titabar. It covers 2.5km length and 4km breadth and 200 families.

The present study emphasizes the results according to survey in Jorhat, Sivasagar and Dibrugarh districts. The study reveals that in Sivasagar and Dibrugarh district muga culture is their primary occupation and provides the farmers income of rupees approximately 40,000.00-50,000.00 per year. In Jorhat district paddy cultivation was their primary occupation and in off time farmers engaged themselves in muga or eri culture to utilize their time and to meet their general demand. Out of 132 farmers field surveyed 57.57 % (76) belongs to OBC, 40.15 %
(53) belongs to Schedule Tribe, 1.51 %(2) belongs to General and 0.75 % (1) belongs to Schedule Cast. Out of 132 farmers 45.81% (75) are male rearers and 43.18 % (57) are female rearers.

Methodology

To assess the basic status of muga farmers through field survey, a structured questionnaire was prepared. Traditional knowledge on muga silk culture with regards to rearing, host plant management, disease and disease management, seed production, etc. were collected from traditional muga farmers of Dibrugarh, Sivasagar and Jorhat districts. Dibrugarh and Sivasagar districts are major muga growing districts of Assam and both of the districts are reservoir of indigenous traditional knowledge. From each district two villages are selected. From Sivasagar district, Sukafa Nagar and Mathurapur, from Dibrugarh district, Khawang and Tinkang and from Jorhat district, Kochari Gaon and Madhabpur villages were selected. From each district 44 muga farmers were selected for collection of data. Information was collected covering 132 farmers of Jorhat, Sivasagar and Dibrugarh districts.Most of the farmers surveyed were associated with more than 25 years with muga culture. A questionnaire was prepared to collect primary information and interviewed personally to know the indigenous practices adopted during rearing, seed production diseases and pest management. Collected samples of soil, Som (*Persea bombycina)* leaves and muga silkworm which are subjected for residual analysis.

For collection of base line data for the period of 2012 to 2014,132 farmers are selected from Dibrugarh , Sivasagar and Jorhat district. From each district 44 farmers are selected to collect the information regarding their productivity within three years, their field problems and indigenous traditional knowledge applied in the field. Most of the farmers have more than 25 years of experiences in muga rearing and specially Dibrugarh and Sivasagar, both two districts are reservoir of traditional knowledge (ITK). Collected the ITKs from them and document all the ITKs and developed an organic module in CSB experimental farm to improve productivity at farmer's level.

Conclusion

Muga culture is as old as Assamese culture. It is a tradition and pride of Assam. However, in recent days it is facing various problems and ITKs may contribute to a greater extent in developing eco-friendly technologies or to solve the field problems encountered in recent days. So, it is very important to document the ITKs, focus to refine the same or to integrate with improved practices in muga culture and development of bio–intensive module such as vermicompost, organic manure, bio-fertilizers, safer bio-control agents, safer natural plant extracts, organic disinfectants, organic degumming process and pesticide residual problems, etc are urgently required for enhancing production of organic muga silk..

The present short duration study was taken up to understand the available ITKs with muga farming communities and documented 41 ITKs in different processes of silk cultivation such as host plant managements, seed production, rearing, pest and disease management. It was also focused to understand basic problems of muga culture. The *farmers reported that* one of the major challenges of muga *silkworm rearing during Chotua (Feb-March) and Jethua (May-June) crop is Uzy fly which caused crop damage up to 60-70 % at 4rd and 5th instars larval stage*. However, the farmers faced a major problem of muga silkworm mortality up to 85% during Aherua (Jun-Jul) and Bhodia (Aug-Sep) crops during 2012 to 2014 mostly due to pesticide applied in nearby tea gardens and field crops. Apart from this, several pests such as spiders, red ants, bugs, wasps and diseases like flacherie and muscardine are reported. Hence, a pilot study was initiated to manage uzy fly, red ants, and flacherie disease by using plant extract and conducted rearing during Kotia crop, 2015 which provided an encouraging result for developing specific phyto formulation. Besides these, to overcome the problems of pesticide contamination in muga eco-system, an antidote/detoxifying chemical have been identified and tested in eri and muga silkworm. A phyto-analogue of the identified detoxifying chemical have also been identified which need to be refined and tested in various level to develop a full proof technology. As this work was taken up to understand the scientific process to take up research projects, it is required to take up a full project with minimum duration of 3 years for developing a suitable bio-intensive module for muga silkworm rearing.

Table: Rearing parameters for the rearing of *Bhodia* (August-September) crop

(M=Male, F=Female, H=Hatching, dfl=Disease free laying , D/B=Date of bushing, L/D=Larval duration, Fl= Flacherie , Gr = Grasserie, Pb=Pebrin, ERR=Effective Rate of Rearing)

Sl. no	Source of DFL	Dfls (g)	Fecundity (No)	Worms brushed (No)	Mortality pattern (No.)				Larval weight (g)		Cocoon (No)	ERR (%)
					Fl	Gr	Pb	Others	M	F		
1	Muga silkworm reared adjacent to tea garden	25	143	358	0.0	0,0	0.0	338	10.07	14.25	20	5.58
2	Control	25	145	362	43	0.0	0.0	69	11.53	16.18	250	69.0

Table : Cocoon assessment (Muga silkworm reared adjacent to tea garden).

Cocoon	Avg. Cocoon weight (g)	Avg. Shell weight (g)	Silk ratio (%)
Male cocoon	4.14	0.42	10.14
Female cocoon	6.01	0.56	09.31

Table : Cocoon assessment (Control)

Cocoon	Avg. Cocoon weight (g)	Avg. Shell weight (g)	Silk ratio (%)
Male cocoon	4.34	0.43	9.91
Female cocoon	7.07	0.61	8.77

Table: Rearing performance of muga silkworm treated with phyto-chemicals

Treatment	Dfls (g)	Av. fecundity	Worms brushed	Av.Disease incidence (No.)				Av. Larval weight (gm)		Cocoon (No)	Av. ERR (%)
				Fl.	Gr	Pb	Other	M	F		
T 1	15	149.06	678	1.66	0	0	85.66	10.55	17.84	418	61.65
T 2	15	152.16	659	20.33	0	0	89	9.69	16.73	326	49.47
Control	15	149.06	732	39.33	0	0	106	10.27	16.62	344	46.99
±S.D		1.78	13.31	18.83	0	0	10.90	0.438	0.67	16.28	12.43

(M=Male, F=Female, dfl=Disease free laying, Rep=Replication, Fl= Flacherie, Gr = Grasserie, Pb=Pebrin, ERR=Effective Rate of Rearing)

Table: Cocoon assessment (Treatment wise)

Treatment	Cocoon	Av. Cocoon Weight (g)	Av. Shell Weight (g)	Silk Ratio (%)
T 1	Male cocoon	4.61	0.49	10.62
	Female cocoon	7.04	0.69	9.80
T 2	Male cocoon	4.31	0.45	10.44
	Female cocoon	6.18	0.56	9.06
Control	Male cocoon	4.35	0.43	9.88
	Female cocoon	7.12	0.61	8.56

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Project Code: AIB 5869
Project title: Popularization of new eri breed C2 at farmers' field
Project Period : October, 2014- September, 2015
Funding Agency : CSB, Bangalore
Total Budget Allocation : Rs. Lakhs
Project Investigators : S.A. Ahmed, Principal investigator
M.C. Sarmah, Co-Investigator

Objectives

1. To popularize the new eri silkworm breed C2 in the farmers' level for enhancement of eri silk production.
2. To ensure continuous production and supply of seeds of eri silkworm C2 breed through farmers' participatory method

Highlights of achievements

Conducted awareness programme at Koliapani, Tinsukia, Amsoi (Morigaon) and Danichapori under Dadhara SMV covered 400 farmers. Four batches of training were organized and covered 120 farmers at Dhansripar (Dimapur), Makum (Tinsukia), Danichapori (Golaghat), Dhanubhanga (Goalpara) and Nagaland in eri host plant management and improved rearing techniques. One technology demonstration programme on C2 breed rearing was also organized. More than 20000 eri C2 breed were distributed to farmers under SMV.Farmers' groups have been identified for producing large quantity of eri C2 breed. Training on seed production was organized during April, 2015.

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Multi-locational trial

PIE 5853: Collection, characterization, evaluation and conservation of perennial host plants for eri silkworm rearing.

Scientist involved: Dr. M.C. Sarmah, Sc-D, Dr. B.N. Sarkar, Sc-C and Dr. S.A Ahmed, Sc-C.

Objective: To recommend high yielding kesseru genotypes HF -008 and HF-005 for commercial exploitation.

Progress

Selection of location: Three Assam State Sericulture departmental farms Borduar, ESG of Kamrup district, Dhanubhanga, ESG of Goalpara district and Tupia, ECC of Sonitpur district were selected for multilocational trial programme. Prior to conduct trial programme formal permission from Department of Sericulture, Assam was obtained.

Execution of the trial programme

Prior to conduction of programme format for data collection was circulated to each farm in-charges. Identification of selected genotypes was done in each farm. Rearing and leaf yield data were collected as per format. Three seasons rearing data were complied. Eri silkworm breed C2 was utilized to conduct the bioassay. Leaf biomass production is presented in Table 4. Thus it was found that both the accessions showed the result during trial programme in conformity with institute result.

Table: Bioassay data of kesseru during Autumn crop Nov, 2015 (Average of 3 farm's data)

Particulars	HF 008	HF 005	Mix population
Av. number of worms/dfls brushed	1500/5	1500/5	1500/5
Feeding behaviour	Regular	Regular	Regular
Moulting behaviour	Regular	Regular	Regular
Larval duration (days)	21	21	21
Wt. of mature larva (g)	8.60	8.45	8.35
No. of cocoon harvested	1250	1230	1210
Cocoon yield/dfls (no)	250	246	242
Cut cocoon yield/100 dfls (kg)	10.0	8.85	6.78
ERR (%)	83.33	82.00	80.66
Good cocoon (%)	96.33	95.00	89.67
Single cocoon weight (g)	3.25	3.50	2.80
Single shell weight (g)	0.40	0.36	0.28
Cocoon shell ration (%)	12.31	10.28	10.00

Table: Bioassay data of kesseru during winter crop Dec, 2015-Jan 2016 (Average of 3 farm's data)

Particulars	HF 008	HF 005	Mix population
Av. number of worms/dfls brushed	1500/5	1500/5	1500/5
Feeding behaviour	Regular	Regular	Regular
Moulting behaviour	Regular	Regular	Regular
Larval duration (days)	35	36	36
Wt. of mature larva (g)	7.80	7.65	7.45
No. of cocoon harvested	1235	1225	1170
Cocoon yield/dfls (no)	240	235	225
Cut cocoon yield/100 dfls (kg)	9.12	8.46	6.30
ERR (%)	82.33	81.67	78.00

Good cocoon (%)	95.66	95.00	88.66
Single cocoon weight (g)	3.12	2.89	2.60
Single shell weight (g)	0.38	0.36	0.28
Cocoon shell ration (%)	12.18	12.46	10.77

Table: Bioassay data of kesseru during spring crop Feb -Mar 2016 (Average of 3 farm's data)

Particulars	**HF 008**	**HF 005**	**Mix population**
Av. number of worms/dfls brushed	1500/5	1500/5	1500/5
Feeding behaviour	Regular	Regular	Regular
Moulting behaviour	Regular	Regular	Regular
Larval duration (days)	24	24	25
Wt. of mature larva (g)	8.50	8.20	7.80
No. of cocoon harvested	1260	1240	1220
Cocoon yield/dfls (no)	255	250	240
Cut cocoon yield/100 dfls (kg)	10.71	10.00	8.40
ERR (%)	84.00	82.67	81.33
Good cocoon (%)	96.33	95.00	89.67
Single cocoon weight (g)	3.55	3.40	2.90
Single weight (g)	0.42	0.40	0.35
Cocoon shell ration (%)	11.83	11.76	12.07

Table: Average leaf biomass yield at 3 locations (Av. 3 seasons data)

Locations	**Leaf biomass yield /plant (kg)**		
	HF 008	**HF 005**	**Mix population**
Autumn	4.05	3.89	3.45
Winter	2.60	2.51	2.28
Spring/Summer	4.45	4.20	3.62
Total leaf production/year (kg)	11.10	10.60	9.35
Potential leaf yield/ha/year (spacing 2x2 m) (MT)	27.75	26.50	23.38
Institute result leaf yield/ha/year (MT)	27.57	26.72	25.00
Deviation (%)	0.65 (+)	0.82 (-)	

ONGOING R&D PROJECTS

Project Title: Establishment of Institutional Biotech Hub (Phase-II)
Duration : April 2014 – Dec., 2016
Funding agency : DBT, New Delhi
Project investigators : M. Chutia, Principal Investigator
R. Das, Co-investigator

Objectives

1. To create basic infrastructure facility for advanced research activities in the field of biological science
2. To create awareness for basic science among the young generation through workshop, training etc.

Highlights of achievements

- "Advanced diagnostic techniques of Infectious disases in insects" was organized at the institute during 21st -23rd March, at CMER&TI, Lahdoigarh, Jorhat, Assam. The workshop was attended by post graduate students, research scholars and young faculty member, delegates, including special invitees from universities and research institutes including Central Muga Eri Research & Training Institute (CMER&TI), Central Silk Board (CSB), Jorhat.
- A total of 31 participants attended the event including young faculty members, research scholars and post graduate students from Assam Agricultural University,

Jorhat; Gauhati University; Rain Forest Research Institute, Jorhat; J.B. College, Jorhat etc.

- Three college students utilised the Biotech hub laboratory for the completion of graduate level internship project
- One research scholar from Kharagpur IIT visited the biotech hubs and utilized the laboratory facility.
- Four demonstration programme were conducted during the period from 2015-16.
- Threeundergraduate students from Central College, Jorhat, pursuing their internship project on Biochemical analysis of food plants of muga silkworm.

Sl No.	Demonstration/Teaching	School/College/Institute
1	Demonstration of the usefulness and application of different sophisticated instruments of Pathology Section was given to the school students	Nakachari Junior College, Jorhat & 105 nos students.
2	Demonstration and awareness programme was organized in Pathology section for the school students to motivate the gathering knowledge on Muga silkworm with reference to disease incidence which is the endemic to Assam as well as North Eastern region.	AAU, Jorhat & 22 nos students.
3	Teaching on preparing minor school project on the life cycle of Muga silkworm	KVK, ONGC, Cinnamara, Jorhat & 7 nos visitors.
4	Demonstration programme on microbes which is responsible to infect in muga cultivation as well as their physical nature	North Bengal University & 29 visitors

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Project code: ARP-5867
Project title: Characterization, transmission and cyto-pathology of infectious flacherie and cytoplasmic polyhedrosis virus in muga silkworm *Antheraea assamensis* Helfer

Project period : July, 2013 - June 2016
Funding Agency : DBT, New Delhi
Total project cost : Rs.26.35 Lakhs

Project investigators : M. Chutia, Principal investigator
R. Kumar, Co- investigator

Objectives

1. Characterization of infectious flacherie and cytoplasmic polyhedrosis virus in muga silkworm.
2. To study the transmission pattern of the viral agents.
3. To study the cyto-pathology of midgut and silk gland from infected larvae.

Highlights of achievements

Isolation of Virus

The viral isolates were obtained from the midguts of infected larvae collected. The midguts of the diseased larvae were homogenized to collect the crude extract. This extract was used for isolation of viral agent.

Purification of Polyhedral Bodies

Then we have purified the polyhedra from infected larvae by Sucrose-Density-Gradient centrifugation according to a modification (Qanungo et al., 2000) of the method Hayashi & Bird (1970).

Isolation of Total Genomic RNA

The samples were first homogenized in liquid nitrogen in sterile morter pestle followed by Trizol reagent. Finally, RNA pellet was then washed with 70% ethanol and centrifuged. Pellet was dried and dissolved in DEPC water and stored at -80°C. Integrity of RNA was confirmed by 1% agarose gel electrophoresis. The process is being further repeated.

We have also tried to detect Nuclear Polyhedrosis Virus in infected muga silkworm. It is a dsDNA virus. So, we have isolated viral DNA from the collected samples.

Extraction of OBs

At first, the OBs were extracted from individual diseased larvae for characterization of Nuclear Polyhedrosis Virus. To each cadaver 1ml sterile distilled water was added and disrupted by vortexing. Extract was filtered through cheese cloth. The filtrate was centrifuged at 15,000×g for 5 min. The supernatant was removed. Pellet was washed with 2 ml distilled water and centrifuged. The pellet was resuspended in 1ml of sterile distilled water and stored at 4°C. These OBs were then observed under light microscope.

Isolation of Viral DNA and PCR

DNA extraction was performed by using viral DNA isolation kit according to the protocol given with the kit. The DNA yields were stored at -20°C until use.

Then we have performed the PCR to identify the polyhedrin gene in viral DNA, by using previous reported degenerate primers.

Electrophoresis of PCR Product

We have performed agarose gel electrophoresis to concentrate the PCR product to discrete a band on the gel. The PCR product was analysed by one percent agarose gel electrophoresis.

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Project code: APR - 5865

Project title: Etiology of bacterial diseases and molecular characterization of the pathogens of muga silkworm in NE India

Project period : March 2013-February 2016
Funding Agency : DST, New Delhi
Total project cost : Rs. 27.37 Lakhs
Project investigators : M. Chutia, Principal investigator
R. Das, Co- investigator

Objectives

1. Isolation of bacterial pathogens through standardization of cultural media from diseased cadavers of muga silkworm.
2. To study the biochemical and molecular characterization of the pathogens.
3. To study the epidemiology of the disease.

Highlights of achievements

Collection of sample and Isolation of bacteria:

Diseased cadavers of muga silkworm were collected from different parts of N.E India like Nangpoh (Megalaya), Boko (Kamrup), Lakhimpur & Bahgarh (Sivasagar).The samples were surface sterilized with 0.1% mercuric chloride solution and washed thrice with distilled water. After sterilization, silkworms were dissected to collect the contents from surface of foregut, midgut, and hindgut. Serial dilution was carried out from which 10^{-5}, 10^{-6} dilutions were plated on nutrient agar plates and the plates were incubated for 24 hr at 37 °C.

1) The Diseased cadavers of muga silkworm were collected and the samples were surface sterilized with 0.1 % mercuric chloride solution and washed thrice with distilled water.
2) After sterilization the silkworms were dissected to collect the contents from surface of foregut, midgut, and hindgut.
3) Serial dilution was carried out from which 10^{-5}, 10^{-6} dilutions were plated on nutrient agar plates and the plates were incubated for 24 hr at 37 °C.
4) The various media used for the isolation of the bacteria from the diseased cadavers of muga silkworm are as follows:

   - HiCrome Bacillus Agar
   - MYP Agar Base
   - EMB Agar
   - *Cetrimide HiVeg Agar* Base
   - Azide Blood Agar Base
   - Streptococcus Agar Base
   - Pseudomonas Agar

Pathogenicity test of the bacterial isolates:

The isolated pathogens are used for pathogenecity test in laboratory based on artificial environment viz. moisture, humidity, temperature, etc. Isolated Bacterial pathogens are injected and also feeded to healthy larvae to observe the disease intensity by following Koch's Postulates.

After performing pathogenicity test, 3 Nos. of bacteria were found to be pathogenic and are named as Patho-1, Patho-2, and Patho-3, respectively.

Disease symptoms and the pathogenic bacterium

The infected larvae became lethargic and motionless, soft and flaccid, inactive and vomited gut juice. The larvae released chain type excreta and exhibited rectal protrusion as well. Larval head and thorax became translucent and paralyzed. After death, the larval body turned slightly hard and blackish in colour with foul smell. The isolated pathogen was a gram-positive, rod-shaped, non-motile spore forming bacterium with the active cell size of 2.4-3.2 x 0.5-0.8 µm. It was positive towardsstarch hydrolysis, methyl red test, phenylalanine deamination, ornithine utilization, lysin utilization and oxidase test while there were negative results for citrate utilization, gelatin liquefaction, H_2S production, arabinose test, lactose test, trehalose test, adonitol test, urease test, catalase test, glucose test, sorbitol test and Voges-Proskauer test.These observations are in accordance with the reported biochemical characters of *Lysinibacillus* sp.

Molecular identification

Consensus sequence of 1427 bp 16S rDNA gene was used to carry out BLAST alignment search tool of NCBI genbank database and based on sequence data, the pathogenic bacterium was identified as *Lysinibacillus sphaericu*s strain (AAA-13) (similar to JUN-6 GenBank Accession Number: KF228925.1) based on nucleotide homology and phylogenetic analysis. The nucleotide sequence data were submitted to the NCBI with accession number KP888564.

Pathogenicity

The isolated *L. sphaericu*s strain (AAB-13) was confirmed to be pathogenic after re-inoculation in mature larvae which was administered *per os*. The pathogen was so virulent that the visual symptoms, such as cessation of feeding, vomiting, lethargic movement *etc.* were displayed within 6-12 h after inoculation.The larvae died within 2-3 days after infection. However, the degree of virulence may depend on the inoculum concentrations, host plants variability and quality, and prevailing environmental parameters (Das *et al*., 2010). The inoculum load of $\geq 10^6$ CFU/ml (LD50, 8.2 x 10^4) was observed to be sufficient for causing mortality of the larvae. To find out the virulence of AAB-13, the LD50 was determined in 4th instar larvae. Larvae were inoculated orally for establishment in the gut, with different doses, and their deaths were recorded for 3 days after challenge. The LD50 of the AAB-13 isolates was 9.4 x 10^5 at 48 h, whereas it was 8.2 x 10^4 at 72 h. The virulence was much higher and proportionate to the inoculum concentration and also differed at different time point.

Disease epidemiology

It was observed that the disease appeared throughout the year (2013-14) with the intensity varyiing in different months. This was because of the environmental factors particularly the temperature variations round the year. The season wise variations of relative humidity (82 ± 10 %) and precipitation (11.92 mm) were not significantly different (data not shown) in the sites. Extremely heavy rainfall and wind may affect the silkworm larvae during outdoor rearing if proper precaution (*e.g.*, use of nylon net) is not taken. The disease was recorded throughout the year in the rearing fields and the infection percentage varied from season to season. Temperature variations were not significantly different in the rearing sites (n=4, r^2=0.98, P<0.001), but varied season wise. The per cent disease infections (PDI) were negatively correlated with the temperature but not dependent on the RH (r^2=0.16). The disease was more prevalent during summer months (June-August) when temperature rises up to 30-35°C. However, higher temperature and RH were the most important factors for disease development.

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Project code: APR - 5866
Project title: Sustainable eri silkworm rearing: evaluation of *Ailanthus* species
Project period : March 2013–June 2016
Funding Agency : DST, New Delhi
Total project cost : Rs. 18.74 Lakhs
Project investigators : SA Ahmed, Principal Investigator
M.C. Sarmah, Co- investigator
P.K. Handique, Co-investigator
B.N. Sarkar, Co-investigator

Objectives

1. To evaluate and biochemical analysis of different *Ailanthus* germplasm

2. To evaluate and define superior genotype (s) / species of *Ailanthus* through bioassay for eri silkworm rearing.
3. To extend the information on silkworm nutrition of different *Ailanthus* species.

Highlights of achievements

Carbohydrate was found highest in semi mature leaves of Castor (44.55 %), which was at par with *A. grandis* (46.97 %) in all maturity level. High content of lignin was found in tender leaves of castor (69.63 %) which was at par with borpat (59.57 %) and lowest in borkesseru (13.33 %). Crude protein highest in borkesseru (16.25%) and lowest in kesseru (6.82 %), which was found nearly equal in both castor and borpat (8.55 - 9.76 %). Crude fat was recorded highest in castor (8.10 %) and was at par with *A. grandis* (7.60 %) and lowest in *A. excelsa* (5.10 %). Content of β-sitosterol (mg/g) recorded highest in semi-mature leaves (69.63) followed by mature (45.95) and tender leaves (31.34) of *A. grandis* compared to other food plants which was at par with castor (66.58). Chlorogenic acid which is considered as anti-herbivore chemicals recorded lowest in both *A. excelsa* (0.28 %) and *A. grandis* (0.43 %) than Kesseru (1.92 %) and castor (1.04 %) in all maturity level. Phytic acid was found comparatively highest in both castor (4.08 %) and borpat (2.89 %) than kesseru (1.29%). Crude fibre content was observed highest in semi mature leaves of Kesseru and was at par with *A. grandis* (19.54 - 25.51 %) and the castor recorded the lowest *i.e.,* 8.47 %. Total phenol recorded comparatively lower in *A. grandis* (1.09 %) than castor (2.40%) and *A. excelsa* (2.49 %) in all maturity level. Low tannins contents were recorded in *A. grandis* (0.42 %) and *A. excelsa* and Kesseru (0.35 %) compared to Castor (2.40 %).

The lowest larval period (18.33 ± 0.58 days) was observed during July-August season in the treatment of Castor (I-II) + *Ailanthusgrandis* (III-V) *i.e.,* T_2 , which was at par with *A. grandis* feeding from brushing till spinning (T_1). The highest cocoon yield per 100 dfls (14.36 ± 1.44 kg) was recorded in the treatment T_2 with average single shell weight (g) of 0.52 ± 0.04 and effective rate of rearing (%) of 90.15 ± 3.14. The highest silk recovery of 86.70 % recorded in T_2 with 11.50 % of boil off loss which was due to less content of sericin in *A.grandis* fed cocoon. Hence, *A. grandis* can be effectively utilized throughout the year in eri silkworm rearing and as the best supplement to castor during late stage rearing *i.e.,* 3rd to 5th instars. It was also found that T_2 (Castor + Borpat) is the best treatment among all other combinations.

The efficiency of conversion of ingested (ECI) in percent found highest in mature larval stage of castor (18.08 ± 0.02) which is at par with borpat (17.19 ± 0.06). The lowest ECI was recorded in borkesseru (0.11 ± 0.001). The efficiency of conversion of digested (ECD) in percent is highest in castor (1.724±0.012) in later stage and lowest in borkesseru (0.088 ± 0.002), where borpat (1.522±0.018) the second highest among them. The approximate digestibility (AD) in percent highest in early stage of borkesseru (97.745 ± 0.102) and lowest in castor (42.187 ± 0.038) and borpat (45.12 ± 0.015). The growth rate (GR) in percent is highest in 2nd instar larva of borpat (0.028 ± 0.001) and lowest in borkesseru and kesseru (0.004±0.002). The consumption index (CI) in percent was highest in early stage of borkesseru (50.962 ± 0.129) and lowest in kesseru (0.472 ± 0.028).

Project code: ARP-5868
Project title: Isolation and characterization of antifungal peptides from Muga Silkworm *Antheraeaassamensis* Helfer
Project period : May, 2014 – June 2017

Funding Agency : **DBT, New Delhi**
Total project cost : **Rs.78.28 Lakhs**
Project investigators : **Kartik Neog, Principal Investigator**
B. G. Unni, Principal investigator (NEIST, Jorhat)
A.K. Ghosh, Principal investigator (IIT, Karagpur)
S. C. Kundu, Co-investigator (IIT, Karagpur)

Objectives

1. Isolation and purification of antifungal peptides from the haemolymph of fungal challenged muga silkworms *Anthereae assamensis* Helfer.
2. Biochemical characterization of isolated antifungal peptides.
3. Determination of mode of action of antifungal peptides against various fungi of *Candida* and *Aspergillus* sp

Highlights of achievements

Cells of *Candida albicans* cells through third abdominal leg, and after 48 hrs of injection, haemolymph were collected. After removal of haemocytes through centrifugation, protein were extracted from the haemolymph using methanol: acetic acid: water (90: 1: 9) protein content was estimated and analyzed by Tricine SDS-PAGE. Tricine SDS-PAGE analysis showed induction of some protein bands of low molecular weight after fungal injection. After evaporation of methanol and freeze drying, samples were used for antimicrobial assay in pour plate method. Zone of inhibition show antifungal activity. Further analysis of extracted protein sample through reverse phase HPLC showed different peaks indicating presence of different proteins / peptides in the extracted sample. Proteins in each peak were analyzed and got total 25 antifungal peaks and 24 antibacterial peaks. Percent of inhibition showed good antibacterial activity than antifungal. Mass spectroscopy results of in-gel digestion showed similarity with chitinase, putative protein turandot and putative odorant-binding protein. Further experiments are required to analyze these proteins more critically.

Comparison of polypeptide in non-immune and immune haemolymph extracts

To obtain a haemolymph extract free from high molecular mass proteins an acidic / methanol extraction was done and analyzed by Tris-Tricine SDS-PAGE. The result showed several polypeptides of molecular mass below 21 kDa. In the extract of immune haemolymph additional peptide bands with molecular mass 3 and 14 kDa were detected when compared to the extract prepared from non-immune haemolymph. This suggested that additional bands contained peptides appearing in the haemolymph in response to immune challenge.

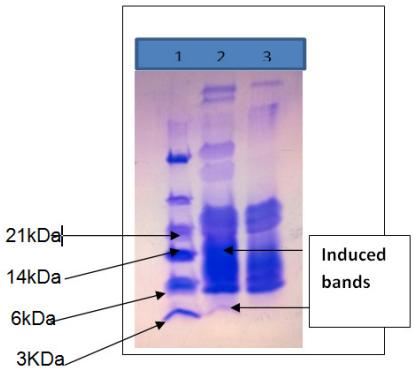


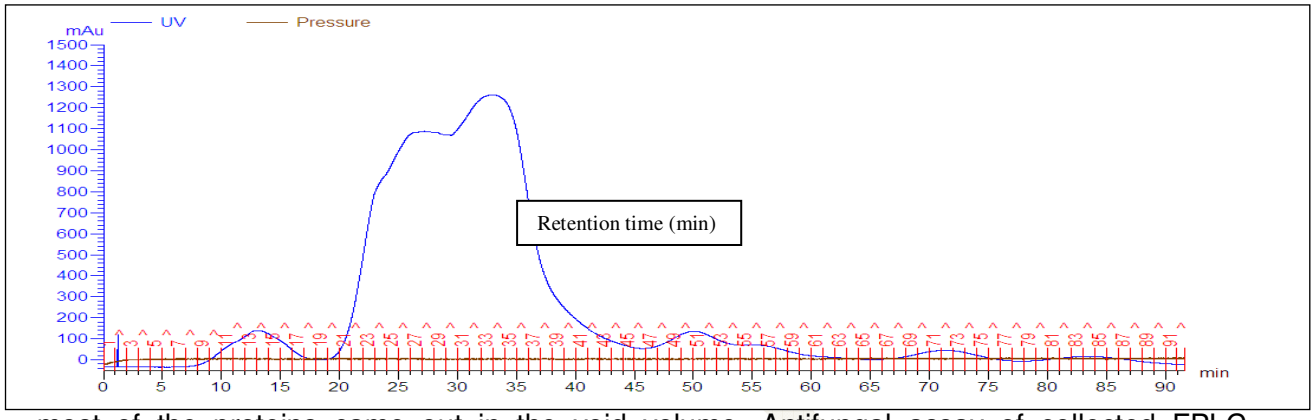
Fig. Lane 1: protein molecular marker, Lane 2: Immunized haemolymph extract, Lane 3: non-immunized haemolymph extract.

Antifungal assay of haemolymph

Antifungal assay of haemolymph was also done by spread plate method using *Candida albicans.* A clear zone of inhibition was observed around the well containing crude haemolymph extract and fluconazole but not around 0.1% TFA alone indicating presence of antifungal compound in the haemolymph.

Fractionation of immune haemolymph extract by gel filtration chromatographyand analysis of its antimicrobial activity

The first step of purification was done by gel filtration on a column of Superdex G-30 with 50 mM ammonium acetate, pH 5, as elution buffer and following picks were collected.



most of the proteins came out in the void volume. Antifungal assay of collected FPLC fractions was done by spread plate method, *Candida albicans* was spread on solidified PDA agar plate. But no zone of inhibition was observed in any collected fractions.

Fractionation of immune haemolymph extract by HPLC and analysis of its antimicrobial activity:

Due to ineffective fractionation of haemolymph extract by size exclusion chromatography, purification of immune and non-immune haemolymph extract was done through reversed phase C-18 chromatography (HPLC) column. This has allowed effective separation of proteins into several (28) peaks. The obtained fractions were collected, lyophilized and tested for antimicrobial activity. For the immunized haemolymph extract 19 fractions showed antimicrobial (8 antifungal and 12 antibacterial) activity, fraction nos. 1 and 12 showing both antibacterial and antifungal activity.

Table. Antimicrobial activity of HPLC fractions of immune haemolymph extract

Fraction no.	Anti- *Candida albicans* activity(% of growth inhibitor)	Anti- *E. coli* activity (% of growth inhibitor)
1	77.67	85.53
2	21.88	-
3	21.88	-
4	7.68	-
5	-	21.28
6	-	35.74
7	4.05	-
8	7.53	-
9	11.30	-
10	-	16.32
11	-	47.10
12	12.89	21.90
13	-	23.76
14	-	20.66

15	-	23.55
16	-	-
17	-	36.77
18	-	40.49
19	-	22.11

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Project Code: AIT-5872

Project Title: Whole Genome Sequencing and functional genomics of Golden Silk Moth *Antheraea assamensis* (Collaborative project with SBRL, Kodathi, IIT, Guwahati, ISC, Bangalore and CDFD, Hyderabad)

Project Period : 3 years (20154-18)
Funding Agency : CSB
Total Budget allocation : Rs. 11.20 lakhs.
Scientists involved : Dr. Kartik Neog (PI)

Objectives

1. To perform whole genome sequencing of prototype of *A. assamensis* and its assembly.
2. To analyze transcriptome profile of specific larval tissues of *A. assamensis* after bacterial infection and control normal larvae.
3. Identification of functional gene makers associated with silk quality from silk gland by RNA sequencing

Summary of the findings/achievements:

1. A local stock of muga silkworm was collected and being maintained in the institute.
2. Cocoons of the stock have been sent to SBRL, Kodathi, Bangalore for analysis.
3. 72 cocoons of wild origin of muga silkworm was collected from foothills of Nagaland and Assam border.
4. 15 nos. of cocoons of the wild stock have been sent to SBRL, Kodathi, Bangalore for analysis.

2. Works done / achievements made during the year (2015-16) under report

A local stock of muga silkworm was collected and being maintained in the institute. Cocoons of the stock have been sent to SBRL, Kodathi, Bangalore for analysis. 72 cocoons of wild origin of muga silkworm was collected from foothills of Nagaland and Assam border. 15 nos. of cocoons of the wild stock have been sent to SBRL, Kodathi, Bangalore for analysis. Process for DNA and sequencing analysis by the collaborating institutes particularly. SBRL, Kodathi is under progress

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Project Code: AIB-5879
Project title: Development of suitable combinations/hybrids of eri silkworm with sustainable performance for commercial exploitation

Project Period : **November, 2014 - October, 2017**
Funding Agency : **CSB, Bangalore**
Total Budget Allocation : **Rs. 3.80 Lakhs**
Project Investigators : **B.N. Sarkar, Principal investigator (I)**
M.C. Sarmah, Principal investigator (II)
S.A. Ahmed Co-investigator

Highlights of achievements

Summary of the findings / achievements

- Isolation of six pure line strains and rearing up to 5th generations has already been completed.
- Seven crosses *viz*. YP x GBZ, YZ x GBS, GBZ x YS, YS x GBS, YZ x YS, GBZ x YP and GBS x GBZ has been prepared based on established combining ability.

- The crosses *viz*. YP x GBZ, YZ x GBS, GBZ x YS, YS x GBS, YZ x YS, GBZ x YP and GBS x GBZ, breed dfls has been supplied to the seven farmers of Tamulisiga and Dadhara to evaluate the performance of cross breeds at farmers level. Rearing of the cross breed has been completed. Simultaneously the parents strain were maintaining at institute level.

Performance of generation wise rearing of isolated pure line strains in different period:

1st generation: (December, 2014 – February, 2015)

Strains	Hatching (%)	Larval wt. (g	Cocoon wt. (g)	Shell wt. (g)	Fecundity(nos.
YP	86	7.00	3.10	0.51	358
YS	82	6.80	2.95	0.46	349
YZ	89	7.40	3.20	0.54	360
GBP	83	6.90	2.88	0.43	349
GBS	80	6.70	2.75	0.44	344
GBZ	85	7.10	2.85	0.50	355
St. dev.	3.19	0.25	0.17	0.04	6.16
C. Level (95.0%	3.35	0.26	0.18	0.05	6.46

2nd generation:(March, 2015 - April, 2015)

Strains	Hatching (%)	Larval wt.(g)	Cocoon wt.(g)	Shell wt.(g)	Fecundity(nos.)
YP	85	6.90	3.00	0.48	345
YS	83	6.60	2.85	0.43	335
YZ	88	7.10	3.10	0.51	354
GBP	82	6.40	2.78	0.42	336
GBS	80	6.30	2.79	0.42	333
GBZ	86	6.90	2.88	0.46	344
St. dev.	2.90	0.32	0.13	0.04	7.99
C. Level (95.0%	3.04	0.33	0.13	0.04	8.38

3rd :generation(May, 2015 - June,2015)

Strains	Hatching (%)	Larval wt.(g)	Cocoon wt.(g)	Shell wt.(g)	Fecundity(nos.)
YP	85	6.90	3.10	0.49	344
YS	83	6.80	2.98	0.44	334
YZ	89	7.20	3.15	0.51	358
GBP	82	6.40	2.78	0.42	336

GBS	81	6.70	2.95	0.45	337
GBZ	86	6.90	2.97	0.46	349
St. dev.	2.94	0.26	0.13	0.03	9.25
Confidence Level (95.0%)	3.09	0.28	0.14	0.03	9.71

4th :generation(July, 2015 - Aug,2015)					
Strains	Hatching (%)	Larval wt.(g)	Cocoon wt.(g)	Shell wt.(g)	Fecundity(nos.)
YP	83	7.00	3.10	0.50	351
YS	83	6.60	2.85	0.43	335
YZ	87	7.20	3.16	0.52	358
GBP	82	6.40	2.78	0.42	336
GBS	80	6.30	2.79	0.42	333
GBZ	87	6.90	2.99	0.48	348
St. dev.	3.33	0.36	0.16	0.04	10.25
Confidence Level (95.0%)	3.49	0.47	0.17	0.05	10.76

5th :generation(Sept,2015 - Nov,2015)					
Strains	Hatching (%)	Larval wt.(g)	Cocoon wt.(g)	Shell wt.(g)	Fecundity(nos.)
YP	83	7.80	3.45	0.52	361
YS	84	6.90	3.00	0.46	345
YZ	87	7.60	3.46	0.55	364
GBP	80	6.72	3.10	0.42	346
GBS	81	6.80	3.12	0.44	343
GBZ	85	7.20	3.30	0.56	358
St. dev.	2.58	0.45	0.19	0.06	9.20
Confidence Level (95.0%)	2.71	0.47	0.20	0.06	9.65

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REGULAR PROGRAMMES

Project title: Induction of Indoor rearing technique for *Antheraea assamensis* Helfer through field trials.
Project period : Oct., 2011 onward
Funding agency : Central Silk Board, Bangalore
Project Investigator : K. Neog, Principal investigator

Objectives

1. Development of a comprehensive package for rearing muga silkworm under indoor conditions for its early larval instars.
2. Domestication of muga silkworm through complete indoor rearing

Highlights of achievements

Indoor rearing up to 2nd instar: 45 dfls were first brushed indoor with 72 % hatching. Up to 2nd instar 95 % survivability was observed, after which the worms were reared outdoor under nylon nets till spinning. 500 worms were utilized for experimental poses, and a total of 720 good cocoons were harvested. 430 cocoons are kept for grainage.

Complete Indoor rearing for domestication:5 dfls of 14th generations of the same stock were brushed in this month with 72 % hatching. 78 nos. of good cocoons were obtained. 37 cocoons are kept for continuation of the next generation.

Average 5th instar male larval weight in outdoor was 6.712 g and female larval weight was 8.569 g; whereas in case of complete indoor rearing, male and female larval weight was 6.176 g and 8.515 g, respectively.

Average male cocoon weight under outdoor condition was recorded to be 3.847 g while it was 5.293 g for female cocoons. In case of complete indoor rearing, male and female cocoon weight was 4.121 g and 5.418 g, respectively.

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Project title: Forecasting and forwarning for pests and disease of muga host plants and silkworm

Project Period : January, 2014 onwards
Funding Agency : Central Silk Board, Bangalore
Project Investigator : R. Das, Principal investigator
M. Chutia, Co-Principal Investigator

Objective

1. Development of forecasting and forewarning system for pests and diseases of muga host plants and silkworm to provide timely forewarn that muga farmers able to take disease management strategies against the host plant and silkworm diseases and pests

Highlights of achievements

Fungal disease in muga silkworm was recorded during December – January with more than 10 %. Bacterial disease was recorded throughout the year and found maximum (10 %) during June-July and December. Viral disease was also recorded during Feb-March, June –Aug and Nov-Dec, in Lower Assam. Uzi infestation was recorded more than 60 % in all the locations.

Pest and diseases are one of the major causes for reduction of muga production. Major foliar diseases of muga food plant som are leaf spot (*Phyllosticta perseae,*) red rust, (*Cephaleuros parasiticus*), anthracnose (*Colletotrichum gloeosporioides*f) and grey blight disease (*Pestalotiopsis desiminata*). In soalu brown blight (*Colletotrichum gloeosporioides*) and grey blight (*Pestalotiopsis thea*) are major diseases.

The major pests were recorded stem borer (*Zeuzera indica*) and leaf gall (*Aspondylia* sp&*Pauropsylla beesoni*) on som and soalu. Uzi flies (*Exorista sorbillanse / Blepharipa zebina*) are the major pest of muga silkworm.

The flacherie (*Bacillus thurimgensis*) and muscardine (*Beauveria bassiana*) disease are major disease of muga silkworm.

The diseases and pest cause a huge loss (10-43%). Accordingly on the basis of data recorded during the period forewarning calendar was developed. It is reported that leaf spot disease of som was observed from May to November but diseases intensity was more than

10PDI during July – August while in case of soalu, it was recorded more than 10% during July-August. Red rust was recorded with less than 10 PDI in som and soalu. Anthracnose disease was recorded in som from May to December with more than 10% PDI during August-September. Similarly, grey blight disease was recorded highest (more than 10%) during – September and September-October in som and soalu, respectively.

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IMPORTANT EVENTS

Vanya Reshom Krishimela at the main institute

Vanya Reshom Krishimela,of CMER&TI, Lahdoigarh was organized on 11th February, 2016 (Thursday) at Dergaon of Golaghat district of Assam. Above 400 sericulture farmers including participants from NGOs, SHGs, DOS staff and Entrepreneurs from different districts of Assam *viz*., Sivasagar, Dibrugarh, Golaghat, Jorhat *etc*. took part in the event. In the inaugural session, Shri B.Choudhury, Director I/C of the institute welcomed the invited guests and other participants of *Krishimela*. He highlighted about the achievements made by the institute in the R&D sector including the extension activities and has impact on increasing

trend of raw silk production both in muga and eri sector. He expressed that *Vanya Reshom Krishimela* is a big platform for participation of muga and eri farmers and expressed his happiness for active participation of large number farmers' in the Krishimela.

On the occasion an exhibition was also organized on different technologies on pre and post cocoon sector evolved by the institute were displayed. Several Entrepreneurs, SHGs participated in the exhibition and displayed their products including diversified fabrics. All dignitaries and farmers were impressed on the innovations of the new technologies, products etc. developed by the institute as well as SHGs. The exhibition was inaugurated by Honb'le Chief Guest, Prof & Head L.K. Hazarika, Dept. of Entomology and Dean College of Sericulture, Assam Agricultural University, Jorhat.

The inaugural session of the *Krishimela* was inaugurated by an invocation presented by artists of the institute. Dignitaries like Dr. B.K. Singh, Scientist-D and Head, MSSO, Guwahati, Shri S. Deori, Joint Secretary (Tech), Regional office, CSB, Guwahati and Shri P.K. Das, Joint Director, Upper Assam, Jorhat, Department of Sericulture, Govt. of Assam, took part in the Vanya Reshom Krishi Mela. The function was formally inaugurated by lightening of a lamp. Dr. B.K.Singh, Scientist-D, MSSO, Guwahati on his speech opined that technical session of krishimela helps in dissemination of latest technologies developed by the institute. He told that MSSO is playing significant role in production and supply of muga and eri seed to the farmers. Though MSSO is having capacity to produce 2 lakhs dfls per year, but they able to produce 6 lakhs dfls last year for their dedication and hard work. MSSO is functioning now in Public Private Partnership (PPP) mode for development of seed production strategy. Shri S. Deori, Joint Secretary (Tech), RO, Guwahati spoke on developmental schemes of Central Silk Board. He expressed that after discontinuation of CDP now more ambitious project initiated like NERTPS is being implemented. He expressed that 8 projects worth of Rs.136 crores submitted to Central Government and already been approved. He stressed upon technology dissemination from lab to field. Shri P.K. Das, Joint Director of Sericulture, Upper Assam, Jorhat and opined about scope of product diversifications like preparation of jacket, sari, tie and blending of eri yarn with other silk like muga and mulberry can enhance economical gain of farmers. Shri S.N. Konwar, a progressive farmer as well as president of *Reshom Palak Santha* expressed that large gathering in the Krishimela reflexes about interest of famers in muga and ericulture. He appealed the Department of Sericulture, Govt of Assam to work hard for development of muga and eri farmers.

In the speech of Hon'ble Chief guest Pr. L.K. Hazarika mentioned about GI of muga silk. He expressed that at present a golden revolution is needed for upliftment of vanya silk industry. This is possible through entrepreneurship development along with unstinted support from Central Silk Board and Assam Sericulture Department. Development of high yielding race, improved food plants and financial support can bring overall improvement of muga and eri farmers. He also opined that consumption of pupa can tackle protein deficiency among poor farmers. Association of private farmers along with Govt agency can solve the problem of seed sector of the industry. He offers his thanks to farmers for their active participation. He also praised for displaying of diversified products in the exhibition.

Different press media persons took part on the occasion. A technical session was organized in the occasion and scientists of the institute viz., Dr. Ranjana Das, Scientist-D, Dr. S.A Ahmed, Scientist-C and Shri G. Rajkhowa, Scientist-D presented and demonstrated about different improved technologies both in muga and eri sector through audiovisual aids. A fruitful interaction took place between farmers and the scientists. Feed back of Vanya Reshom Krishimela was also collected from the farmers in prescribed format, which is enclosed as Annexure-I.

The meeting was ended with vote of thanks.

Sadhbhavana Diwas

The birth anniversary of late Prime Minister of India, Shri Rajiv Gandhi was observed as 20/08/2015 "Sadhbhavana Diwas" in the institute. All the Scientists/Officers/staff of the

Institute assembled in the Conference Hall at 11:00 am on 20/08/2015 and took the Sadhbhavana Pledge administered by Shri B. Choudhury, Director In-charge.

Blood Donation Camp

On the occasion of National Voluntary Blood Donation Day, the Institute had organized a Voluntary Blood Donation Camp successfully at its office premises on 01.10.2015 in association with Jorhat Medical College. All the employees of CMER&TI, Lahdoigarh, and GEC, Chenijan Farm came forward in the Camp and after a thorough medical check-up by the Doctors, 10 employees of this institute have donated their blood voluntarily.

Swachh Bharat Abhiyan

After launching the **"Swachh Bharat Abhiyan"** by the Hon'ble Prime Minister of India, cleanliness drives have been conducted by the Institute as a continuous ongoing process in and around its office premises, Campus, Farms and Quarter Complexes. Special attention had been given and sanitized all the common areas like laboratories, canteen, washrooms, toilets, corridors and stairs, where regular cleaning and maintenance are required. Sufficient numbers of Dust Bins have been kept in proper places. All the unwanted old files, news papers, records etc. have been weeded out. Jungle cutting/ cleaning in all the farms have also been done in a regular basis. Special Cleanliness Drives have been conducted by the Institute on 02.10.2015 and also during the periodfrom 25.09.2015 to 31.10.2015 and 18.12.2015 to 27.12.2015 under "Swachh Bharat Abhiyan".

Vigilance Awareness Week

Vigilance Awareness Week, 2015 was observed at CMER&TI, Lahdoigarh during the week from 26th to 31.10.2015. On 26.10.2015, all the Officers and Staff of the institute have taken the "Pledge" of Vigilance Awareness Week administered by Shri B. Choudhury, Scientist-D. The messages received from the Hon'ble President, Vice President, Prime Minister, Home Minister, Comptroller & Auditor General of India, Chief Vigilance Officer have been read out by the Scientists and officers. As a part of the Vigilance Awareness Week, essay writing and debating competitions on the theme of the Awareness Week - "Preventive Vigilance is a tool for Good Governance" were organized by the Institute on 29.10.2015 in which the employees of the Institute participated with full enthusiasm. The concluding function of the Awareness Week on 31.10.2015 was chaired by Shri B. Choudhury, Scientist-D and Dr. D.K. Dev Sharma, Sub-Divisional Medical & Health Officer, Jorhat graced the function as the Chief Guest.

DBT sponsored national workshop-cum-training programme

A three-days DBT sponsored national workshop-cum-training programme on "Advanced diagnostic techniques of Infectious disases in insects" was organized at the institute during 21st -23rd March, at CMER&TI, Lahdoigarh, Jorhat, Assam. The workshop was attended by post graduate students, research scholars and young faculty member, delegates, including special invitees from universities and research institutes including Central Muga Eri Research & Training Institute (CMER&TI), Central Silk Board (CSB), Jorhat.

A total of 31 participants attended the event including young faculty members, research scholars and post graduate students from Assam Agricultural University, Jorhat; Gauhati University; Rain Forest Research Institute, Jorhat; J.B. College, Jorhat etc.

Sri B. Choudhury, Director i/c of the institute in his welcome address informed about the activities of the institute, research areas and facilities together with its mandate areas. CMER&TI is the only institute in the country and in the country doing research and developmental activities in the field of Vanya silk i.e. muga and eri silkworm. He expressed the role of Central Silk Board especially CMER&TI, Lahdoigarh in sericulture sector specially

its new technologies which are presently being disseminated to the farmers for higher silk recovery. Mr. B. Choudhury, Scientist-D of the institute informed that the main objective of the programme is to motivate young generations and to provide an idea about the recent developments in seri-biotechnology sector and hands on training on basic techniques related to seri-biotechnology. Dr. (Mrs). R. Das, Dr. M. Chutia, Dr. Rajesh Kumar, Dr. D.K. Gogoi Dr. G. Subrahmanya, Sri Jeevan B of CMER&TI, Lahdoigarh delivered lectures on different aspects of silkworm diseases and its diagnostics techniques in the workshop.

Dr. RSC Jayaraj, Director, Rain Forest Researc Institute, Jorhat attended the velidictory function of the event and encouraged the participants for their future. The participants were also informed about the available facilities at CMER&TI, provision of subsidies to procure reeling machines, procuring good dfls (disease-free laying, eggs) and seedlings of host plants etc. Laboratory experiments and field demonstration and field visit to the participants including the Insect Repository was arranged in each day of the workshop. The trainees were exposed to first-hand experience on modern tools that can be adopted for research programmes.

CMER & TI, Lahdoigarh CSB Member Secretary

Hon'ble Member Secretary of Central Silk Board, Bengaluru, Dr. H. Nagesh Prabhu visited CMER&TI, Lahdoigarh on 16th October, 2015. The Member Secretary appreciated the efforts of the institute towards R&D activities and extension works. He opined that CMER&TI, Lahdoigarh is the only institute that can promote Muga & Eri culture in the country in general and state in particular.

Research Council Meeting

The 47th Research Council Meeting of CMERTI, Lahdoigarh was held on 17th August, 2015 under the Chairmanship of Dr. K. Giridhar, Director of the institute. He emphasized on the field oriented, farmers' friendly research projects and requested the scientists to carry out the activities effectively.

Research Advisory Committee Meeting

The 30th Research Advisory Committee Meeting of CMERTI, Lahdoigarh was held on 23rd December 2015. The meeting was chaired by Prof. Bolin Kr. Konwar, VC, Nagaland University and participated by Dr. P. Jaya Prakash, Director (Tech.) of CSB, Bengaluru, Dr. N. Muraleedharan, Director of Tocklai Tea Research Institute, Jorhat, Dr. T. C. Bora, Retd. Scientist of Biotechnology Division, NEIST, Jorhat, Prof. D. K. Jha, Dept. of Botany, Gauhati University; Sri D. J. Bora, Deputy Director of Sericulture, Govt. of Assam, Sri J. Deka, Deputy Secretary (Tech.), Regional Office, Guwahati; Dr. B. B. Sinha, Sc.-D, MSSO, Guwahati, Sri Soni Vijay Kumar, Sc.-C, RSTRS, Khanapara, Sri Hema Gogoi, muga farmer, Golaghat; Smt. Lakhimai Lahon, eri farmer, Titabor; all the Scientists of the Institute and Regional Stations. Sri B. Choudhury, Director incharge of the institute highlighted the R&D activities and achievement of the institute during the last six months.

Extension Officers' Meeting

The 2nd EOM was held on 28th November, 2015 to review the progress of extension activities conducted by the main institute, its regional stations and different RECs. Sri R. Satish Kumar, Director (Finance), CSB, Bengaluru attended the meeting. He appreciated the extension activities undergoing in various levels and assured possible financial grants from the Central Office.

Renewal of ISO Certificate

The 2nd Surveillance Audit of the institute under ISO 9001 : 2008 was conducted by the Certification Body on 8th October, 2015 and renewed the certificate which is valid up to November, 2016. 2nd Surveillance Audit was held on 16th November,2015 at RMRS, BOKO to renew the certificate for another one year.

Inauguration of VC room

Video Conference facility has been established at CMERTI, Lahdoigarh in 2015. The VC room was inaugurated by Dr. H. Nagesh Prabhu, Member Secretary, Central Silk Board, Bengaluru on 16th October, 2015. The first VC session was held on 30th November, 2015 in which discussion was held with Central Office, Bengaluru.

Hindi Workshop

केन्द्रीय मूगा एरी अनुसंधान व प्रशिक्षण संस्थान, लाहडोईगढ़,जोरहाट में दिनांक 30.12.2015 को पूर्वाह्न 11.00 बजे हिन्दी कार्यशाला का आयोजित हुई जिसकी अध्यक्षता श्री डी.चौधुरी, वैज्ञानिक –डी तथा प्रभारी निदेशक ने की। उक्त कार्यशाला में 8 मंत्रित राजभाषा अधिकारी तथा नगर राजभाषा कार्यान्वयन समिति, जोरहाट का सचिव श्री अजय कुमार, उत्तर-पूर्वी विज्ञान तथा प्रौद्योगिकी संस्थान, जोरहाट उपस्थित रहें।संस्थान का सभी अधिकारी तथा कर्मचारियों ने उक्त कार्यशाला में भाग लिया। संस्थान में नव नियुक्त 9 वैज्ञानिक-डी का कार्यालयीन राजभाषा हिन्दी की अवधारणा तथा केन्द्रीय कार्यालयों में राजभाषा हिन्दी का विभिन्न प्रयोगात्मक कार्यकलाप का ब्यौरा में जानकारी देना की दृष्टि से यह कार्यशाला आयोजित किया गया। श्री अजय कुमार, राजभाषा अधिकारी, निस्ट, जोरहाट ने राजभाषा विभाग, भारत सरकार द्वारा समय-समय पर राजभाषा प्रयोग से संबंधित जो संसद में कभी-कभी राजभाषा हिन्दी का ब्यौरा उठाए गए सवाल एवं जवाब तथा राज्य वार भारत की अलग-अलग राजभाषाएं का ब्यौरा में विस्तार से व्याख्यान दिया। श्री अजय कुमार ने अपना व्याख्यान का दौरान कहा कि केन्द्रीय सरकार का कार्यालयों में कार्यरत कर्मचारीवर्ग का राजभाषा हिन्दी संबंधी सभी नियमों का अनुपालन करना अनिवार्य है। अनुपालन नहीं करना की स्थिति में सख्त कार्रवाई भी हो सकती है। इसके अतिरिक्त सवारत अधिकारी तथा कर्मचारियों का प्रशिक्षण यथा प्रवीध, प्रवीण तथा प्राज्ञ की परीक्षा में उत्तीर्ण होना की अनिवार्यता का संबंध में अवगत कराया गया। संस्थान का श्री गजेन्द्र टाया, क.हि.अ का धन्यवाद प्रस्ताव का पश्चात कार्यशाला का समापन किया गया।

EXTENSION AND TRAINING ACTIVITIES

EXTENSION EVENTS

Training under SMV

CMER&TI organised a training programme w.e.f. 5th to 8th October, 2015 for 4 days under Seri Model Village (SMV) to educate the beneficiaries of Charaideo, Sivasagar about the new technologies related to muga food plant cultivation and muga silkworm rearing. 50 muga farmers were benefited from the training programme. Sri N. Borgohain, Superintendent, Sonari, DOS Assam participating the training programme underlined the

need to adopt latest technologies developed by the Research Institute for better production of quality cocoons. Sri Sumbit Konwar, Extension Officer, Sonari, DOS Assam delivering lecture hoped that such training programme will enhance the skill of muga rearer to implement the technology in field. Dr. Ranjana Das, Sri D. Goswami and Smt. Ranuma Das, Scientists of the institute educated the trainees about latest technologies developed by the institute for muga food plant cultivation and muga silkworm rearing.

Organization of Exhibition

Central Muga Eri Research & Training Institute, Lahdoigarh, Jorhat, Assam organized a day long exhibition programme at Regional Agricultural Research Station, Titabor, Assam on November 6, 2012. Improved technologies of muga and eri host plant cultivation and their management, muga and eri silkworm rearing, muga reeling and eri spinning and different diversified products of muga and eri were attractively displayed in the exhibition. Sri N.M S.Deka, Honble' Minister of Agriculture in Assam, Dr. K.M Bujorbaruah, Honble' Vice Cencellor, AAU, Jorhat, Assam and more than 1000 farmers were visited the exhibition stall to see and learn different technologies of muga and eri culture. Many of the farmers and youth groups from different parts of Assam were found to show their kin interest to take up muga and eri culture newly with the technologies after visit the exhibition stall. Sri D. Goswami, Sri D. Mech, Scientist-C and Sri SA Ahmed, Scientist –B of CMER&TI, Lahdoigarh actively took part for demonstration the technologies displayed in exhibition invited by RARS, Titabor on the occasion of its Farmer's day.

Technology Awareness Meet at RERS, Mendipathar

A Technology Awareness Meet on Ericulture was organized at the premises of "Charaibaha Yubak Sangha",Charaibaha, Kamrup; Assam on 11th August, 2015. The meet was organized by RERS, Mendipathar; Meghalaya with the support of the State Sericulture Dept. Govt. of Assam. A total of 100 eri farmers of the area participated in the camp. Besides, 8 other dignitaries from different organizations were present in the Awareness Meet.Welcoming the gathering, Sri P. N. Borgohain, Scientist of RERS gave a brief account on the scientific technologies involved in ericulture starting from systematic plantation of eri host plants, improved silkworm rearing technology and post cocoon technology. Other dignitaries appealed the farmers to accept this traditional eri culture in a scientific way towards commercialization and as a source of family income.

Another Technology Awareness Meet cum Exhibition on ericulture was organized by RERS, Mendipathar at the Deochar village, Kamrup, Assam on 22nd August, 2015. Nine dignitaries from different private organizations, NGO and State Sericulture Department, Govt. of Assam were present in the meet. The meeting was chaired by Sri Dinesh Kalita, Head Master, D. N. D High School, Deochar. Sri S. Paliwal, Scientist of RMRS, Boko gave a detail account on the present status of ericulture in Assam and NE States. Sri Rohit Kalita, a progressive eri weaver of Deochar, explained about his ideas regarding management of his private handloom weaving industry engaging 400 nos. of handloom weavers to join in the path of self- reliance. Sri A. K. Gogoi, Scientist of RMRS explained about the package & practices of systematic Kesseru plantation. Sri Keshab Kalita, an official from the Dept. of State Sericulture, Govt. of Assam, urged the farmers to involve more actively in this economically viable culture by generating self-employment. Sri Bimal Kalita, Sri Benudhar Kalita and Sri Rupam Kalita, social workers of the Deochar area spoke on the occasion. Sri Srikant Thakuria, a Retired Teacher of Deochar Primary School actively participated in the event. Total 128 nos. of eri farmers of Deochar, Nowapara, Paneri, Banhjani, Natun Simna area of Kamrup district attended the program. In the exhibition, various exhibits were vividly displayed depicting importance of ericulture for the human society.

Awareness Meet at REC, Lakhimpur

REC, Lakhimpur organized an awareness programme on 23rd July, 2015 at Dusutimukh, Narayanpur, Laklhimpur. 55 muga rearers and graineures from the district took part in the function. The programme was chaired by Sri Dambaru Saikia, Asst. Manager of Sericulture, Naharani, Lakhimpur; Dr. K. Neog, Scientist from CMER&TI, Lahdoigarh; Sri Gopal Bhuyan, Asst. Manager, Narayanpur; Sri Nagen Saikia, S. D, Dusutimukh, Lakhimpur; Sri N. M Rahman and Kumud Gogoi, Tech. Asst's from SSPC, MSSO, Narayanpur were present in the programme. Sri S. K. Saikia, In-Charge, REC, Lakhimpur urged the farmers for adopting advanced technologies developed by Research Institute to cope up with changing scenario of global warming, pest and disease incidences, competition for land by other sectors etc. Dr. K. Neog, in his speech appraised about latest achievements made by CMER&TI. He also made the farmers aware about the website of the institute and "The Silk Portal" launched by CSB and explained the farmers how to get benefit out of it.

Sri Bulton Borah, a private graineur and progressive farmer of the region pointed out that seed supply in required quantity and quality is the main problem in muga culture, followed by non hatching of eggs of *Aherua* and *Bhadia* crops, large scale mortality of worms by flacherie disease during *Aherua* and *Bhadia* crop rearings and uzi fly infestation during *Chatua* crop. Sri Dambaru Saikia in his presidential address pointed out that, the top position of Lakhimpur district on production of muga cocoons and yarn would remain unaltered only if the farmers change their traditional attitude and apply new technologies in muga culture.

Exhibition on Ericulture at Dhopdharr

An exhibition on ericulture was organized at Dhopdhara, Goalpara, Assam on 12th August, 2015. The exhibition was organized by RERS, Mendipathar to motivate the farmers towards ericulture. In addition of 85 farmers, dignitaries from different organizations, SHG, NGO's and Officials of Dept. of Sericulture participated in the event.

Farmers Training Programme at Jaljori, Golaghar

A four days eri training programme was organized at Farmers Field School, Jaljori, Golaghat w.e.f. 8th to 11th September, 2015 in two batches covering 100 farmers. In the training programme, eri silk industry, its potentiality, scope of development, improved eri silkworm breed/ race and rearing technology, different types of eri host plants, improved method of cultivation and maintenance, improved eri seed production technology and potentiality of *Borpat* for eri silkworm rearing and eri seed production through Private Graineurs System were covered.

Farmers Training Programme at Udalguri, BTC

Two days Farmers Training Programme was organized on 28th and 29th October, 2015 at Bhurachuburi village, Sastrapara of Udalguri District of BTC, Assam. Dr. M.C. Sarmah, Dr. B.N. Sarkar and Sri D. Mech, Scientists took part in the Training programme. A total of 53 participants were present in the programme. Sri D. Mech, Sc-D, Coordinator of FFS, Udalguri explained the objective and impact of Eri Farmers Field School, Udalguri, BTC, Assam. He told that, Udalguri is now become one of the potential zone of eri cocoon production. Dr. M.C. Sarmah and Dr. B.N. Sarkar, scientists explained about eri host plant cultivation, package of eri silkworm rearing for healthy cocoon harvest. In the training programme, the advantage of rearing high yielding eri breed C2, the benefit of wooden collapsible mountage for cocooning of eri silkworm, maintenance of harvest time for cocoon after spinning, maintenance of suitable temperature and RH in the cocooning hall for proper cocooning were highlighted. Mrs. Punnya Doimari (lead farmer of FFS, Udalguri) expressed that she produced 8,000 eri dfl's in the spring crop, 2015 and generated a good income by selling the dfl's to Govt. agency.

Field day organized at Barekuri

A Field Day Programme was organized at SMV, Barekuri on 21st August, 2015. More than 100 farmers actively participated in the programme. Dr. K. Giridhar, Director, CMER&TI,

Dr. D.K. Gogoi and Dr. S.A. Ahmed, Scientists participated in the programme. Dr. S.A. Ahmed emphasized on adoption of new technologies such as disinfection, feeding techniques, rearing of improved breed (C2), platform rearing, using of improved mountage etc. for quality cocoon production for socio-economic up-liftment of eri farmers. He appreciated the efforts of eri farmers in developing the model eri village in the remote corner of Assam through adoption of the technologies. Many farmers interacted and highlighted their experiences. They informed that chawki rearing with *Castor* followed by late stage rearing (3rd instar) with *Borpat* gave the best results.

Field day at Nambarjuli, Kamrup

A Field Day was organized on 30th August, 2015 by RERS, Mendipathar at Nambarjuli, Kamrup. Sri Hari Charan Rabha, the village head of Nambarjuligaon chaired the meeting and total of 67 eri farmers participated in the programme. Ten dignitaries from the State Sericulture Dept, Govt. of Assam, social workers and the scientific staff of CSB were present on the occasion. Farmers interacted in the discussion with the CSB scientists regarding their problems facing on ericulture.

Demonstration at Charaideo

CMER&TI conducted a technology demonstration programme on maintenance of som plantation and application of organic fertilizer on 21st August, 2015 at Bormathurapur, Charaideo in Sivasagar district. Sri Dulal Goswami, Dr. Ranjana Das and Smt. Ranuma das, Scientists demonstrated the technology of pest and disease control in muga food plants, silkworm rearing and application of vermicompost in som plants 34 nos of farmers from Bormathurapur area participated in the programme.

EXTENSION ACTIVITIES IN BRIEF

- For dissemination of technologies in muga and eri culture, 4 muga and 4 eri SMV with 100 beneficiaries in each SMV and one PCT SMV covering 62 beneficiaries were implemented during 2015-16. Improvement was noticed in respect of cocoon production, raw silk production and income generation among the farmers. Cumulative impact assessment from the rearing performance during 2015-16, revealed that level of cocoon production is enhanced by 28.0 % in Muga SMV and 40.8% in Eri SMVs.
- Under Transfer of Technology (TOT) programme on Integrated Technology Package of muga culture, 508 farmers were covered. Demonstration programmes on integrated technology package of muga culture and on job practical training at the field of Lead farmers in 4 different muga FFS were conducted. Impact assessment result showed that adopting the latest technologies by the farmers, average muga cocoon yield was increased from 50 to 61 cocoons per dfl.
- 300 farmers were covered in the demonstration programmes on Integrated Technology Package of eri culture and on job practical training at the field of Lead farmers in 3 different eri FFS. Impact assessment result showed that adopting the latest technologies by the farmers, average eri cocoon (shell) yield was increased from 7.5 kg to 9.50 kg per 100 dfls.
- 4143 farmers were sensitized with the technologies developed by the institute on muga and eri culture through implementation of Seri Model villages and different training programmes organized at the institute.
- Institute organized a National Seminar 'Problems & prospects of muga and eri silk sectors' at IIE, Guwahati during 25-26th February, 2016.
- Institute conducted one Krishimela, 12 Technology Awareness Programmes, 12 Field day and 10 Group Discussions among the sericulturists.

TRAINING ACTIVITIES

- A total of 3571 beneficiaries were trained on different seri- technologies under different Training Programmes. Organized Farmers skill training of 6 days duration covering 480 farmers, Farmers skill training of 3 days duration covering 100 farmers, NIAM sponsored training programme covering 30 farmers, Tech. Orientation Programme for 24 farmers under CSS-CBT and conducted Orientation training to 16 SOs/SAs. Further, the institute organized training for the beneficiaries under SMVs & FFS, Farmers Training Programme sponsored by DOS-UP, Refresher Training Programme to RSPs and Foundation Training to CSB Young Scientists.
- Organized one national level workshop cum training programme on "Advanced diagnostic techniques of infectious diseases in insects" was organized at the institute during 21st -23rd March, 2016 where 31 scientists / scholars/ students from different organizations participated.
- Under Institutional Biotech Hub project, one workshop on "Diversity, exploration, Taxonomy and management: Advanced tools and techniques for Lepidopteran insects was organized Two demonstration and one awareness programmes were conducted and 225 nos. of students from nearby School and Colleges participated

UNITWISE EXTENSION ACTIVITIES

#	Programme	Target for the year 2015-16		Progress till end of quarter		Remarks
		Physical	Financial	Physical	Financial	
1	**Workshop/ seminar**					
	CMER&TI, Lahdoigarh	**1**	**2.00**	1	2.00	
2	**Organization of Krishimela= 4 (Unit cost Rs. 1.00 lakh)**					
	CMER&TI, Lahdoigarh	1	1.00	1	1.00	
	RMRS, Boko	1	1.00	1	1.00	
	RERS, Mendipathar	1	1.00	1	1.00	
	REC,Coochbehar	1	1.00	1	1.00	
	Total	**4**	**4.00**	**4**	**4.00**	
3	**Technology Awareness Programme - 20 nos (Unit cost Rs. 0.20 lakh)**					
	CMER&TI, Lahdoigarh	4	0.80	12	1.41	
	RMRS, Boko	3	0.60	3	0.60	
	RERS, Mendipathar	2	0.40	4	0.60	
	RERS, Shadnagar	2	0.40	2	0.40	
	REC, Tura	1	0.20	2	0.40	
	REC,Coochbehar	2	0.40	4	0.40	
	REC, Lakhimpur	2	0.40	2	0.40	
	REC, Fatehpur	2	0.40	3	0.50	
	REC, Kokrajhar	1	0.20	1	0.20	
	REC, Diphu	1	0.20	2	0.40	
	Total	**20**	**4.00**	**35**	**5.31**	
4	**Field day (Unit cost Rs. 0.20 lakh)**					
	CMER&TI, Lahdoigarh	4	0.80	12	1.05	
	RMRS, Boko	3	0.60	3	0.60	
	RERS, Mendipathar	2	0.40	4	0.50	
	RERS, Shadnagar	2	0.40	3	0.40	
	REC, Tura	1	0.20	3	0.30	

	REC,Coochbehar	2	0.40	4	0.40	
	REC, Lakhimpur	2	0.40	2	0.40	
	REC, Fatehpur	2	0.40	2	0.40	
	REC, Kokrajhar	1	0.20	1	0.20	
	REC, Diphu	1	0.20	1	0.20	
	Total	**20**	**4.00**	**35**	**4.45**	
5	**Group Discussion =70 nos (Unit cost Rs. 0.01 lakh)**					
	CMER&TI, Lahdoigarh	10	0.10	10	0.10	
	RMRS, Boko	10	0.10	10	0.10	
	RERS, Mendipathar	7	0.07	7	0.07	
	RERS, Shadnagar	6	0.06	6	0.06	
	REC, Tura	5	0.05	5	0.05	
	REC,Coochbehar	8	0.08	8	0.08	
	REC, Lakhimpur	7	0.07	7	0.07	
	REC, Fatehpur	7	0.07	7	0.07	
	REC, Kokrajhar	6	0.06	6	0.06	
	REC, Diphu	4	0.04	4	0.04	
	Total	**70**	**0.70**	**70**	**0.70**	

TRAINING PROGRAMMES

#	Name of the Programme	Target		Cumulative Progress (Up to Mar 2016)	
		Physical (Nos.)	Financial (Rs. in Lakh)	Physical (Nos.)	Financial (Rs. in Lakh)
1	**Farmers Skill Training (6 days)**				
	CMER&TI	600	22.50	621	19.934
	RMRS, Boko	300	11.25	314	11.250
	RERS, Mendipathar	300	11.25	300	11.250
	REC, Coochbehar	150	5.625	163	5.625
	REC, Tura	150	5.625	150	5.625
	REC, Lakhimpur	150	5.625	150	5.625
	Total	**1650**	**61.875**	**1698**	**59.309**
2	**Farmers Skill Training (3 days)**				
	CMER&TI	200	4.000	225	3.950
	RERS, Shadnagar	100	2.000	125	2.000
	REC, Fatehpur	100	2.000	100	2.000
	Total	**400**	**8.000**	**450**	**7.950**
2	Exposure visit	90	2.250	90	2.250
3	Tech. Orientation Programme	75	2.250	24	0.670
4	**Training Programme funded by agency other than CSB**				
	DOS Staffs of UP	65	1.790	65	1.790
	NIAM sponsored training programme	150	5.000	90	2.940
5	Training Impact Assessment	1	2.000	0	0
6	Sericulture Resource Centre	4	13.00	0	0
7	Training Capex	-	-	-	-
8	**Other Misc. Training Programme**				

	Orientation training to SOs/SAs	19	0.160	16	0.160
	Foundation Training to CSE Young Scientists	60	4.910	60	4.330
	Refresher training to RSP	204	5.100	190	4.330

PLAN FOR LAND USE AND RESOURCE CONSERVATION (As per earlier Action Plan)

A	Raising of seedlings/ sapling (nos)	Target	Achievement	Remarks
	Som / Soalu seedling			
1	CMER&TI, Lahdoigarh	20000	-	
2	RMRS, Boko	20000	50000	
3	REC, Lakhimpur	5000	5000	
4	REC, Coochbehar	5000	5000	
B	**Raising of Kesseru seedlings**			
1	CMER&TI, Lahdoigarh	25000	15000	
2	RERS, Mendipathar	10000	7500	
3	REC, Kokrajhar	5000	-	
C	**Supply of Som seedlings**			
1	CMER&TI, Lahdoigarh =	15000	6000	
2	RMRS, Boko	20000	25600	
4	REC, Lakhimpur	3000	263	
5	REC, Coochbehar	5000	3000	
D	**Supply of Castor seeds (Kg)**			
1	RERS, Mendipathar	40	43	
2	REC, Diphu	40	18	
E	**Supply of kesseru seedlings**			
1	CMER&TI, Lahdoigarh	25000	6400	
2	RERS, Mendipathar	5000	7100	
F	**Silkworm rearing**			
	Muga Commercial rearing (gm Dfl)			
1	CMER&TI, Lahdoigarh	3035	1497	
2	RMRS, Boko	2500	760	
3	REC, Lakhimpur	500	320	
4	REC, Coochbehar	500	530	
5	REC, Kokrajhar	400	200	
	Muga Seed crop rearing (gm Dfl)			
1	CMER&TI, Lahdoigarh	1700	2384	
2	RMRS, Boko	700	2576	
3	REC, Lakhimpur	400	297	
4	REC, Tura	600	1000	
5	REC, Coochbehar	600	600	
	Eri silkworm rearing (dfl)			
1	CMER&TI, Lahdoigarh	550	441	
2	RERS, Shadnagar	400	200	
3	RERS, Mendipathar	500	500	
4	REC, Kokrajhar	200	-	
5	REC, Diphu	200	150	
	REC, Fatehpur	100	-	

G	**Cocoon production**			
	Muga Commercial cocoons (Nos.)			
1	CMER&TI, Lahdoigarh	183000	39918	
2	RMRS, Boko	150000	28557	
3	REC, Lakhimpur	30000	1295	
4	REC, Coochbehar	30000	5600	
5	REC, Kokrajhar	24000	3903	
	Muga Seed cocoons (Nos.)			
1	CMER&TI, Lahdoigarh	68000	61501	
2	RMRS, Boko	28000	8955	
3	REC, Lakhimpur	16000	2352	
4	REC, Tura	24000	27064	
5	REC, Coochbehar	24000	6538	
	Eri cocoons (Kg)			
1	CMER&TI, Lahdoigarh	48	33.6	
2	RERS, Mendipathar	40	33.7	
3	RERS, Shadnagar	32	35.0	
4	REC, Kokrajhar	16	-	
5	REC, Diphu	16	7.9	
6	REC, Fatehpur	8	-	
H	**Muga dfl production (gm)**			
1	CMER&TI, Lahdoigarh	17000	19917	
2	RMRS, Boko	8000	11240	
3	REC, Lakhimpur	3000	553	
4	REC, Tura	4000	2145	
5	REC, Coochbehar	4000	1400	
	Eri dfl production (No.)			
1	CMER&TI, Lahdoigarh	2000	3915	
2	RERS, Mendipathar	7000	9845	
3	RERS, Shadnagar	2000	200	
4	REC, Diphu	2000	2000	
I	**Dfl supply**			
	Muga dfl supply (gm)			
1	CMER&TI, Lahdoigarh	17000	19917	
2	RMRS, Boko	6800	8974	
3	REC, Lakhimpur		-	
4	REC, Tura	4000	2045	
5	REC, Coochbehar	4000	1320	
	Eri dfl supply (No.)			
1	CMER&TI, Lahdoigarh	1650	3915	
2	RERS, Mendipathar	7000	9345	
3	RERS, Shadnagar	2000	200	
4	REC, Diphu	2000	1398	

Other Achievements

1) The institute graded as "**excellent"** in RFD achievement during 2015-16 and secured 93.5 score in total.

2) **Developed Insct Repository** for insect fauna of seri-ecosystem and wild silk moths of North East India AT Entomology Section, CMER&TI, Lahdoigarh

3) **Dr. M. Chutia, Scientist C** of CMER&TI received Post Doctoral Fellowship in the University of Leciester, UK and worked on **bacteriophages those infect clinical and environmental strains of *Clostridium difficile* and *Pseudomonas aeruginosa* and their therapeutic application** from February 2015 to January 2016. The work carried out by Dr. Chutia was highlighted by the University Press and British Media (BBC News) for his novel techniques used in the study to treatment of bacterial infection.

RESEARCH PUBLICATIONS
(2015-16)

Research articles/ Book Chapter

1. Ahmed SA, Singh NI, Sarkar CR (2015) Role of forest biodiversity in conservation of non-mulberry silk in India. *Munis Entomology & Zoology*, 10 (1): 342-357.
2. Bhuyan D, Dutta K, Sarmah MC, Sarkar BN, Neog K (2015) Effect of differential feeding on eri silk worm *Samia ricini* (Donovan) and its pupal protein concentration. *International Journal of Education and Science Research*. II (5): 21-24.
3. Das AK, Khanikor B, Neog K (2016) Biology of *Cotesia dictyoplocae* Watanabe (Hymenoptera: Braconidae) a parasitoid of *Antheraea assamensis* Helfer (Lepidoptera: Saturniidae). *Journal of Entomology and Zoology Studies* 4(2): 236-240.
4. Das R, Das K (2016) Effect of abiotic factors on infestation of uzifly in different instar muga silkworm, *Antheraea assamensisi* Munis Entomology and Zoology, 11, No. 1, January 2016
5. Dash C, Ahmed SA, Giridhar K (2015) Women empowerement through technological interventions in ericulture: A case study in Upper Assam, *Journal of Community Mobilization and Sustainable Development* , 9(2):124-128
6. Gupta A, Das AK, Neog K, Verghese A (2016). First report of *Cotesia dictyoplocae* (Watanabe) (Hymenoptera: Braconidae) from India, a larval parasitoid of *Antheraea assamensis* Helfer (Lepidoptera: Saturniidae). Florida Entomologist (accepted).
7. Kumar R, Chutia P, Gogoi B, Ahmed M, Rajkhowa G (2015) A new record of *Bibasis gomata* (Lepidoptera: Hesperiidae) on kesseru, *Heteropanax fragrans* (Roxb.) from India. *Munis Entomology & Zoology*, 10 (2): 502-505
8. Kumar R, Mittal V, Chutia P, Ramamurthy VV (2015) Taxonomy of *Fulgoraecia melanoleuca* (Fletcher, 1939), (Lepidoptera: Epipyropidae) in India, a biological control agent of *Pyrilla perpusilla* (Walker) (Hemiptera: Lophopidae). *Zootaxa,* 3974 (3): 431–439.
9. Mech D, Kumar R, Singh NI, Goswami D, Das R, Giridhar K (2015) Impact of Front Line Demonstration on Muga Cocoon Yield at Farmers' Level in Assam, India. *Asian Journal of Agricultural Extension, Economics & Sociology* 8(2): 1-8, 2016.
10. Neog K, Dutta P, Goswami D (2015) Studies on moisture retention capacity of som and soalu genotypes and its impact on survival of early instar muga silkworm A*ntheraea assamensis* Helfer under indoor conditions. World Journal of Pharmaceutical Research, 4 (7), 876-882.
11. Sarkar BN, Sarmah MC, Ahmed SA, Giridhar K (2015) Eri silkworm rearing on perennial host plant. *Indian Silk*. 5-6 (53-54 old) 12-2: 30-32.
12. Sarkar BN, Sarmah MC, Giridhar K (2015) Grainage performance of eri silkworm *Samia ricini*(Donovan) fed on different accession of castor food plants. *International Journal of Ecology and Ecosolution,* 2(2): 17-21.
13. Sarmah MC, Sarkar BN, Ahmed SA, Giridhar K (2015) Performance of C2 breed of eri silkworm, *Samia ricini* (Donovan) in different food plants. *Entomology and Applied Science Letters 2, 1:47-49*

Papers presented in the conference/ seminars

1. Ahmed SA, Dash C, Gogoi B, Sarmah MC (2015) Role of eri culture in harnessing untapped oppurtunities in diversified silk sector. Proceedings on UGC sponsored National Seminar on Future of Muga and Pat industry in Sualkuchi areas of Assam, 29th-30th April 2015, pp. 26-27.

2. Ahmed SA, Dash C, Sarmah MC (2016) Inclusive rural development and mitigation of environmental challenges through adoption of innovative approaches and technologies in ericulture. Abstracts National Workshop on Emerging Needs and Critical Gaps in Muga and Eri Silk Sectors organized by MSSO, Guwahati on 10-11 March, 2016 at ASAMB, Ulubari, Guwahati pp 49.
3. Ahmed SA, Gogoi B, Sarkar CR, Singh NI (2016) Role of Primary and Secondary metabolities of *Ailanthus* leaves in rearing performance of Eri Silkworm. National Seminar on Problems and Prospects of Muga and Eri Silk Sectors organized by CMER&TI, Lahdoigarh on 25-26 February, 2016 at Guwahati, pp. 40-46
4. Bhuyan D, Sarmah MC, Dutta K (2016) Seasonal variation on the rearing performance of eri silkworm, *Samia ricini* (Donovan) reared on Kesseru *Heteropanax fragrans*. National Seminar on Problems and Prospects of Muga and Eri Silk Sectors organized by CMER&TI, Lahdoigarh on 25-26 February, 2016 at Guwahati pp. 101
5. Bhuyan PM, Sandilya SP, Kardong D, Gogoi DK (2015) Isolation and characterization of cellulolytic gut-bacteria of muga silkworm reared in different localities of Assam. Paper presented in the *National Symposium on Bioresources Sustainable Devlopmant,* 28th to 29th Oct, 2015.
6. Bhuyan PM, Sandilya SP, Kardong D, Gogoi DK (2015) Isolation and characterization of cellulolytic gut-bacteria of muga silkworm (*Antheraea assamensis* Helfer) reared in different localities of Assam". Paper presented in the National symposium on "*Bioresources and Sustainable Development"* 28th to 29th October, 2015.
7. Bhuyan PM, Sandilya SP, Kardong D, Neog K, Gogoi DK (2016) Isolation and characterization of lipase producing gut-bacteria of muga silkworm (*Antheraea assamensis* Helfer) reared in different localities of Assam. Paper presented in the National Seminar on "Problems & Prospects of Muga and Eri Silk Sectors" organized by CMER&TI, CSB, Lahdoigarh, Jorhat at Indian Institute of Entrepreneurship, Lalmati, Guwahati, w.e.f. 25th to 26th February' 2016.
8. BN Sarkar et al. (2016) A study of eri silkworm *Samia ricini* (Donovan) embryonic development (National Seminar on Problems and Prospects of Muga and Eri Silk Sectors organized by CMER&TI, Lahdoigarh on 25-26 February, 2016 at Guwahati pp. 65-68.
9. Changmai A, Dutta P, Gogoi DK, Neog K (2016) Antimicrobial Peptides: Role in Silkworm Immunity. Paper presented in the National Seminar on "Problems & Prospects of Muga and Eri Silk Sectors" organized by CMER&TI, CSB, Lahdoigarh, Jorhat at Indian Institute of Entrepreneurship, Lalmati, Guwahati, w.e.f. 25th to 26th February' 2016
10. Chutia M, Sahota J, Nale JY, Clokie MRJ (2016) Developing *Galleria* model for assessing phage therapy in *Pseudomonas aeruginosa* infection. Paper presented in 'Bacteriophage 2016' conference organized by *EuroSci* held at O_2 Arena, London during 19-21st January 2016, Abstract book p. 11-12
11. Gogoi B, Ahmed SA (2016) Effect on Growth and Nutrition of Eri Silkworm, Samia ricini (Donovan) with reference to Ailanthus Germplasm. National Seminar on Problems and Prospects of Muga and Eri Silk Sectors organized by CMER&TI, Lahdoigarh on 25-26 February, 2016 at Guwahati, pp. 69-73
12. Neog K, Changmai A, B. Choudhury (2016) Evaluation of different host plants in terms of biochemical properties, rearing performance and cocoon characters of muga silkworm *Antheraea assamensis* Helfer. Paper presented at 103rd Conference of Indian Science Congress Association held at Mysore, 3-7th January, 2016.

13. Neog K, Changmai A, Choudhury B (2015) Evaluation of different host plants in terms of biochemical properties, rearing performance and cocoon characters of muga silkworm *Antheraea assamensis* Helfer. Paper accepted for Oral Presentation at 103rd Conference of Indian Science Congress Association to be held at Mysore, 3-7th January, 2016.
14. Neog K, Changmai A, Choudhury B (2015) Evaluation of different host plants in terms of biochemical properties, rearing performance and cocoon characters of muga silkworm. Paper accepted for Oral Presentation at 103rd *Conference of Indian Science Congress Assocation* to be held at Mysore, 3-7th Jan 2016.
15. Neog K, Choudhury B (2016) Field efficacy of *Terminelia chebula* based bioformulation "Muga Heal" for healthy larvae and production of quality silk fibre by muga silkworm. Paper presented in the National Seminar on Emerging needs and Critical Gaps in Seed production in Muga & Eri Sector organized by MSSO, CSB, Guwahati w.e.f. 10th & 11th March, 2016.
16. Neog K, Choudhury B (2016) Preliminary report on the effect of phytoecdysteroid Sampoorna on synchronization of maturation and cocoon characters in silkworm *Antheraea assamensis,* Helfer. Paper presented in the National Seminar on "Problems & Prospects of Muga and Eri Silk Sectors" organized by CMER&TI, CSB, Lahdoigarh, Jorhat at Indian Institute of Entrepreneurship, Lalmati, Guwahati, w.e.f. 25th to 26th February' 2016
17. Neog K, Dutta P, Gogoi D, Mech D, Choudhury B (2016) Insect stimulants on the growth, development and productivity of muga silkworm, Paper presented in the National Seminar on Emerging needs and Critical Gaps in Seed production in Muga & Eri Sector organized by MSSO, CSB, Guwahati w.e.f. 10th & 11th March, 2016.
18. Neog K, Giridhar K (2015) Field efficacy of juvenile hormone analogue methoprene on the growth, cocoon characters and fecundity of muga silk worm *Antheraea assamensis* Helfer (Lepidoptera: Saturniidae). Paper accepted for Best Poster Award Presentation at 103rd Conference of Indian Science Congress Association to be held at Mysore, 3-7th January, 2016.
19. Neog K, Giridhar K (2015) Field efficacy of juvenile hormone analogue methoprene on the growth, cocoon characters and fecundity of muga silk worm. Paper accepted for Best Poster Award Presentation at 103rd *Conference of Indian Science Congress Assocation* to be held at Mysore, 3-7th Jan 2016.
20. Sandilya SP, Bhuyan PM, Kardong D, Neog K, Gogoi DK (2016) *Bacillus firmus* MAJ PSB12, A P solubilizing rhizobacteria and its plant growth promoting ability in eri silkworm host plant castor (*Ricinus communis* L). Paper presented in the National Seminar on "Problems & Prospects of Muga and Eri Silk Sectors" organized by CMER&TI, CSB, Lahdoigarh, Jorhat at Indian Institute of Entrepreneurship, Lalmati, Guwahati, w.e.f. 25th to 26th February' 2016.
21. Sarkar BN et al (2016) Role of abiotic factor in eri silkworm *Samia ricini* (Donovan) egg desiccation and hatching failaure during summer season Abstracts National Workshop on Emerging Needs and Critical Gaps in Muga and Eri Silk Sectors organized by MSSO, Guwahati on 10-11 March, 2016 at ASAMB, Ulubari, Guwahati pp. 31.
22. Sarmah MC, Sarkar BN, Ahmed SA, Choudhury B (2016) New wooden collapsible strip type mountage for eri- a breakthrough. National Workshop on Emerging Needs and Critical Gaps in Muga and Eri Silk Sectors organized by MSSO, Guwahati on 10-11 March, 2016 at ASAMB, Ulubari, Guwahati.
23. Sarmah MC, Sarkar BN, Ahmed SA, Choudhury B (2016) Promotion of eri culture in North East India –a road map. National Seminar on Problems and Prospects of

Muga and Eri Silk Sectors organized by CMER&TI, Lahdoigarh on 25-26 February, 2016 at Guwahati pp 28-34.

Technical bulletins / leaflets/booklets

1. Kendriya muga eri o prasikshan pratitshan, Kaljoyi
2. Eri hutanere toiyari vashra hamogri aru iyar bybakxiyik dikh.
3. এৰী পলুৰ উন্নত জাত ছী-2 পালনৰ উন্নত পদ্ধতি Eri polur natun unnat jat “C2” palonor unnat paddhati
4. চোম গছৰ বজ্ঞ্ঞানকি কৃষি পদ্ধতি
5. Som gasor baigyanik krishi paddhati
6. মুগা পলুৰ উন্নত কাৰকিৰী কৌশল Muga polu palonor unnat karikori kaushal
7. নৰিোগী মুগা সচ উত্পাদন প্ৰনালী Nirogi muga sans utpadon pranali
8. উৰ্জি মাখৰি জৈবিকি নযিন্ত্ৰন
9. Uzi makhir jaibik niyantran
10. মুগা খাদ্য বৃক্ষৰ মজ্জা খোৱা পোক নযিন্ত্ৰন
11. Muga khadya brikhyar majja khowa puk niyantran
12. এৰী পলুৰ খোলা সজাৰ উন্নত আহলিা
13. Eri palur khola bandhar unnat aahila
14. এৰী পলুৰ খাদ্য বৃক্ষ ৰোপন অৰু প্ৰতপিালন পদ্ধতি
15. Eri polur khadya brikhya rupon aru pratipalon paddhati
16. মথিোপ্ৰীন ব্যৱহাৰৰ জৰয়িতে মুগা চকৰীৰ পৰা অধীক কনি উত্পাদন পদ্ধতি
17. Mithoprin biywahar jariyate muga chakarir para adhik kani utpadan paddhati
18. মুগা পালনত ৰোগ নবিাৰনৰ অৰ্থে পৰশিোধকৰ প্ৰস্তুত্কৰন অৰু ব্যবহাৰ
19. Muga palanat rog nibaranar arthe parihodhokor prastutkaran aru bibyahar
20. Utpadamkham C-2 sankar jator eripolu palon
21. Eri hutare toiyari basra hamgri aru iyar byaboyashik dikh

Book/booklets/ news items

1. Singh BK, Ahmed SA, Velayudhan K, Singha BB, Sahu M, Choudhury R, Baruah NB, Das, Bitopan B (2015) Ericulture- at a glance. Published by MSSO, Central Silk Board, Guwahati
2. Proceedings of National Seminar on Problems and Prospects of Muga and Eri Silk Sectors Edited by S.A. Ahmed, R. Kumar, K. Neog and M.C. Sarmah (2016), Published by Director, CMER&TI, Lahdoigarh
3. U. Hazarika and Vinod Kumar (2016) Soil Sampling and Analysis (A Practical Manual for Soil Fertility Analysis.
4. M.D. Senapati (2015) Eri Awareness. The Asomia Khabar, 14th July,2015
5. M.D.Senapati (2015) Adhunik Padhatire Eri Polu Palan. The Asomia Khabar, 8th August,2016

Newsletters

1) CMER&TI Sericultural News: Vol. 16: January-June, 2015 and Vol. 17 July-December, 2015
2) CMER&TI ***Hindi Newsletter***: Vol. 3; January-June, 2014 and Vol. 4 July-December, 2015.

Workshop/Training Attended

1. Dr. Rajesh Kumar, attended training as a resource person of fruit fly in the training entitled "Fruit fly identification and management training" held during 14-18 August, 2015 at PPD, Kathmandu, Nepal.
2. Dr. B. Choudhary, Dr. K. Neog and Dr. M. C. Sharma attended training on "Work Ethics for Development Professionals" held during 10-12 August, 2015 at NIRDPR-NERC, Guwahati (Assam).
3. Dr. N. I. Singh, Dr. Rajesh Kumar and Dr. S. N. Bagchi attended training on quarantine procedures under CSB Act-2006 held during 14-16 October 2015 at NSSO, CSB, Bangaluru.
4. Shri. D. Mech, Dr. B. N. Sarkar and Dr. S. A. Ahmed attended training as a resource person training entitled "Training Programme on Professional Skills for Trainers of Extention Institutions" held on 01-04 December, 2015 at NIRDPR-NERC Guwahati (Assam).

New Recruitment

Following nine scientists have been recently joined at CMER&TI, Lahdoigarh.

1. Mr. Dharmendra Kumar Jigyasu	Environment and Ecology
2. Dr. Kh. Subadas Singh	Zoology (ENT)
3. Mr. Rajal Debnath	Biotechnology
4. Dr. Gangavarapu Subrahmanyam	Microbiology
5. Dr. Dr. Ranjini M. S	Zoology (Genetics)
6. Dr. Vinodakumar S. Naik	Agronomy
7. Dr. Prashanth Sangannavar	Genetics and Plant Breeding
8. Mr. Jeevan. B	Plant Pathology
9. Mr. Vijay. N	Agricultural Statistics

Promotion of Scientist

- Dr. Urmimala Hazarika of PMC section and Dr. M. C. Sarmah of GCC, Chenijan have been promoted to Scientist-D under Modified Flexible Complementing Scheme of CSB w.e.f. 1st January, 2016.

Retirement from Servic

1. Dr. K Giridhar	Director	30.11.15
2. Dr. P. K. Handique	Scientist D	31.12.15
3. Sri. Naren Ch. Saikia	T. A	30.09.15
4. Sri. Mohendra Boruah	T. A	31.08.15
5. Sri. Bhubon Ch. Boruah	Watchman	31.10.15

वर्ष 2015-16 का दौरान राजभाषा हिन्दी की गतिविधियां तथा उपलब्धियां

केन्द्रीय मृग एरी अनुसंधान केन्द्र,केन्द्रीय रेशम बोर्ड , लाहाईगढ़, जोरहाट पूर्वोत्तर (असम))7 भारत का प्रमुख अनुसंधान संस्थान है जो पूर्वोत्तर भारत केसातका राज्यों का अतिरिक्त देश का (कई राज्यों का रेशम कृषकों का सम्मिलित कर देश का मूगा और एरी क्षेत्र में अनुसंधान तथा विकासात्मक कार्यों सेसंबंधित विभिन्न योजनाएं का सफलकार्यान्वयन तथा इसका मार्ग प्रशस्त करना में निरन्तर प्रयासरत है।

भारत ,गृह मंत्रालय ,का हिन्दी अनुभाग द्वारा राजभाषा विभाग इसका अतिरिक्त संस्थान सरकार द्वारा जारी वार्षिक कार्यक्रम तथा समय समय पर अपनेमुख्यालय सेप्राप्त विभिन्न ादेशा का अनुपालन कर उन ादेशों में दिए गए लक्ष्य प्राप्त किया गया। वर्ष में राजभाषा हिन्दी का कार्यान्वयन में प्राप्त लक्ष्य का विवरण मेवार नीचेदिया गया है।

1. राजभाषा अधिनियम 1963 की धारा 3(3) का अंतर्गत जारी कागजात - 595
2. भेजेगए पत्रादि का पूरा ब्यौरा

क्षेत्र	हिन्दीi/ द्विभाषी में	केवल अंग्रेजी में	भेजेगए पत्रादि की कुल संख्या	हिन्दीi/ द्विभाषी में भेजे गए पत्रों का प्रतिशत
क	111	29	140	79 %
ख	-	-	-	-
ग	3873	1600	5473	71 %

3. फाइलों पर हिन्दी में टिप्पण

	हिन्दी में	अंग्रेजी में	कुल संख्या
वर्ष का दौरान लिखी गई टिप्पणी	498	631	1129

4. हिन्दी कार्यशाला संस्थान में वर्ष 2015-16 का दौरान राजभाषा हिन्दी संबंधी नियम और हिन्दी टंकण

पर चार हिन्दी कार्यशालाएं हुई थीं जिसका विवरण नीचेदिया गया है।

कार्यशाला की तिथि	प्रशिक्षित अधिकारीकर्मचारी की कुल संख्या 79
1. 30.06.2015	प्रशिक्षित अधिकारी की संख्या - 37
2. 29.09.2015	प्रशिक्षित कर्मचारी की संख्या - 42
3. 30.12.2015	

4. 31.03.2016

5. अधीनस्थ इकाइयों में □ यांजित किए गए राजभाषा□ हिन्दी निरीक्षण का□ ब्यौरा□
   1. क्षेत्रीय मूग□ अनुसंधान, □क्रा□ असम।
   2. अनुसंधान विस्तार कान्द्र, कूचबिहार (प.□गाल)
   3. अनुसंधान विस्तार कान्द्र- तुरा□ (मेघालय)
   4. अनुसंधान विस्तार कान्द्र - काकराझार (□ी.टी.सी.)

<u>संस्थान में हिन्दी पखवाड़ा□ और हिन्दी □िवस मनाया□ गया□</u>

प्रत्यक्ष वर्ष की तरह इस वर्ष भी संस्थान में □िनांक 2015 ,सितम□र 11 स□ 1तक हिन्दी पखवाड़ा□ का□ □ यांजन किया□ गया□ इस □ौरान हिन्दी नि□न्ध लेखन,ड्राफ्टिं-नोटिंग ,गशब□वाली व , हिन्दी क्यूज प्रश्नाली और हिन्दी गीत जैसी प्रतियोगिताएं □ यांजित की गई जिसमें सभी ,अनुवा□ अधिकारी व कर्मचारियों न□भरचर भाग लिया□ □िनांक 2015 ,सितम□र 14क□ हिन्दी □िवस तथा□ समापन समारोह का□ □ यांजन संस्थान का प्रभारी नि□ेशक श्री □ी चौधुरी की .अधक्ष्यत□ में किया□ गया□ उनका□ द्वारा□ □ीप प्रज्जलन करना□का पश्चात कार्यक्रम का□ श्रीगणेशा किया□ गया□

कार्यक्रम में हिन्दी □िवस का□ उपलक्ष्य मा□कान्द्रीय राभाम □ो□ें गलूरू अध्यक्ष तथा□ , स□स्य सचिव द्वारा□ जारी संदेशा का□ पाठ किया□ गया□ इस कार्यक्रम में हिन्दी पखवाड़ा□का □ौरान □ यांजित हिन्दी प्रतियोगिताओं में विजित प्रतिभागियों का□ क्रमश प्रथमतृतीय तथा□ ,द्वितीय , सांत्वना□ पुरस्कर स□पुरस्कृत किया□ गया□

वर्ष का□ □ौरान संस्थान तथा□ इसका□ अधीनस्थ इकाइयों का□ जिन अधिकारी तथा□ कर्मचारियों न□मूल रूप में हिन्दी में काम कियाय राभाम □ो□ की उ□ार यांजना□ का□ तहत नका□ का□ कान्द्री , पुरस्कार प्रा□न किया□ गया□

इसका□ अतिरिक्तसंस्थान का□ अनुभागों तथा□ इसका□ अधीनस्थ इकाइयों द्वारा□ वर्ष का□ □ौरान , राजभाषा□ हिन्दी का□ □ेहतर कार्य निष्पा□न करना□वाला□संस्थान का□ अनुभागों तथा□ इसका□□अधीनस्थ इकाईयों का□ क्रमशःपत्र प्रा□न किया□ गया□ जिसका□ विवरण नीचा□ -तथा□ पुरस्कर का□ रूप में प्रमाण , -□ीया□ गया□ है

संस्थान का□ अनुभागों का नाम जिन्हें प्रमाण -पत्र प्रदान किया गया-

1. पी. एम. सी, अनुभाग - प्रथम
2. स्थापना□ अनुभाग - द्वितीय,
3. लेखा□ परीक्षा□ तथा□ लाक निर्माण अनुभाग - तृतीय
4. विस्तार अनुभाग और स्थापना□ अनुभाग (निजी अनुभाग) - चतुर्थ

अधीनस्थ इकाईयों का नाम जिनका प्रमाण-पत्र प्रदान किया गया-

1. एरी अनुसंधान प्रसार कान्द्र, फतेहपुर (उत्तर प्रा□ेा) - प्रथम
2. अनुसंधान विस्तार कान्द्र, कुचबिहार (पश्चिम □गाल) - द्वितीय,
3. क्षेत्रीय एरी अनुसंधान कान्द्र, □क्रा□ कामरूप (असम) - तृतीय
4. क्षेत्रीय एरी अनुसंधान कान्द्र,शा□नगर,(□ न्ध्र प्रा□ेा) - चतुर्थ

और अनुसंधान विस्तार केन्द्र,कोकराझार,(टी.टी.सी.)

.7 संस्थान में हिन्दी तथा द्विभाषी में कई पत्रिकाएं प्रकाशित किए गए जो निम्नवत हैः-

1. हिन्दी न्यूज लेटर, खण्ड-III,अवधिः- जनवरी- जून,2015 व न्यूज बुलेटिन (अंग्रेजी-हिन्दी)
2. हिन्दी न्यूज लेटर, खण्ड-IV,अवधि- जुलाई-दिसम्बर,2015 व न्यूज बुलेटिन (अंग्रेजी-हिन्दी)
3. इसके अतिरिक्त, संस्थान में पहली बार असमीया, हिन्दी व अंग्रेजी ई-मैगजीन (2015-2016) के
   प्रकाशन किया गया।

.8 संस्थान द्वारा राजभाषा हिन्दी में बेहतर कार्य करने पर प्राप्त पुरस्कार व प्रशस्ति पत्र

वर्ष के दौरान राजभाषा हिन्दी में बेहतर निष्पादन किए (क) जाने पर राजभाषा कार्यान्वयन समिति ,(नराकास)द्वारा संस्थान के शिल्ड और प्रशस्ति पत्र प्रदान किया गया।

.कसंस्तान द्वारा न्यूज लेटर प्रकाश करने पर डॉ दी (ख) सिंह,कार्यान्वयन) उपनिदेशक , क्षेत्रीय कार्यान्वयन कार्यालय पूर्वोत्तर क्)षेत्र ,(राजभाषा विभाग, भारत सरकार, गुवाहाटी से प्रशस्ति पत्र प्राप्त हुआ है।

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