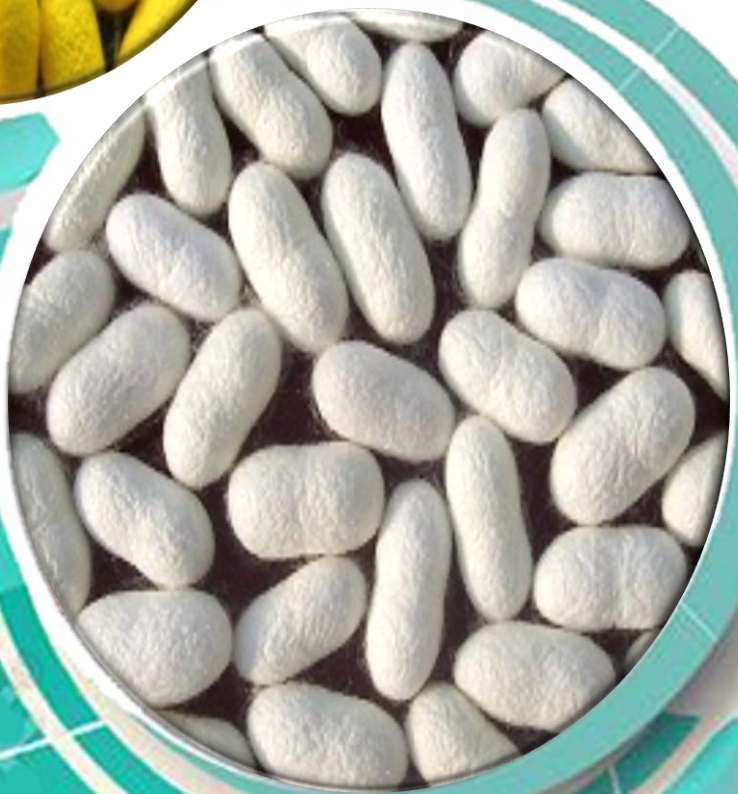
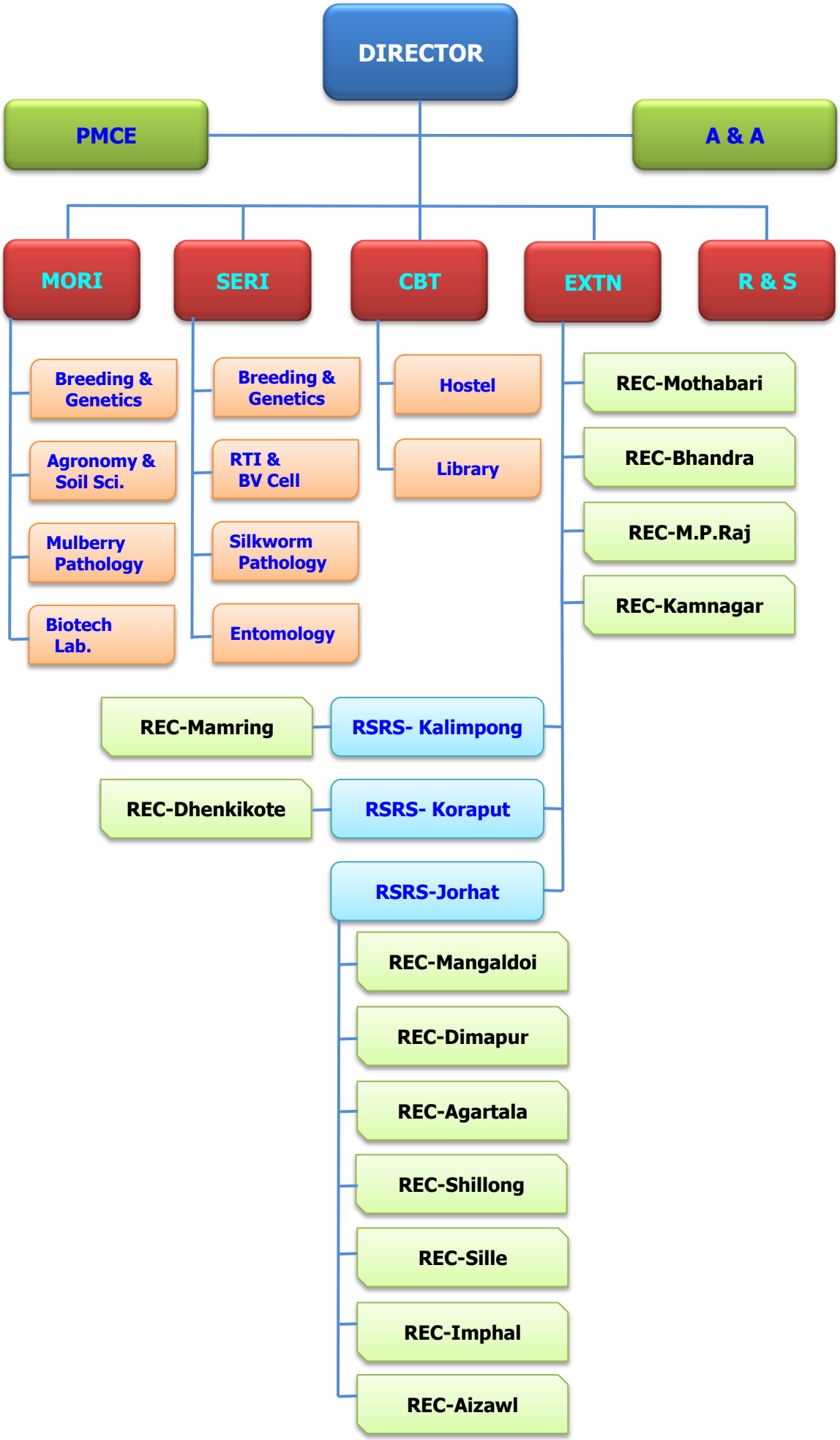
वार्षिक प्रतिवेदन

Annual Report

2018-19



Central Sericultural Research & Training Institute
Central Silk Board, Ministry of Textiles, Govt. of India
Berhampore-742101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वार्षिक प्रतिवेदन

ANNUAL REPORT

2018-19

केंद्रीय रेशम उत्पादन अनुसंधान एवं प्रशिक्षण संस्थान

केंद्रीय रेशम बोर्ड, वस्त्र मंत्रालय, भारत सरकार

बहरमपुर – *742101,* पश्चिम बंगाल

Central Sericultural Research & Training Institute

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

Berhampore – 742101, West Bengal

प्रस्तावक
डॉ. वी. शिवप्रसाद
निदेशक, केंरेउअप्रसं-बहरमपुर

Published by
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Director
CSRTI- Berhampore

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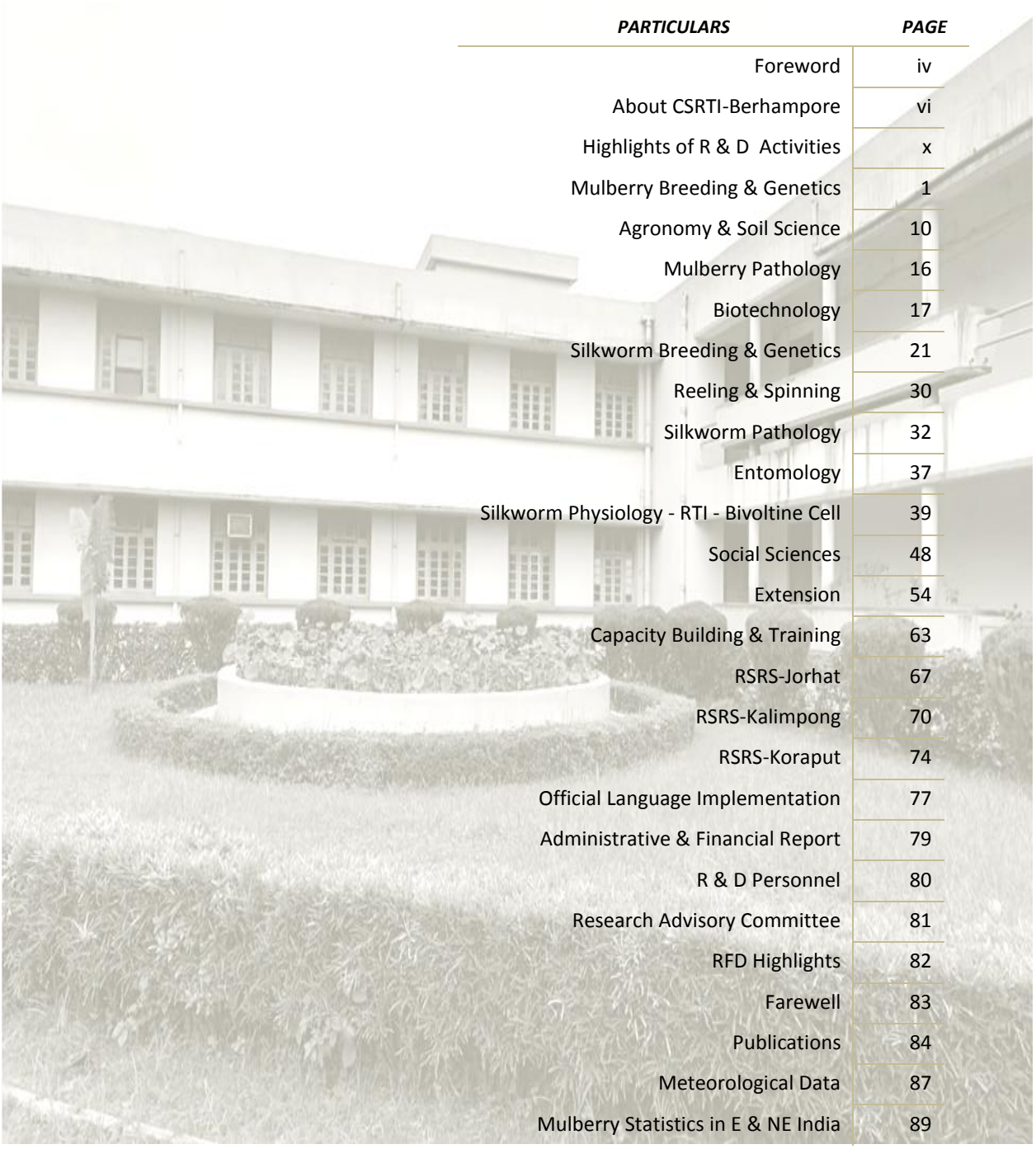


प्रस्तावना

केन्द्रीय रेशम उत्पादन अनुसंधान एवं प्रशिक्षण संस्थान, बहरमपुर, पश्चिम बंगाल अपनी स्थापना काल अर्थात् 15 अक्टूबर, 1943 से अब तक 75 वर्ष की अथक यात्रा संपन्न कर चुकी है। आरम्भिक समय से ही केरेउअवप्रसं, बहरमपुर रेशम उद्योग के सतत विकास के लिए उन्नयन के पथ पर अग्रसर होते हुए देश के पूर्वी तथा उत्तर पूर्वी क्षेत्रों के कृषकों के ऊर्ध्वमुखी आर्थिक विकास की दिशा में आवश्यकता आधारित अनुसंधान के माध्यम से उत्कृष्टता बनाए रखने हेतु निरंतर प्रयासरत है। संस्थान का मुख्य उद्देश्य उत्कृष्ट शहतूत उपजातियों का विकास, विभिन्न कृषि-जलवायु परिस्थितियों /क्षेत्रों के लिए उपयुक्त नस्लों /संकरों का विकास, मृदा स्वास्थ्य कार्ड का डिजिटलीकरण, शहतूत कृषि हेतु उन्नत पैकेज का अनुप्रयोग, शहतूत पर्ण एवं कोसा फसल उत्पादकता में सुधार, प्रक्षेत्रों का मशीनीकरण, प्रौद्योगिकी हस्तांतरण व विस्तार संचार कार्यक्रमों का क्रियान्वयन शामिल है। केरेउअवप्रसं, बहरमपुर अपनी अधीनस्थ इकाइयों (3 क्षेरेउअके एवं 12 अविके) के माध्यम से पूर्वी तथा पूर्वोत्तर के क्रमशः पांच एवं आठ राज्यों के हितधारकों को तकनीकी सहायता प्रदान करने के साथ ही साथ विभिन्न विकास कार्यक्रमों के क्रियान्वयन की भी सुविधा प्रदान करते आ रहा है।

वर्तमान वर्ष के दौरान, केरेउअवप्रसं, बहरमपुर द्वारा परिणाम फ्रेमवर्क डॉक्यूमेंट (RFD) एवं स्वीकृत कार्य योजना के अनुरुप शहतूत कृषि से जुड़े विभिन्न विषयों को सम्मिलित करते हुए 26 अनुसंधान एवं विकास परियोजनाएं मुख्य संस्थान व क्षेत्रीय रेशम उत्पादन अनुसंधान केन्द्रों में आरंभ किया गया है। ग्यारह अनुसंधान एवं विकास परियोजनाओं को सफलता पूर्वक संपन्न किया गया और उल्लेखनीय उपलब्धियों में कई उत्कृष्ट शहतूत किस्मों की पहचान शामिल है जो उच्च नाइट्रेट अपचायक गतिविधि, सूखा सहिष्णुता, बैक्टीरियल पर्ण चित्ती रोग के लिए प्रतिरोधी; लागत प्रभावी ड्रमकिट फर्टिगेशन प्रणाली का विकास; व्यापक वृक्षारोपण प्रणाली; पूर्वी तथा उत्तर पूर्वी क्षेत्रों में वाणिज्यिक उपयोग हेतु रेशमकीट संकरों (BCon1 x BCon4 & M6DPC x SK6.7) का प्राधिकरण; उन्नत संकरो एवं द्विप्रज संकरों की पहचान; पश्चिम बंगाल में विगत 20 वर्षों से शहतूत कृषि के विकास के रुझान; पूर्वी भारत में हितधारकों / विस्तार कार्मिकों की कौशल स्थिति को दर्शाती है। अन्य उपलब्धियों में विभिन्न कार्यक्रमों के माध्यम से विभिन्न बाधाओं के कारण लक्षित उत्पादन की तुलना में द्विप्रज रेशम उत्पादन (115MT) की सुविधा सम्मिलित है। संस्थान द्वारा जैविक नियंत्रण एजेंटों (स्किम्नस पैलाडिकोलि एवं क्रायसोपरलाज़ स्ट्रोवी) का बड़े पैमाने परगुणन भी आरंभ किया गया। रेशम उत्पादन की लागत को कम करने हेतु पश्चिम बंगाल में कोसोत्तर क्षेत्र में प्रौद्योगिकी का हस्तांतरण, सुवर्ण (संशोधित चरखा) एवं सौरो-नीर (सौर-जलतापन प्रणाली) के संस्थापन की शुरुआत से उल्लेखनीय सफलता हासिल हुई है। विभिन्न हितधारकों के लिए नवीनतम तकनीकी इनपुट एवं क्षमता निर्माण कार्यक्रमों के साथ जागरूकता कार्यक्रम का आयोजन किया गया। इसके अतिरिक्त, संस्थान द्वारा विभिन्न सहयोगी अनुसंधान कार्यों में भी सक्रिय तौर पर भाग लिया गया।

साथ ही, हितधारकों को लाभ पहुंचाने वाले प्रमुख क्षेत्रों की उत्कर्षता हेतु वैज्ञानिक और तकनीकी कर्मियों का अनवरत प्रयास जारी रहेगा। मैं, प्रबुद्ध अध्यक्ष महोदय और अनुसंधान समन्वय समिति [आरसीसी] तथा अनुसंधान सलाहकार समिति [आरएसी] के सदस्यों द्वारा दिए गए बहुमूल्य सुझावों व महत्वपूर्ण समीक्षा के लिए सादर धन्यवाद देता हूँ। मेरी यह कामना है कि अनुसंधान एवं विकास, विस्तार, मानव संसाधन विकास एवं हितधारकों के लिए इस उत्कृष्ट संस्थान की सेवा-सहायता की मानकता और उत्कृष्टता आने वाले वर्षों में भी कायम रहे। साथ ही साथ, मैं, संस्थान तथा इसके अधीनस्थ इकाइयों के वैज्ञानिकों / अधिकरियो / पदधारियों के अथक प्रयास की सराहना करता हूँ। मैं, केन्द्रीय रेशम बोर्ड / रेशम निदेशालय /वस्त्र निदेशालय द्वारा अनुसंधान एवं विकास के क्रियान्वयन हेतु प्रदत्त उनके अमूल्य सहयोग के प्रति अपना आभार प्रकट करता हूँ।

मुझे यह विश्वास है कि केरेउअवप्रसं, बहरमपुर की 2018-19 की वार्षिक रिपोर्ट सभी के लिए बहुमूल्य सूचनाप्रद खजाना सिद्ध होगा।

[डॉ. वी. शिवप्रसाद]

निदेशक

Foreword

Central Sericulture Research and Training Institute, Berhampore West Bengal has completed 75 years of journey since 15th October 1943. Since inception, CSRTI-Berhampore is consistently thriving for sustainable development of sericulture industry by maintainance of excellence through need-based research in Eastern and North-Eastern India. The focus areas includes development of improved mulberry varities, development of silkworm hybrids for different agro-climatic zones, soil fertility analysis, improved package of practices for mulberry cultivation, improvement of leaf and cocoon crop productivity, mechanization, technology transfer and extension programmes. CSRTI-Berhampore through its nested units (3 RSRSs & 12RECs) across fiveEastern and eight NE states renders technical support to the stakeholders and facilitates implementation of various developmental programmes.

During the current year, CSRTI-Berhampore as mandated by Results Framework Document (RFD) and Approved Action Plan has undertaken 26 R&D projects in the main institute and RSRSs addressing various issues in mulberry sericulture. Eleven R&D projects were successfully concluded and remarkable achievements include identification of several improved mulberry varieties exhibiting higher nitrate reductase activity, drought tolerance, resistantce to bacterial leaf spot disease; development of cost-effective drum kit fertigation system; wider plantation systems; authorization of silkworm hybrids (BCon 1 x BCon 4 & M6DPC x SK6.7) for commercial exploitation in E & NE region; identification of improved crossbreeds and bivoltine hybrids; growth trends of mulberry sericulture for the last 20 years in West Bengal; skill status of stakeholders/extension personnel in Eastern India. The other achievements include facilitation of bivoltine silk production (115MT) albeit lower than the targeted production due to various constraints through various programmes. The institute also initiated mass multiplication of biological control agents (Scymnus palladicolli & Chrysoperla zastrowi). Remarkable breakthrough is the transfer of technogy in post-cocoon sector, initiation of establishment of Suvarna (modified Charkha) & Souro-neer (solar water heating system) in West Bengal for reducing cost of silk production. Awareness programmes were undertaken with the latest technological inputs and capacity building programmes were conducted for the various stakeholders. In addition, the institute actively participated in different collaborative research works.

The strenuous efforts of scientific and technical personnel would continue for excellence in the thrust areas benefitting the stakeholders. Sincere thanks are due to learned Chairpersons and members of Research Coordination Committee (RCC) & Research Advisory Committee (RAC) for valuable suggestions and critical review. I profoundly wish the standard and quality of R&D, Extension, HRD services for the stakeholders will stand in the years to come from the esteemed institute. The whole-hearted contributions of scientists, technical and administrative personnel in thr institute and its nested units are appreciated. The support received from CSB/DoS/DoT is herewith acknowledged gratefully for implementing R&D programmes.

Sure that Annual Report of CSRTI-Berhampore for the year, 2018-19 would be a valuable information treasure for all.

Dr. V. Sivaprasad
Director

के रे उ अ व प्र सं - बहरमपुर का संक्षिप्त विवरण

केन्द्रीय रेशम उत्पादन अनुसंधान एवं प्रशिक्षण संस्थान (केरेउअवप्रसं) की स्थापना पूर्वी तथा उत्तरपूर्वी भारत में (पूर्वः पश्चिम बंगाल, ओडिशा, बिहार, झारखंड, छत्तीसगढ़; उत्तर-पूर्व: अरुणाचल प्रदेश, असम, मणिपुर, मेघालय, मिजोरम, नागालैंड, सिक्किम एवं त्रिपुरा) रेशम उद्योग को अनुसंधान, विकासात्मक, तकनीकी, प्रौद्योगिकी, विस्तार सहायता प्रदान करने हेतु बहरमपुर में किया गया था। केरेउअवप्रसं, बहरमपुर का 76वाँ वर्ष जारी है तथा इस क्रम में संस्थान द्वारा क्षेत्र हेतु उपयुक्त शहतूत उपजातियों का विकास, रेशमकीट की नस्लें / संकरों, शहतूत कृषि के लिए पैकेज का अनुप्रयोग, रेशम कीटपालन व नवाचार / उत्पादों / प्रक्रियाओं के विकास में अपना महत्वपूर्ण योगदान किया गया है।

63 एकड़ के जीवंत परिसर में फल-फूल रहा यह संस्थान अनुसंधान एवं विकास के प्रमुख विषयों (शहतूत संवर्धन, रेशम संवर्धन, कोसोत्तर, विस्तार व क्षमता निर्माण) समेत सस्य विज्ञान व मृदा रसायन, प्रजनन व आनुवांशिकी (परपोषी पौध व कीट), फसल संरक्षण, कीटपालन प्रौद्योगिकी एवं जैव-प्रौद्योगिकी के साथ परियोजना मॉनिटरिंग समन्वय व मूल्यांकन (पीएमसीई) कक्ष के अलावे प्रशासनिक इकाइयों से प्राप्त सक्रिय सहयोग से उत्कृष्टता की परिकल्पना कर रही है। संस्थान विभिन्न संस्थानों / संगठनों द्वारा प्रायोजित अनुसंधान एवं विकास परियोजनाएं भी संचालित करती है। साथ ही, केरेउअवप्रसं, बहरमपुर द्वारा हितधारकों के लाभार्थ प्रौद्योगिकी से जुड़े पैम्फलेट / पुस्तिकाओं का प्रकाशन विविध भाषाओं में नियमित रुप से किया जाता है। वैज्ञानिकगण राष्ट्रीय और अंतर्राष्ट्रीय पत्रिकाओं, वैज्ञानिक सेमिनार / संगोष्ठियों में शोध-लेख प्रस्तुत करते हैं।

दृष्टि

पूर्वी तथा उत्तर-पूर्वी राज्यों को रेशम कृषि के क्षेत्र में उत्कृष्ट केंद्र बनना

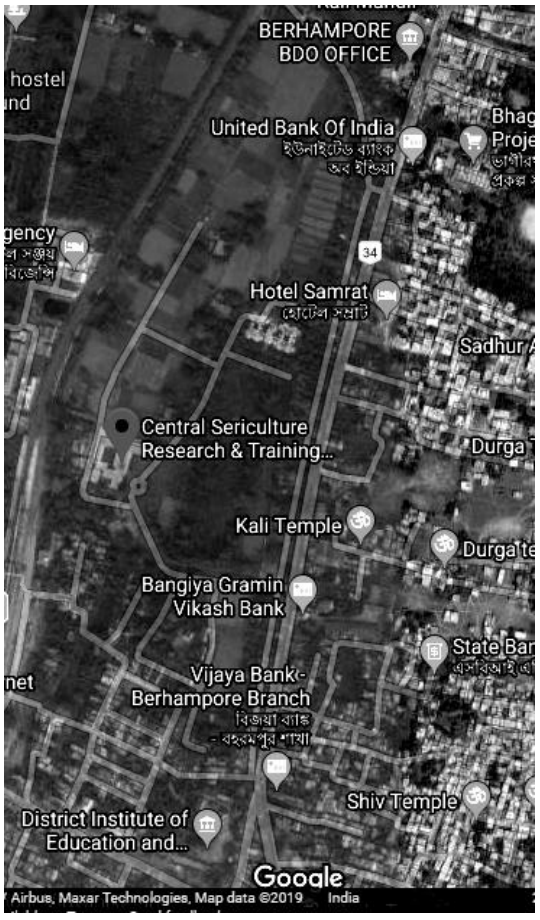
मिशन

- प्रमुख (थ्रस्ट) क्षेत्रों में अनुसंधान व विकास परियोजनाओं को आरंभ करना
- अधि-उपज शहतूत उपजातियों को लोकप्रिय बनाना
- क्षेत्र और मौसम विशिष्ट रेशमकीट संकरों को लोकप्रिय बनाना
- उन्नत शहतूत पैकेज को लोकप्रिय बनाना
- प्रौद्योगिकी हस्तांतरण कार्यक्रम का क्रियान्वयन
- लाभकारी रोजगार के अधिक से अधिक अवसर पैदा करना

उद्देश्य

- भारतीय रेशम के उत्पादन, उत्पादकता एवं गुणवत्ता को समृद्ध करने हेतु वैज्ञानिक, तकनीकी व आर्थिक अनुसंधान का संचालन करना
- परपोषी पौधों, रेशम कीटपालन, कोसोत्तर प्रौद्योगिकी तथा इसके प्रचार-प्रसार के लिए पैकेज का विकास
- उत्पाद एवं प्रौद्योगिकी व उद्योग इंटरफेस का व्यावसायीकरण
- इनपुट लागत व कठिन परिश्रम को कम करने का प्रयास
- शुद्ध आय एवं उत्पादकता बढ़ाने हेतु उप-उत्पाद का उपयोग

- आयात प्रतिस्थापन तथा विदेशी मुद्रा के अर्जन हेतु अंतरराष्ट्रीय स्तर के रेशम का उत्पादन बढ़ाना
- मानव संसाधन विकास
- प्रजनकों के स्टॉक का रख-रखाव
- रोग एवं पीड़क की निगरानी तथा पूर्वानुमान व पूर्व-चेतावनी
- आईसीटी उपकरणों के माध्यम से ज्ञान, अनुसंधान एवं विकास नवाचारों व शहतूत पैकेज का प्रचार-प्रसार
- प्रतिष्ठित राष्ट्रीय और अंतर्राष्ट्रीय अनुसंधान एवं विकास संस्थानों के साथ सहयोगात्मक अनुसंधान कार्यक्रम / परियोजनाओं का संचालन
- जारी अनुसंधान संबद्ध गतिविधियों एवं वैज्ञानिक व तकनीकी सेवाओं का समर्थन करने के लिए संस्थागत ढांचे को मजबूत करना
- बेहतर तालमेल के लिए अंतर-संस्थागत सहयोग
- रेशम कृषि प्रौद्योगिकियों की तकनीकी-आर्थिक व्यवहार्यता
- तकनीकी व परामर्श सेवाएं प्रदान करना



हितधारकों में विकसित प्रौद्योगिकियों के प्रचार-प्रसार एवं उनसे नियमित तौर पर प्रतिक्रिया प्राप्त करने के लिए संस्थान के पास पूर्व एवं पूर्वोत्तर के क्रमशः पांच व आठ राज्यों में 3 क्षेत्रीय रेशम उत्पादन अनुसंधान केन्द्र (क्षेरेउअके) एवं 12 अनुसंधान विस्तार केंद्र (अविके) का विस्तार नेटवर्क है। ये अधीनस्थ इकाइयां संबंधित राज्यों में रेशम कृषि विभाग के साथ घनिष्ठ समन्वय स्थापित कर हितधारकों को तकनीकी सहायता प्रदान करती हैं। केरेउअवप्रसं, बहरमपुर संबंधित सरकार तथा गैर-सरकारी एजेंसियों के साथ समन्वय कर सभी विकासात्मक कार्यक्रमों (क्लस्टर विकास, संस्थान-ग्राम लिंकेज, आदर्श रेशम ग्राम, सेरी-मॉडल गांव आदि) का क्रियान्वयन करती है।

कल्याणी विश्वविद्यालय, कल्याणी के तत्वावधान में, केरेउअवप्रसं, बहरमपुर में शहतूत रेशम कृषि में संपूर्ण भारत के छात्रों हेतु रेशम कृषि (PGDS) में 15 महीने का पोस्ट-ग्रेजुएट डिप्लोमा पाठ्यक्रम का संचालन किया जाता है। संस्थान कृषकों, रीलरों, केरेबो व गैर-केरेबो अधिकारियों, छात्रों आदि के लिए विभिन्न विषयों में कई प्रशिक्षण कार्यक्रम (30 दिनों तक के लिए) आयोजित किए जाते हैं। केरेउअवप्रसं, बहरमपुर स्नातक [M.Sc.] के छात्रों हेतु भुगतान आधार पर शोध प्रबंध की सुविधा प्रदान करने का भी कार्य किया जाता है। प्रशिक्षण प्रभाग में आधुनिक कक्षाएं, पुस्तकालय व छात्रावास की सुविधाएं भी उपलब्ध हैं।

ABOUT CSRTI-BERHAMPORE

Central Sericultural Research & Training institute (CSRTI) was established at Berhampore for rendering research, developmental, technical, technological, extension support to the silk industry in Eastern and North Eastern India (East: West Bengal, Odisha, Bihar, Jharkhand, Chhattisgarh; North-East: Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura). CSRTI-Berhampore is on its 76th year and contributed to the development of mulberry varieties, silkworm breeds/hybrids, package of practices for mulberry cultivation, silkworm rearing and innovations/products/processes suitable to the region.

The Institute thrives in 63 acre lively campus and envisages excellence in R&D major disciplines (moriculture, sericulture, post-cocoon, extension & capacity building) including Agronomy & Soil Science, Breeding & Genetics (host plant & insect), Crop Protection, Rearing Technology, and Biotechnology with active support from Project Monitoring Coordination & Evaluation (PMCE) cell besides Administration units. The institute undertakes R&D projects sponsored by various institutions/organizations. CSRTI-Berhampore regularly publishes technology pamphlets/booklets for the benefit of stakeholders in various languages. The scientists contribute research articles in national and international journals, scientific seminars/symposia.

VISION

To become a Centre of Excellence in Sericulture in Eastern & North Eastern region

MISSION

- Undertaking R&D projects in thrust areas
- Popularizing of high yielding mulberry varieties
- Popularizing region & season specific silkworm hybrids
- Popularization of improved package of practices
- Implementing Transfer of Technology programmes
- To create greater opportunities for gainful employment

OBJECTIVES

- Conduct scientific, technical and economic research to enhance production, productivity and quality of Indian silk
- Development of package of practices for Host Plant, Silkworm rearing, Post Cocoon Technology and its dissemination
- Commercialization of Products & Technologies and industry interface
- Efforts to reduce input cost & drudgery
- By-product utilization to increase net income and productivity
- Enhance production of international grade silk for import substitution and earning foreign exchange
- Human Resource Development
- Maintenance of Breeders Stocks
- Disease & Pest Monitoring and Forecasting and Forewarning
- Dissemination of knowledge, R&D innovations and package of practices through ICT tools

- Undertake collaborative Research Programmes/Projects with reputed National and International R&D institutions
- Strengthening institutional framework to support ongoing research allied activities scientific and technical services
- Inter-institutional collaboration for better synergy
- Techno-economic feasibility of sericulture technologies
- Providing technical and consultancy services

For dissemination of developed technologies to the stakeholders and obtain regular feedback, the Institute has an extension network of 3 Regional Sericultural Research Stations (RSRSs), 12 Research Extension Centres (RECs) covering five Eastern and eight North-Eastern states. These nested units provide technological support to the stakeholders in the respective states in close coordination with Departments of Sericulture. CSRTI-Berhampore implements all the developmental programmes (cluster development, institute-village linkage, adharsh resham gram, seri-model village etc.) in coordination with the concerned government and non-goovernment agencies.

Under the aegis of Kalyani University-Kalyani, CSRTI-Berhampore offers 15 months Post-Graduate Diploma in Sericulture (PGDS) for students across India in Mulberry Sericulture. The institute conducts several training programmes (upto 30 days) in various disciplines to the farmers, reelers, CSB & Non-CSB officials, students etc. CSRTI-Berhampore also facilitates M.Sc. students for Dissertation Works on payment basis. The training division has well-equipped classrooms, library and hostel facilities.

अनुसंधनात्मक एवं विकासात्मक उपलब्धियां

केन्द्रीय रेशम उत्पादन अनुसंधान एवं प्रशिक्षण संस्थान, बहरमपुर अपने तीन अधीनस्थ क्षेत्रीय रेशम उत्पादन अनुसंधान केन्द्रों [क्षेरेउअकें] तथा दस अनुसंधान विस्तार केन्द्रों [अविकें] के साथ पूर्वी तथा उत्तर-पूर्वी राज्यों में रेशम उद्योग के विकास में उल्लेखनीय योगदान करते आ रहा है। शहतूत एवं रेशमकीट प्रजनन, फसल उत्पादन व संरक्षण, प्रौद्योगिकी के हस्तांतरण, विस्तार तथा प्रशिक्षण कार्य-कलापों में अनुसंधान व विकास गतिविधियों को आरंभ करने के परिणामस्वरुप पश्चिम बंगाल, ओडिशा, छत्तीसगढ़, झारखंड, बिहार, असम, नागालैंड, सिक्किम, मणिपुर, त्रिपुरा, मेघालय, अरुणाचल प्रदेश एवं मिजोरम राज्य के कृषकों के लिए उपयुक्त प्रौद्योगिकी विकसित की गई। संस्थान तथा इसके अधीनस्थ केन्द्रों की मुख्य उपलब्धियाँ निम्नानुसार हैः

शहतूत फसल सुधार, उत्पादकता तथा संरक्षण

- आठ (08) अधि-उपज वाली शहतूत संततियों की पहचान ***V1*** प्रजाति की अपेक्षा उच्च नाइट्रेट अपचायक गतिविधि (8.79 -16.45 $\Delta Ag^{-1}FWh^{-1}$), बेहतर पर्ण गुणवत्ता एवं संवर्धन ट्रेट्स के तौर पर की गई।
- दस शहतूत जीन प्ररूपों (पीवाईडी - 08, 27, 26, 04, 01, 15, 21, 03, 30 & 23) की पहचान अधि-उपज तथा सूखा प्रवण क्षेत्र हेतु की गई।
- 6 जीन प्ररुपों अर्थात सिंचित अवस्था हेतु (C - 1, 11, 384, 2, 212 & 5) तथा वर्षाश्रित अवस्था के अधीन चार जीन प्ररुपों (C- 45, 108, 1 & 384) में S1635 की अपेक्षा अधिक पर्ण उपज दर्ज की गई।
- शहतूत में जीवाण्विक पर्ण चित्ती रोग के लिए एसएसआर मार्कर्स की पहचान की गई तथा जीन प्ररुप BLS-7 का प्रदर्शन मानक उपजाति S-1 की अपेक्षा बेहतर (24.93% के डीएसआई की तुलना में 2.5 फोल्ड कम) पाया गया।
- ड्रम किट व ड्रिप टेप फर्टिगेशन प्रणाली के माध्यम से उर्वरक की अनुशंसित मात्रा 75% का उपयोग कर पर्ण उपज में ~30% ट/हे., कुल पर्ण घुलनशील्क प्रोटीन (~56%), जल उपयोग (~67%) तथा पोषक तत्व उपयोग करने की क्षमता में (~66%) की वृद्धि दर्ज की गई।
- शहतूत हेतु ग्रोइंग डिग्री डेज (जीडीडी) आधारित पर्ण उपज मौसम मॉडल 3'x3': $Y = -0.0002 (GDD^2) + 0.79 (GDD) – 53.22$ (R^2=0.74); 2'x2': $Y = -0.0003 (GDD^2) + 0.62 (GDD) – 58.57$ (R^2=0.77) **का** आकलन किया गया, जहाँ ***Y*** शहतूत पर्ण उपज है।
- अधि-झाड़ी पौधरोपण (S1635; दो फसल) में औसत पर्ण उपज/पौध/वर्ष 6'x6' (1452ग्रा) एवं 5'x5' (1236ग्रा) की तुलना में 1943 ग्रा (8'x8') दर्ज की गई।

रेशमकीट फसल सुधार, उत्पादकता एवं संरक्षण

- रेशमकीट संकरो Bi x Bi: BCon1 x BCon4 तथा संकर नस्लो: M6DPC x (SK6.7) को पूर्वी एवं उत्तर पूर्वी राज्यों में वाणिज्यिक उपयोग के लिए केन्द्रीय रेशम बोर्ड के संकर प्राधिकरण समिति द्वारा प्राधिकृत किया गया।
- दो बहु x द्वि संकरो (12Y x BCon1.4 & 21Y x BCon1. 4) के ओएफटी में नियंत्रण N x (SK6.7) की अपेक्षा बेहतर उपज पायी गई।
- कवच अवयव के संबंध में (10-12%) SK6 x SK7 व BCon1 x BCon4 की तुलना में दो द्विप्रज युग्मित संकरों का प्रदर्शन बेहतर पाया गया।
- एकल संकर BHP2 x BHP8 (200 रोमुच; दो कृषको) की प्रक्षेत्र जांच में औसत कोसा उपज 68 किग्रा/100 रोमुच फाल्गुनी-2019 में दर्ज किया गया।
- RBL1-BC5 संतत्ति में उच्च प्लास्टिसिटी के साथ सजातीय नस्लों के विकास हेतु प्रयास किया जा रहा है। बहुप्रज (कवच भार: 0.25-0.26 ग्रा) तथा द्विप्रज (कोशितीकरण: 93%) का वांछित लक्ष्य प्राप्त किया गया।
- निस्तरी संकर की तुलना में पांच उत्कृष्ट बहुप्रज एक्सेशनों (एक्सेशन संख्यक. 01, 25, 69, 79 व 80) की पहचान संकर अध्ययन (एक्सेशन 290) के माध्यम से पूर्वी क्षेत्र में की गई।

- अपोलोफ़ोरिन- ///का सफलतापूर्वक क्लोन कर पिचिया पस्टोरिस में अभिव्यक्त किया गया। ~20kDa एवं ~33kDa के पुनः संयोजक लिपोप्रोटीन में रोगजनक जीवाणु के विरुद्ध जीवाणुरोधी गतिविधि देखा गया।
- पश्चिम बंगाल में शहतूत रेशमकृषि के परिदृश्य में शहतूत क्षेत्रफल (-1.38) के लिए नकारात्मक सीजीआर के साथ घनीय प्रवृत्ति एवं कोसा (2.35) हेतु सकारात्मक सीजीआर के साथ घातीय प्रवृत्ति तथा कच्चे रेशम (3.72) का उत्पादन रेशम निदेशालय, पश्चिम बंगाल के साथ समय-श्रृंखला (1989-2018) डाटा उपलब्धता के आधार पर दर्शाया गया है। कोसा उत्पादन में लघु कृषकों (1:1.58) का प्रति रुपये निवेश का रिटर्न सीमांत कृषकों (1:1.47) की तुलना में अधिक था। 70% कृषकों को आर्थिक दक्षता के संबंध में संसाधन उपयोगी कुशल पाए गए।
- पूर्वी क्षेत्र में कौशल-अंतर विश्लेषण से कृषकों (~ 11%) एवं ~ 80% विस्तार श्रमिकों की कौशल स्थिति निम्न पाया गया। शहतूत कृषि एवं रेशम कीटपालन के लिए आवश्यक कौशल के संबंध में प्रौद्योगिकी प्रदर्शन का स्थान सर्वोपरि था।
- कौशल उन्नयन हेतु प्रशिक्षण मैनुअल (सीबीटी) तैयार कर इसका उपयोग कौशल उन्नयन कार्यक्रमों के लिए किया जा रहा है।

प्रौद्योगिकी हस्तांतरण

- पश्चिम बंगाल, ओडिशा, बिहार, असम, मणिपुर, मिजोरम, नागालैंड और त्रिपुरा (16.78 लाख रोमुच; कोसा उपज: 48.54 किग्रा/100 रोमुच) में क्लस्टर संवर्धन कार्यक्रम (15 क्लस्टरों) के माध्यम से उल्लेखनीय मात्रा में अर्थात् 115.86 मैट्रिक टन द्विप्रज कच्चे रेशम का उत्पादन किया गया।
- स्किमनस पल्लीडिकोली, चूर्णी मत्कुण के परभक्षी के लिए बड़े पैमाने पर गुणन प्रशिक्षण आयोजित किया गया था। जैव-नियंत्रण एजेंट निर्मुक्त करने के परिणामस्वरूप 66-75% अंडे की कॉलोनियों (colonies), शिशुकीट तथा वयस्क चूर्णी मत्कुण में कमी पायी गई।
- 13045 हितधारकों को नई प्रौद्योगिकियों पर प्रशिक्षित 250 विस्तार संचार कार्यक्रमों के माध्यम से किया गया।
- एम-किसानः 94 वैज्ञानिक सुझावों / संदेश 5253 को विभिन्न भाषाओं (बंगाली, हिंदी, उड़िया, नेपाली) में कृषकों संप्रेषित किए गए।
- रेशम-5केः 7118 किसानों को नामांकित कर फसल-वार डाटा अपलोड किया गया।
- 8835 मृदा स्वास्थ्य कार्ड तैयार कर वेबसाइट पर अपलोड किए गए हैं।
- पांच वीडियो वृत्तचित्र (मुर्शिदाबाद रेशम और केरेउअप्रसं का इतिहास; मृदा परीक्षण-नर्सरी की तैयारी एवं शहतूत की उपजातियां; शहतूत रोग व पीड़क प्रबंधन; कीटपालन गृह एवं रेशमकीट रोगों का विसंक्रमण तथा नियंत्रण पद्धति; रेशम कृषि में महिलाओं की भूमिका) तैयार कर उनका सीधा प्रसारण (टेलीकास्ट) किया गया।
- शहतूत प्रौद्योगिकियों से संबंधित 11 रेडियो कार्यक्रम आकाशवाणी के माध्यम से प्रसारित किए गए।
- अर्धवार्षिक आर एंड डी न्युज बुलेटिन (न्युज एंड व्यूज) तथा 22 लीफ्लेट / पैम्फलेट / पुस्तिका प्रकाशित किए गए।

यंत्रीकरण

- सुवर्णा (संशोधित चरखा) तथा सौरो-नीर (सौर जल तापन प्रणाली) का विकास ईंधन एवं मानव दिवस की लागत को कम करने हेतु निजी उद्योगों के सहयोग से किया गया।

दक्षता निर्माण व प्रशिक्षण

- 20 पीजीडीएस छात्रों (2017-18) को पुरस्कृत किया गया तथा 37 नए छात्रों ने पीजीडीएस पाठ्यक्रम में दाखिला (2018-19) लिया।
- 238 कृषकगण एफएसटी के तहत तथा 21 अधिकारी विविध शहतूत रेशम कृषि प्रौद्योगिकी पर टीओपी के अधीन प्रशिक्षित किए गए।
- 1260 कृषक रेशम संसाधन केंद्रों (6 एसआरसी) के माध्यम से रेशम कृषि एवं प्रौद्योगिकियों के विभिन्न पहलुओं पर प्रशिक्षित किए गए।
- पूर्वी तथा उत्तर-पूर्वी राज्यों से 742 कृषकों एवं छात्रों को रेशम कृषि में उपयोग की जाने वाली आधुनिक तकनीकों से अवगत कराया गया।

HIGHLIGHTS OF R & D ACTIVITIES

Central Sericultural Research & Training Institute, Berhampore along with three Regional Sericultural Research Stations (RSRSs) and twelve Research Extension Centers (RECs) has been rendering significant contributions for the development of sericulture industry in Eastern & North-Eastern region. The R & D activities undertaken in mulberry & silkworm breeding, crop production & protection, transfer of technology, extension and training activities resulted in developing technologies suitable for the farmers in the states of West Bengal, Odisha, Chhattisgarh, Jharkhand, Bihar, Assam, Nagaland, Sikkim, Manipur, Tripura, Meghalaya, Arunachal Pradesh and Mizoram. The salient achievements of main institute and nested units are as follows:

MULBERRY CROP IMPROVEMENT, PRODUCTION & PROTECTION

- Eight (08) high yielding mulberry progenies were identified with high nitrate reductase activity (8.79 -16.45 $\Delta Ag^{-1}FWh^{-1}$), better leaf quality & propagation traits as compared to V1 variety.
- Ten mulberry genotypes (PYD - 08, 27, 26, 04, 01, 15, 21, 03, 30 & 23) were identified for high yield and drought tolerance.
- Six genotypes (C - 1, 11, 384, 2, 212 & 5) for irrigated and four genotypes (C- 45, 108, 1 & 384) for rainfed condition recorded significantly higher leaf yield over S1635.
- SSR markers for bacterial leaf spot disease in mulberry were identified and the genotype C-7 performed better (2.5 less folds DSI) than the control variety, S-1.
- 75% Recommended dose of fertilizer (RDF) through drum kit & drip tape fertigation systems increased leaf yield by ~30% t/ha, total leaf soluble protein (~56%), water use efficiency (~67%) & nutrient use efficiency (~66%) over control.
- Growing degree days (GDD) based leaf yield weather models for mulberry (S1635) were estimated [3'x3': $Y = -0.0002 (GDD^2) + 0.79 (GDD) – 53.22$ (R^2=0.74); 2'x2': $Y = -0.0003 (GDD^2) + 0.62 (GDD) – 58.57$ (R^2=0.77), where Y is mulberry leaf yield].
- Average leaf yield/plant/year recorded in high bush plantation (S1635; two crops) was 1943g (8'x8') followed by 6'x6' (1452g) & 5'x5' (1236g).

SILKWORM CROP IMPROVEMENT, PRODUCTION & PROTECTION

- Silkworm hybrids, Bi x Bi: BCon1 x BCon4 and crossbreed: M6DPC x (SK6.7) were authorized for commercial exploitation in Eastern and North eastern states by Hybrid Authorization Committee, Central Silk Board.
- OFT of two Multi x Bi hybrids (12Y x BCon1. 4 & 21Y x BCon1. 4) performed better yield (20%) over control, N x (SK6.7).
- Two bivoltine double hybrids (BHP1.BHP3 x BHP8.BHP9 & BHP3.BHP2 x BHP8.BHP9) performed better with respect to shell content (10-12%) than SK6 x SK7 & BCon1 x BCon4.
- Field trial of single hybrid, BHP2 x BHP8 (200 dfls; two farmers) recorded an average cocoon yield of 68kg/100 dfls in Falguni-2019.
- The efforts to develop congenic breeds with higher plasticity are at RBL1-BC5 generation. The desired targets for multivoltine (shell weight: 0.25-0.26g) and bivoltine (pupation: 93%) was achieved.

- Five superior multivoltine accessions (Accession Nos. 01, 25, 69, 79 & 80) were identified through crossbreed studies (Acc. 290) superior than Nistari hybrid in the Eastern zone.
- Apolipophorin-III was successfully cloned and expressed in *Pichia pastoris*. Recombinant lipoprotein of ~20kDa & ~33kDa exhibited antibacterial activity against pathogenic bacteria.
- Mulberry sericulture scenario in West Bengal showed cubic trend with negative CGR for mulberry acreage (-1.38) and exponential trend with positive CGR for cocoon (2.35) & raw silk (3.72) production based on time-series (1989-2018) data available with DoS-WB. Return per rupee investment for cocoon production was higher with small farmers (1:1.58) as compared to marginal famers (1:1.47). 70% farmers were resource use-efficient with regard to economic efficiency.
- Skill gap analysis in Eastern zone indicated lower skill status with farmers (~11%) and ~80% for extension workers. Technology demonstrations with regard to essential skills for mulberry cultivation & silkworm rearing ranked first. Training manual for skill upgradation (CBT) was prepared & is being utilized for skill upgradation programmes.

TRANSFER OF TECHNOLOGY

- A record quantity of 115.86MT bivoltine raw silk was produced through Cluster Promotion Programme (15 clusters) in West Bengal, Odisha, Bihar, Assam, Manipur, Mizoram, Nagaland and Tripura (16.78 lakh dfls; cocoon yield: 48.54 kg/100 dfls).
- Mass multiplication training was conducted for *Scymnus pallidicolli*, a predator of mealy bug. BCA release resulted in the reduction of 66-75% egg colonies, nymph and adult mealy bugs.
- 13045 stake holders were sensitized with new technologies through 250 ECPs.
- m-Kisan: 94 scientific advisories/messages in different languages (Bengali, Hindi, Oriya, Nepali, Oriya) were communicated to 5253 farmers.
- Seri-5k: 7118 farmers were enrolled and crop-wise data was up-loaded.
- 8835 Soil Health Cards were prepared and uploaded in the website.
- Five video documentaries (History of Murshidabad silk & CSRTI; Soil test-nursery preparation & mulberry varieties; Mulberry disease and pest management; Disinfection of rearing room and silkworm diseases & control methods; Role of women in sericulture) were prepared and telecasted.
- 11 radio programmes were broadcasted through AIR with regard to technologies of mulberry.
- A half-yearly R&D news bulletin (News & Views) and 22 leaflets/ pamphlets/ booklets published.

MECHANIZATION

- Suvarna (modified charka) & Souro-Neer (solar water heating system) were developed in association with private industries to reduce fuel cost & mandays.

CAPACITY BUILDING & TRAINING

- 20 students awarded PGDS (2017-18) and 37 students admitted in 2018-19.
- 238 farmers were trained under FST and 21 officials under TOP on various mulberry sericulture technologies.
- 1260 farmers were trained on different aspects of sericulture and technologies through Seri Resource Centres (6 SRCs).
- 742 farmers & students from E & NE states were exposed to modern technologies in sericulture.

MULBERRY BREEDING & GENETICS

Concluded Research Project

PIC 3554: Candidate gene based molecular marker(s) for screening promising recombinants in mulberry. [Jan 2016 - Dec 2018]

Suresh, K. (PI; from July 2017), R. Banerjee (April 2016 – June 2017), M. K. Ghosh (upto March 2016), S. Chattopadhyay, Pooja Makwana and V. Vijay

Objective: To develop candidate gene based molecular markers of nitrate reductase and chalcone synthase in mulberry

`The segregating clonal population (N=150) of Kajli OP × V1 was established in augmented randomized block design along with parental genotypes for determining nitrate reductase (NRA) and chalcone synthase activity (CHS). They were evaluated for eleven leaf yield and component traits for five crops in commercial silkworm crop schedules of West Bengal during 2018. Leaf nitrate reductase activity was estimated following Redinbaugh and Campbell (1985) and powdery mildew incidence as per Gawande and Patil (2003) was recorded among the progenies during February and November crops. Chalcone synthase activity estimations were not conducted due to the non-realization of collaboration with the collaborating institute.

The NRA activity ($\Delta Ag^{-1}FW\ h^{-1}$) recorded in parental genotypes was 1.97 in Kajli OP and 5.69 in V1. Wide and significant variation was observed among the progenies for fresh leaf weight (1.894-6.537g), leaf area (115-328 cm^2), primary shoots/plant (4-14), total shoot length (461-2028 cm), leaf senescence at harvest (8-39%) and leaf yield/plant (116-741 g/crop) with regard to leaf yield and component traits.

Estimates of leaf yield and component traits in Kajli OP × V1 population

Estimate	FLW	FLA	SLA	LMC	MRC	LMS	LLS	NPS	TSL	LSH	LYP
Min.	1.894	114.73	146.85	70.25	68.26	20.28	99.67	4.65	461	8.81	116
Max.	6.537	327.60	290.87	79.40	88.91	35.15	199.89	14.51	2028	39.25	741
Mean	3.604	187.86	217.24	75.34	78.55	24.30	151.10	8.11	1032	20.18	419
Kajli OP	2.794	144.36	205.60	74.39	80.05	23.80	143.77	7.92	879	19.04	442
V1	2.787	142.14	208.33	73.85	80.21	25.51	132.10	9.21	898	11.91	529
Range ((normalized)	1.290	1.13	0.66	0.12	0.26	0.61	0.66	1.22	1.52	1.51	1.50
CD@ 5%	0.144	6.54	3.29	0.25	0.66	0.37	3.00	0.30	48.05	0.89	21

FLW: Fresh leaf weight (g); FLA: Fresh leaf area (cm^2); SLA: specific leaf area (cm^2g^{-1}); LMC: leaf moisture content (%); MRC: Moisture retension capacity after six hrs of room temperature storage (%); LMS: Leaves/meter shoot; LLS: Length of the longest shoot (cm); NPS: No. of primary shoots; TSL: Total shoot length (cm); LSH: Leaf senescence at harvest (%);LYP: Leaf yield/plant (g)

Annual leaf yield/plant (kg) of progenies varied from 0.62-3.70 as compared to the parents (V1 (2.65) and K-OP (2.21). Twenty eight high yielding progenies were shortlisted for assessment of leaf quality and propagation efficiency traits. Wide variation was recorded for total soluble sugars (33-43mg/g) and soluble protein (23-41mg/g) and hence could be considered for improvement through selection. Eight progenies were selected for further evaluation for leaf productivity under FYT based on significant higher leaf yield over better parent, V1.

Performace of short-listed mulberry progenies for leaf yield, quality and propagation traits

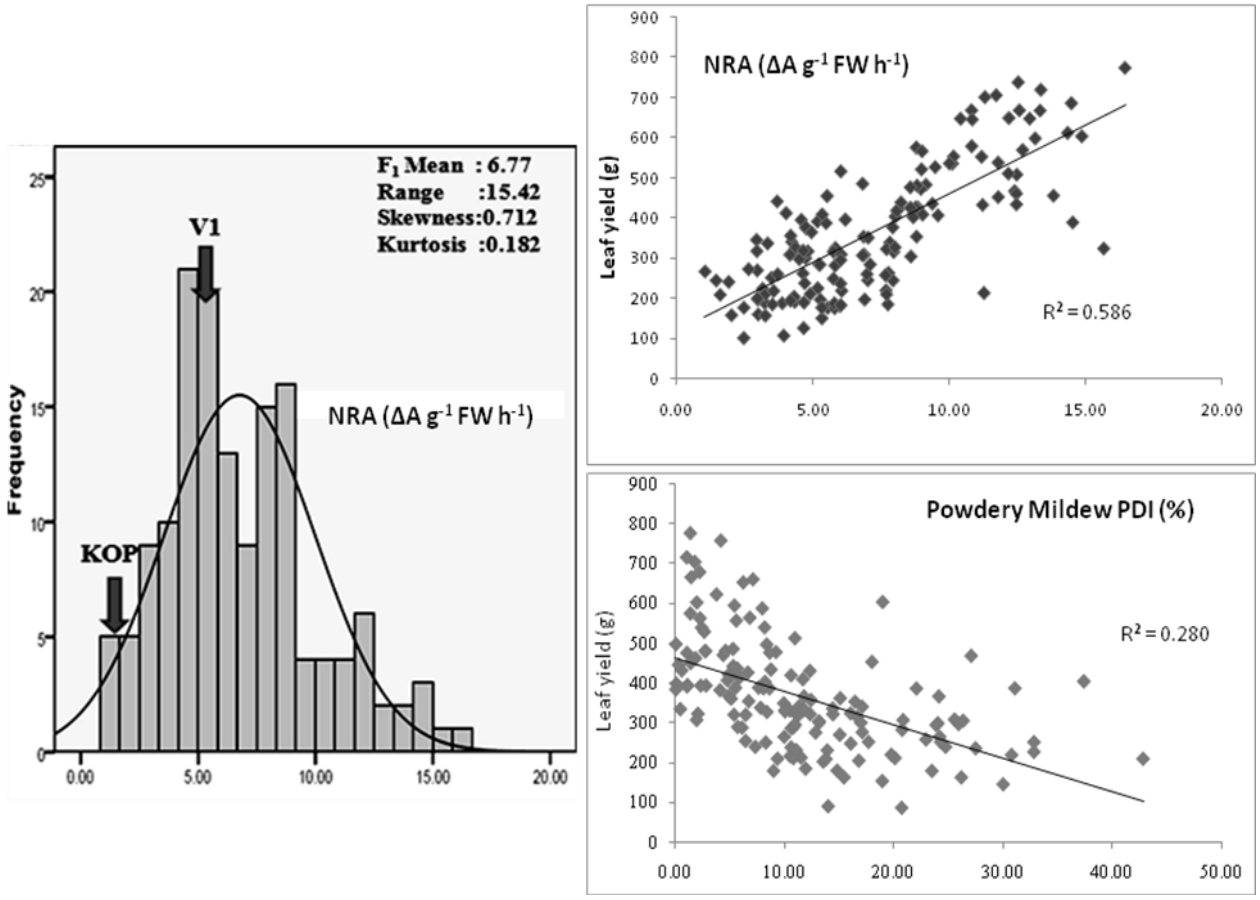
Progeny	LYP	NRA	Leaf quality traits				Propagation traits			Powdery Mildew
			LMC	MRC	TSP	TSS	CSP	NPR	LLR	
B30	3.70*	16.45*	77.93*	89.30*	26.51	37.67*	80*	12*	32*	1.40*
E13	3.67*	13.34*	77.84*	97.39*	27.31	32.99	90*	6*	28*	1.92*
A03	3.57*	14.49*	74.75*	86.68	34.03*	39.48*	93*	7*	31*	0.99*
A09	3.31*	12.70*	74.12	86.31	31.63*	38.87*	96*	7*	25*	4.11*
A06	3.05*	8.79*	72.28	83.57	27.43	33.48	73*	10*	21	1.33*
D33	2.95*	12.19*	74.86	94.21*	27.60	33.87	70	5	25*	2.68*
C05	2.84*	8.96*	78.04*	95.12*	30.14*	36.40	73*	6*	21	1.00*
C04	2.77*	12.47*	76.49*	88.29*	33.37*	39.35*	80*	10*	32*	0.00*
*V1	2.65	5.69	73.56	85.92	29.45	36.30	69	5	19	28.10
K-OP	2.21	1.97	74.39	80.05	34.48	25.50	73	4	16	3.07
$CD_{5\%}$	0.10	1.04	0.84	1.24	0.68	0.88	2	0.6	2	1.04

NRA: Nitrate reductase activity ($\Delta Ag^{-1}FW\ h^{-1}$); TSP: total soluble protein (mg/g FW); TSS: total soluble sugar (mg/g FW); CSP: Cuttings survival (%); NPR: No of primary roots; LLR: Length of the longest root (cm); PDI: powdery mildew disease incidence (%)

Segregating progenies recorded 3–4 fold variation in leaf nitrate reductase activity (1.03- 16.45) as compared to parents (V1: 5.69 & K-OP: 1.97). Seventy one progenies recorded significantly higher NRA as compared to the better parent V1. Significant positive association was noticed between NRA with length of longest shoot (0.462), primary shoots (0.483), total shoot length (0.568) and leaf yield (0.760). Greater biomass accumulation was observed in the progenies with high nitrate reductase activity (> 9.0) indicating that nitrate reductase activity could be selection criteria for the short-listing of high leaf yielding progeny.

Progenies recorded wide variation (Feb: 0.00-40.58%; Nov: 0.00-48.40%) in powdery mildew disease incidence under the field conditions. Significant negative association was noticed between powdery mildew incidences with leaf yield/plant. The progenies *viz*. B01, E20, C04, C07 & C22 were highly resistant (<0.5 PDI) and E26, E01, E25, C25 & C26 were highly susceptible (>30 PDI) to powdery mildew disease. Further, positively skewed and platykurtic distribution of powdery mildew disease in segregating population indicates relatively large number of segregating genes and dominance based complementary interactions. The segregating population (Kajli-OP × V1) assessed for nitrate reductase activity reveals wide variation and

significant positive association with growth traits and leaf yield (0.760) besides negative association with the powdery mildew disease incidence and leaf yield.



Inference: Nitrate reductase activity could be a selection criteraian for leaf yield and genes controlling NRA might be potential candidate genes for MAS in mulberry.

Future work plan: Evaluation of short-listed high yielding progenies with high NRA for leaf productivity and quality including chalcone synthase activity and powdery mildew resistance.

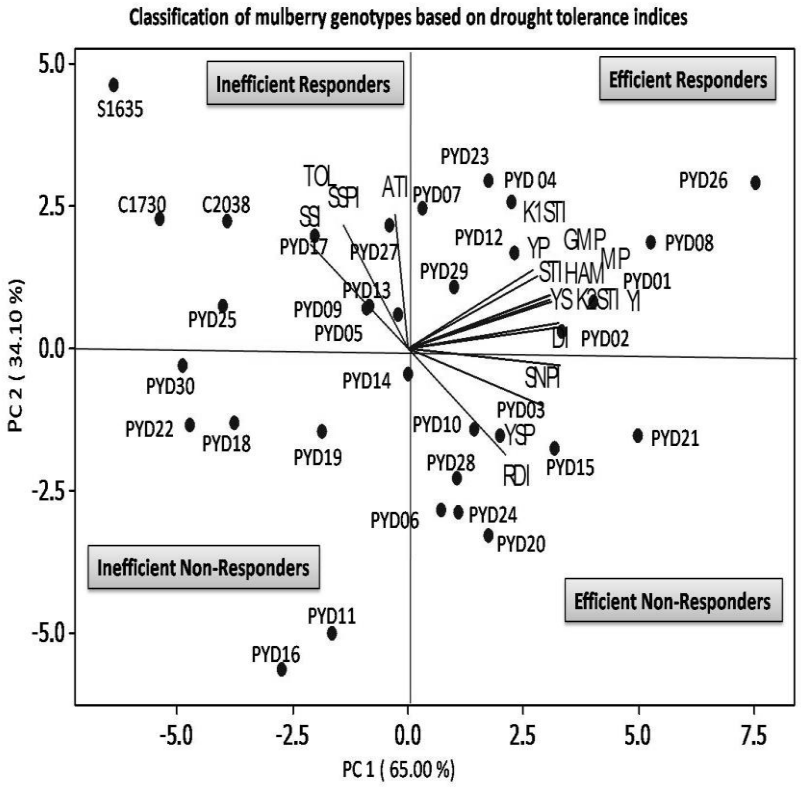
On-going Projects

PIB 3505: Development of drought tolerant mulberry variety for rainfed sericulture
[Jan 2014 - Dec 2019]

Suresh, K. (PI), D. Chakravarty, A. Pappachan, M. Lasker (JRF), K. Jhansilakshmi (upto Nov 2018) and G. Thanavendan (from Dec 2018)

Objective: Development of drought tolerant mulberry variety

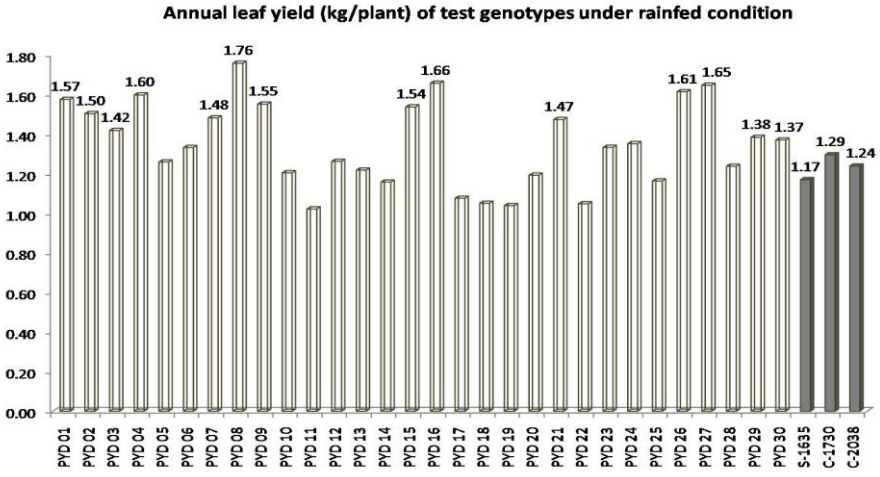
Thirty selected progenies from 2190 seedling population were established in augmented RBD in two replications along with three check varieties (S1635, C1730 & C2038). One year after the establishment, preliminarily data was recorded on morphological, physiological, biochemical traits and leaf yield (65-70



days after pruning). The test progenies were analyzed for drought tolerance based on drought tolerant indices computed from leaf yield of genotypes under well-watered and water stress conditions. PCA and biplot were employed for identifying the tolerant and susceptible genotypes. Further, test genotypes were evaluated under rainfed condition for assessing the leaf yield and quality during different crop seasons.

Identification of high yielding drought tolerant mulberry progenies: ANOVA revealed highly significant differences among the test genotypes for leaf yield, its components as well as all the drought tolerance indices in both the conditions. Leaf yield/plant recorded significant positive association with mean productivity (MP), geometric mean productivity (GMP), harmonic mean (HM), yield index (YI), stress tolerance index (STI) and modified stress tolerance indices (K_1STI & K_2STI). Specific leaf area, fresh leaf moisture, relative water content, primary shoots/plant and total shoot length recorded significant positive association with leaf yield. The results of principal components analysis (PCA) and biplot revealed that the genotypes *viz.*, PYD 26, PYD 08, PYD 01, PYD 02, PYD 21 and PYD 15 exhibit drought tolerance with high yields in well-watered as well as water stress conditions.

Preliminary evaluation of mulberry progenies for leaf yield and quality under rainfed condition: Data was recorded on physiological, biochemical, morphological traits and leaf yield of thirty selected progenies along with three checks under rainfed condition during 2018. On the basis of ANOVA, it could be analysed that all the traits exhibited highly significant differences ($p<0.05$) among the genotypes. The leaf yield/plant varied from 256-680 g^{-1}crop and 1.021-1.756 kg^{-1} year. Ten genotypes (PYD 08, PYD 27, PYD 26, PYD 04, PYD 01, PYD 15, PYD 21, PYD 03,



PYD 30 & PYD 23) recorded significantly high (5-25%) annual leaf yield over check variety (C-2038) under rainfed conditions.

Performance of top drought tolerant genotypes for leaf yield and associated traits

Genotype	LYP (g/plant)	WLR (mg $g^{-1}fwh^{-1}$)	LPC (mg g^{-1} dw)	LLS (cm)	TSS (mg g^{-1}dw)
	WW / WS	WW / WS	WW / WS	WW / WS	WW / WS
PYD 26	568[a] / 505[a]	3.00 / 2.10	7.36 / 36.77[a]	145 / 123	13.99 / 25.87[a]
PYD 08	521[a] / 460[a]	4.82 / 2.87	28.18[a] / 45.52[a]	166[a] / 154[a]	14.44 / 30.95[a]
PYD 01	487[a] / 434[a]	3.04 / 2.04	7.73 / 45.13[a]	134 / 129	13.18 / 27.31[a]
PYD 02	469[a] / 419[a]	3.26 / 2.35	21.86[a] / 45.73[a]	122 / 107	14.67 / 22.64[a]
PYD 21	466[a] / 441[a]	1.88 / 0.44[a]	15.17 / 32.34[a]	158[a] / 127	8.94 / 18.69
PYD 15	436[a] / 407[a]	0.67[a] / 0.75[a]	22.28[a] / 26.58[a]	137 / 123	9.72 / 19.20
PYD 03	422[a] / 387[a]	0.43[a] / 0.83[a]	12.05 / 42.00[a]	151[a] /150[a]	14.37 / 26.13[a]
PYD 13	420[a] / 353[a]	2.12 / 1.68	41.68[a] / 45.22[a]	142 / 139	13.60 / 21.78
PYD 10	414[a] / 376[a]	3.76 / 1.15[a]	8.59 / 18.61	140 / 105	13.22 / 26.23[a]
PYD 17	413[a] / 276[a]	0.51[a] / 3.15	19.51[a] / 37.26[a]	133 / 132	16.12[a] / 24.73[a]
[a]C1730	328 / 261[a]	1.75 / 2.00	14.13 / 19.32	134 / 118	14.28 / 20.50
CD at 5%	20 / 14	0.17 / 0.18	1.22 / 1.58	14 / 9	0.86 / 1.34
Min .	278 / 256	0.22 / 0.27	5.75 / 18.61	114 / 105	8.07 / 15.55
Max.	568 / 505	4.82 / 4.96	45.76 / 49.76	166 / 161	18.39 / 30.95

LYP: Leaf yield per plant; WLR: Water loss rate of excise leaf; LPC: Leaf proline content; LLS: Length of the longest shoot, TSL: Total shoots length, WW: Well watered condition; WS: Water stress condition

Performance of drought tolerant genotypes under rainfed condition (June-July 2018)

Genotype	LYP (kg/year)	LMC (%)	RWC (%)	TSP (mg g^{-1}fw)	TSS (mg g^{-1}fw)	LPC (µg g^{-1}fw)	LLS (cm)	TSL (cm)
PYD 26	1.61[a]	74.81[a]	80.65	30.36	45.76[a]	266.33[a]	143[a]	810[a]
PYD 08	1.76[a]	73.95[a]	79.02	34.29[a]	49.22[a]	193.55	145[a]	1232[a]
PYD 01	1.57[a]	77.23[a]	85.53[a]	35.35[a]	46.39[a]	177.90	118	639
PYD 21	1.47[a]	75.02[a]	79.62	38.53[a]	44.03	202.13	123	1304[a]
PYD 15	1.54[a]	73.65	80.71	31.26	42.86	207.30	116	763
[a]C2038	1.29	73.14	80.02	32.91	42.97	201.70	125	715
CD @ 5%	0.03	0.51	2.76	1.09	1.08	15.30	9	45

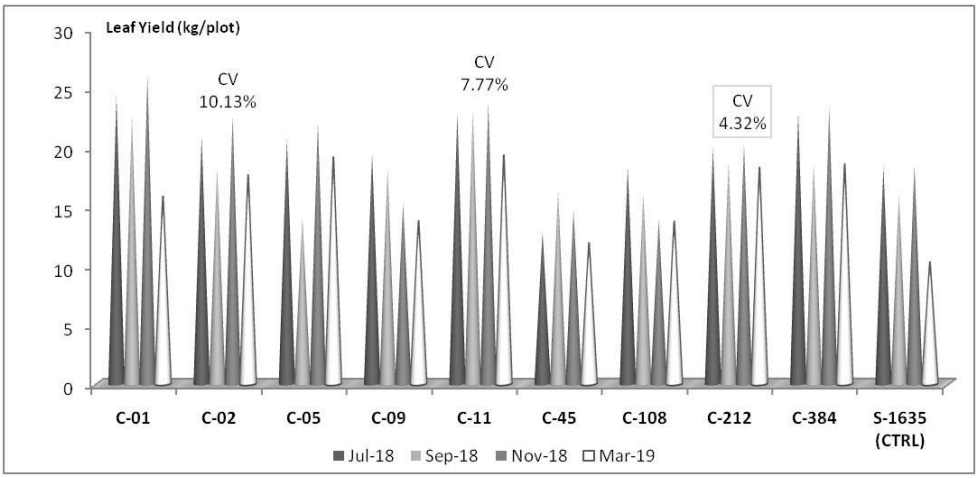
LMC: leaf moisture content; RWC: Relative water content; TSP: total soluble protein; TSS: total soluble sugar; LLS: Length of the longest shoot; TSL: Total shoot length

PIB 3576: Evaluation of new mulberry genotypes for improvement in productivity and quality [June 2016 - July 2020]

Suresh, K. (PI), Anil Pappachan (from July 2018), Deepika K. U. (from March 2019), G. S. Singh, K.C. Brahma, (upto May 2018); SK. Misro (from June 2018); SN. Gogoi (upto Nov 2018) & P. Kumaresan (from Dec2018)

Objective: To evaluate high yielding mulberry genotypes with early sprouting behavior capable of producing sustainable leaf yield during winter month

After establishment, ten low temperature stress tolerant test genotypes including check variety (S1635) were evaluated for leaf yield and component traits along with pest and disease incidence under irrigated and rainfed conditions.



Data related to leaf productivty during different crop seasons along with pest and disease incidence was recorded on fifteen traits. ANOVA revealed highly significant differences for all the traits. The genotypes C1, C11, C384, C2, C212 and C5 recorded significantly higher leaf yield (20-40%) over S1635. During winter crop, leaf yield/plot varied and genotypes *viz.*, C11, C212, C384, C2 and C1 recorded higher yields (30%) over S1635. Growth and leaf quality traits also recorded significantly higher values for most of the test genotypes. Incidence of bacterial leaf spot (0.00-1.73% PDI), *Myrothecium* leaf spot (1.38-10.04% PDI) and *Pseudocercospora* leaf spot (2.06-10.69% PDI) was noticed during different seasons. Minimal natural infestation by whitefly, thrips and mealy bug was also noticed during November and February crops.

Mean values of leaf and morphological traits under irrigated conditions

Name	Days to sprout		FLM	MRC	TSP	LMS	LLS	TSL	LFH
	Normal	winter							
C-01	8	51*	77.93	81.42*	31.89	25.25*	153*	807*	13.43*
C-02	8	56	77.65	82.91*	33.57	25.18	145*	712*	14.61*
C-05	8	57	77.39	82.79*	32.09	23.09	142*	778*	13.03*
C-09	9	63	76.12	81.06*	30.91	24.50	130	731*	13.70*
C-11	8	52	78.13	81.05*	28.86	25.17*	127	772*	13.95*
C-45	9	49*	78.37*	80.21	33.57	24.18	141*	762*	13.63*
C-108	10	54	72.70*	78.89	35.74*	24.83	126	725*	13.11*
C-212	9	51*	78.23	78.77	35.29*	23.80	137	765*	15.52*
C-384	10	54	78.23*	79.85	33.17	23.46	138	762*	15.04*
*S-1635	8	55	77.39	78.99	32.80	24.37	133	654	18.46
CD at 5%	1	3	0.83	1.63	1.01	0.75	6	33	0.91

FLM: fresh leaf moisture content (%); MRC: Moisture retention capacity after six hrs storage (%); TSP: total soluble protein (mg g^{-1} FW); LMS: Leaves per meter shoot; LLS: Length of the longest shoot (cm); TSL: Total shoots length (cm) and LFH: Leaf fall at harvest (%)

Similarly, data was recorded on different traits related to leaf productivty at three test centers (RSRS- Korput, RSRS-Jorhat & REC-Bhandra) during different crop seasons along with pest and disease incidence under rainfed conditions. ANOVA revealed significant differences among test genotypes for all the traits. At REC-Bhandra, leaf yield per crop varied from 10.04-13.03kg per plot (forty nine plants) and C-11, C-45, C-1 & C-108 recorded higher leaf yield over check (S-1635). Leaf yield at RSRS-Koraput varied from 12.64-15.53kg per plot and C-45, C-5, C-108 & C-1 were superior to check variety. Leaf yield per crop varied from 11.14-27.35kg per plot and C-2, C-1, C-384, C-5 & C-11 were superior to S-1635 at RSRS-Jorhat.

Mean values of leaf and morphological traits under rainfed centers (3 crops)									
Name	Leaf moisture content(%)			Length of longest shoot(cm)			Leaf yield (kg/plot/crop)		
Center	BND	KPT	JHT	BND	KPT	JHT	BND	KPT	JHT
C-01	75.91	80.02*	70.11	137*	141*	145*	12.44*	14.23*	24.80*
C-02	78.31	76.50	73.26*	134	125	139*	10.04	13.41*	27.35*
C-05	78.08	78.62	70.19	133	146*	132*	11.56*	14.79*	21.96*
C-09	77.41	77.59	71.19	125	132*	90	11.73*	12.64	13.39
C-11	77.73	78.24	69.58	134	110	118*	13.03*	13.47*	21.33
C-45	78.61	79.89*	71.51	135*	167*	128*	12.57*	15.53*	20.05
C-108	73.21	74.00	70.63	136*	130*	119*	12.03*	14.67*	11.14
C-212	79.56*	77.17	67.53	141*	129*	144*	11.91*	13.54*	15.34
C-384	78.59	78.54	70.63	137*	124	128*	12.37*	13.72*	22.62*
*S-1635	78.37	78.05	70.23	131	119	105	10.45	12.44	18.11
CD @ 5%	0.68	1.05	1.19	4	8	9	0.47	0.90	3.28

BND: REC, Bhandra; KPT: RSRS, Korput and JHT: RSRS, Jorhat

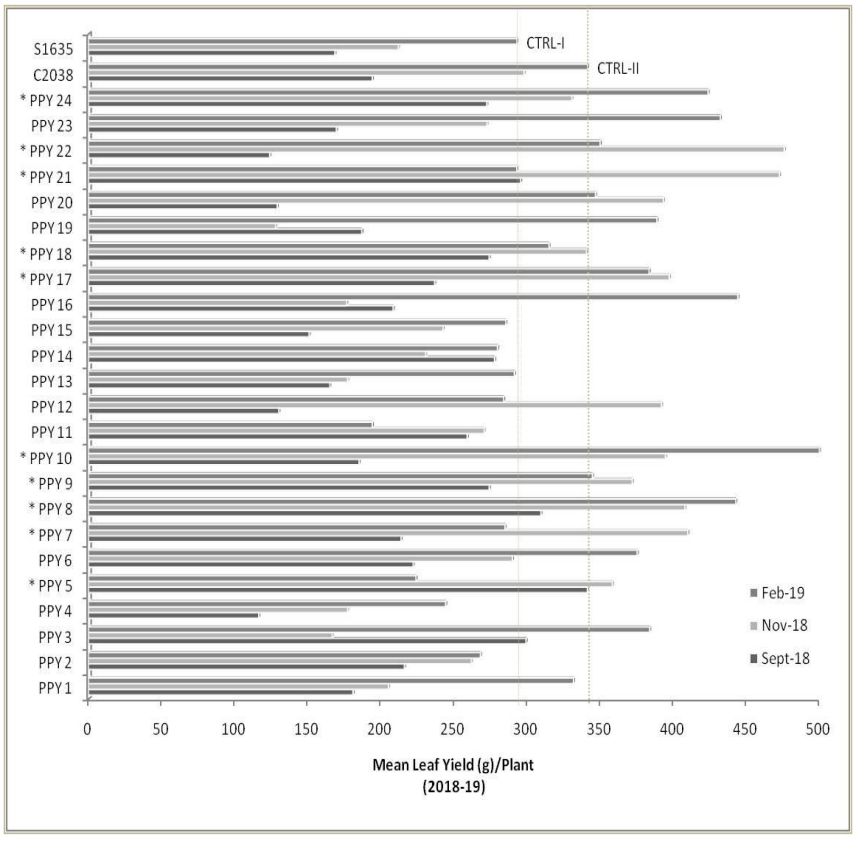
PIB 3610: Preliminary evaluation of newly evolved mulberry genotypes for mulberry improvement [June 2017 - May 2020]

Suresh, K. (PI), D. Chakravarty, A. Pappachan and Yallappa H (from March 2019)

Objective: Evaluation of improved lines for foliage biomass and associated agronomic traits under PYT

Twenty four test genotypes along with two check varieties (S1635 & C2038) were established under RBD in three replications in 60 x 60 cm spacing. Data was recorded (70 days after pruning) for nine traits associated with foliage biomass and quality along with pest and disease incidence during three crop seasons under irrigated conditions.

ANOVA indicates significant genotypic effect, suggesting the presence of sizeable variation among genotypes for all the traits. Ten test genotypes recorded significantly higher leaf yield over the check variety, C2038 besides better leaf quality traits and low pest & disease incidence.



PYE - leaf and morphological traits in top ranking test genotypes (three crops)

Genotype	FLW	FLM	MRC	LMS	LLS	NPS	LSR	LSH	LYP
PPY 08	2.45	75.97	80.61*	25.98*	117*	6.08*	50.71	15.87	387*
PPY 10	3.03	76.52	81.40*	25.99*	107	4.28	52.76	12.70*	366*
PPY 21	2.69	77.86*	83.13*	25.67	121*	5.28*	53.04	9.50*	354*
PPY 24	2.25	75.77	82.03*	28.13*	122*	5.53*	51.86	11.31*	342*
PPY 17	3.10	75.57	79.35*	25.84	125*	4.70*	50.72	10.40*	339*
PPY 09	2.35	76.09	81.28*	25.86	114*	6.00*	51.46	9.14*	330*
PPY 22	2.71	76.30	80.24*	22.85	114*	4.64*	53.62	13.53	317*
PPY 18	1.89	76.01	81.38*	28.18*	116*	5.25*	51.14	6.38*	310*
PPY 05	3.14	76.49	79.89*	28.94*	94	4.86*	56.26*	4.10*	308*
PPY 07	2.53	75.70	79.89*	26.96*	107	4.17	50.31	6.18*	303*
*C-2038	3.19	76.32	78.14	25.34	107	4.18	53.69	14.41	262
CD@5%	0.26	0.44	0.74	0.58	4	0.19	00.80	1.15	22

PIB 3627: Development of superior mulberry (Morus spp.) genotypes through polyclonal seed orchard [June 2018 - May 2021]

D. Chakravarty (PI), Suresh, K, Yallappa H (from March 2019) and Deepika, K.U (from March 2019)

Objective: To establish polyclonal seed orchard for creating enormous genetic variability

For developing a new mulberry variety utilizing available gene pool through polyclonal approach, twenty nine superior divergent genotypes/accessions were established in polyclonal seed orchard. Flower synchronization, sex, ploidy level, *per se* performance on leaf quality & productivity traits, genetic diversity, combining ability, complementarity etc. were considered for identifying the accessions. Four months-old saplings of different accessions were raised as per standard practices in nursery and transplanted in clonal orchard (5' x 5' spacing). The plantation is designed so that each male parent is surrounded by different female parents for facilitating natural pollination. The plants were maintained as per the recommended package of practices under irrigated conditions.

Establishment of Polyclonal Orchard

Type	***Accessions***
Varieties	C-2038, S-1, C-776
Elite	C-2047, C-2032, C-2045, C-2036, C- 2035, S-30, C-2017, KOP, T-13, Gen1
Exotic	*M. indica:* ME-0003, ME-0097 *M. alba:* ME-0042 *M. latifolia:* ME-0006, ME-0011, ME-0066, ME-0086
Indigenous	*M. alba*: MI-0001, MI-0004, MI-0017, MI-0054, MI-0054, MI-0300 *M. indica:* MI-0084, MI-0092, MI-0095, MI-0248

Continuous/Other Activities

Maintenance of mulberry germplasm accessions

Mulberry genetic resources consisting of germplasm accessions, tetraploids, triploids and elite lines were established in field gene bank at CSRTI-Berhampore for maintenance. The recommended agronomic practices with plant protection measures were undertaken periodically. The plants were pruned during July and leaf yield was recorded during September 2014 & 2015.

Profile of mulberry genetic resources at CSRTI-Berhampore

Species	No.	Exotic	Indigenous (kg/plant)	Sex expression of the plant		
				Male	Female	Both
M. alba	58	0.48 - 16.69	0.54 - 10.29	10	32	16
M. indica	50	0.58 - 4.03	0.42 - 12.21	7	33	10
M. latifolia	19	0.46 - 10.56		3	13	3
M. bombycis	14	0.66 - 5.12		1	9	4
Other species	12	0.37 - 6.78			10	2
Elite clones	63		0.31 - 11.20	10	33	20
Total	216	87	129			

Among the germplasm resources, 153 accessions belong to four *Morus* species suitable for sericulture and the remaining are wild species and elite clones. Highly significant differences among the accessions indicated presence of sufficient amount of variability in respect of leaf yield per plant. Among germplasm accessions, mean leaf yield/plant varied from 0.37 to 16.69 kg and highest leaf yield (>10 kg) was recorded in accessions such as China White, OPH-3, Kaliakoliai, Monla1 & Kosen. Among the elite (crossings: C530, C1608, C1690, C1552 & C776; OPH selections: S1704, S1573, S1, S1301, & S642) recorded highest leaf yield per plant.

AGRONOMY & SOIL SCIENCE

Concluded Research Projects

PPS3598: Arsenic contamination in mulberry sericulture of Bengal plain and its alleviation through application of zinc in soil [Nov 2016 - Aug 2018]

V. Vijay (PI), R. Kar, R. Mahesh and G.C. Das

Objectives

- To investigate the extent of arsenic load/accumulation in irrigation water-soil-mulberry plant-silkworm larva continuum under mulberry vegetation
- To formulate dose of zinc for alleviating arsenic pollution in mulberry sericulture by application of zinc
- To validate the efficacy of laboratory findings by conducting appropriate field trials

Dakshin Debipur (24°54'15.4"N 88°01'30.1"E) in Malda district (referring GIS based maps for arsenic affected areas in West Bengal @ *www.soesju.org/arsenic/wb.html; maps.wbphed.gov.in/ arsenic/index.html)* was selected for analysing arsenic load in irrigation water. Three farmers crop (under irrigation from each of five wells ranked for arsenic contamination *i.e.,* high, medium, moderate, low & least) were studied for the *in situ* effects of arsenic contamination and the extent of bio-magnification of As, if any, in the groundwater-soil-plant-silkworm system.

Arsenic contamination in irrigation water was analysed using rapid arsenic test kit (MQuant^{TM}) and Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) at CSRTI-Berhampore and NCCCM-BARC-Hyderabad. Arsenic in soil, mulberry leaf (pooled oven dried powder of 2nd, 5th & 8th leaf from five plants/ crop) and silkworm larva (pooled oven dried powder from ten V instar 3rd-5th day larvae/crop) were analysed using AAS-HG [Perkin Elmer AANALYST 200 atomic absorption spectrophotometer at Arsenic Research Group, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal (Das *et al.*, 2016; Sarkar *et al.*, 2012; Huang and Fuji 1996).

Total arsenic (mg l^{-1}) in 32 shallow tubewell water samples varied (0.0075 ± 0.0008 - 0.6692 ± 0.0135). Available As in the selected 15 farmers' fields ranged from 2.28 to 21.13 mg kg^{-1}. Bioaccumulation of As in mulberry leaf and silkworm ranged from 5.21 to 34.01 mg kg^{-1} and 0.004-0.035 mg g^{-1}, respectively.

Arsenic concentration in samples collected from seri-farmers

Sample	Water Total As [mg l^{-1}]	Soil Avl. As [mg kg^{-1}]	Leaf Total As [mg kg^{-1}]	Silkworm Total As [mg g^{-1}]
F-10;15;17	0.60	08.25 ± 4.20	21.26 ± 6.87	0.014 ± 0.011
F-6;22;23	0.32	11.62 ± 0.49	18.51 ± 6.81	0.017 ± 0.016
F-4;5;28	0.15	13.63 ± 8.32	14.76 ± 8.41	0.017 ± 0.011
F-7 ;11;20	0.08	13.43 ± 9.69	17.74 ± 1.83	0.014 ± 0.010
F-3;12;26	0.007	10.97 ± 7.89	23.98 ± 10.00	0.012 ± 0.012

The survey shows that the total As content (0.007–0.600 mg l^{-1}; mean=0.160) of thirty two shallow tube well waters in the study area was 16 times higher than the safe limit (0.01 mg l^{-1}) of arsenic toxicity as defined by WHO and Bureau of Indian Standards (BIS). The bio accumulated As in silkworm larvae was found to be 0.004–0.035 with a mean value of 0.015 mg gm^{-1}.

Inferences

The lower Arsenic contamination in mulberry and silkworm did not cause any hazardous effects in sericulture (upto 21.13 mg Avl.As kg^{-1} soil) and hence, further studies were discontinued.

PPF 3588: Application of Growing Degree Days as a Model Driver for developing mulberry yield weather model [Oct 2016 to Dec 2018]

R. Mahesh (PI; from Jan 2018), M. Chaudhuri (PI; upto Dec 2017), K. Trivedy (upto June 2018), A. Pappachan and Manjunatha, G. R

Objectives: To prepare a model driven by growing degree days towards forecasting growth and yield of instar specific mulberry leaves under daily accumulated heat and basic weather variables

Mulberry Biofixation (Pruning Dates)			
1st Year	7.10.16	30.12.16	24.3.17
2nd Year	17.06.17	07.9.17	01.01.18
3rd Year	28.3.18	12.06.18	06.09.18

Field experiment was conducted at CSRTI-Berhampore with the existing plantation (S1635) in 2'×2' and 3'×3' spacing. Nine mulberry bio-fixations were done in two successive years under irrigated conditions for phenology study. A plot size of 40 m^2/replication (49 plants in 3'×3'; 111 plants in 2'×2' spacing; 3 replications) was selected for the experimentation. Pruning (bottom) date was considered as mulberry bio-fixation date followed by standard agronomic practices. The phenological observations on fresh leaf yield (5 plants/replication) were recorded at 30, 40, 50, 60 & 70 days after pruning.

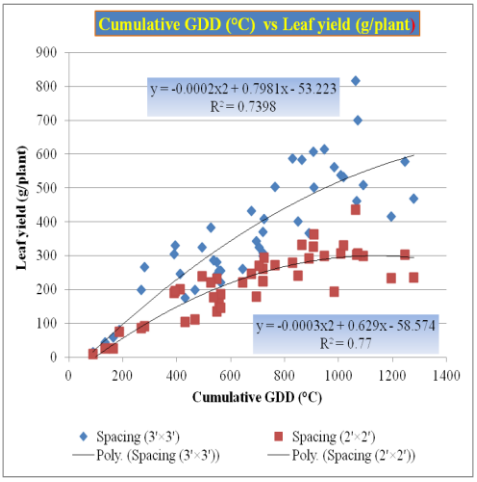
Data on daily maximum and minimum temperature were collected from Agro-meteorology station (CSRTI-Berhampore) during the period. GDD values (day-wise & cumulative) were calculated for each biofixation utilizing the equation, GDD (°C) = $\{(T_{max} + T_{min})/2\} - T_b$ in the following steps: Set T_{max} (upper cardinal temp.) = ≤37.7 (°C); Calculate New T_{avg} (°C) = $(T_{max} + T_{min})/2$; Check, If $T_{avg} < T_b$ (base temp) then $T_{avg} = T_b$; Compute the GDD (°C) = New $T_{avg} - T_b$ (13°C); Negative values are treated as zero or ignored.

Crop yields are influenced by a number of different factors. The current study focuses on the influence of GDD (weather in the form of temperature or heat) on mulberry leaf yield in the West Bengal region. Best-fit regression model (linear/non-linear) was employed to develop a GDD based yield weather model in mulberry. The variables considered in the model for the study is given below: $y_{ij} = f(x_{ij})$ where, Y_{ij}: dependent variables of i^{th} crop of j^{th} spacing (leaf yield); X_{ij} - independent variables of i^{th} crop of j^{th} spacing (accumulated GDD).

Spacing	***GDD Model***	***R^2***
3'x3'	$y = -0.0002(GDD^2) + 0.7981(GDD) - 53.223$	0.74
2'x2'	$y = -0.0003(GDD^2) + 0.629(GDD) - 58.574$	0.77

The cumulative GDD increased with the mulberry leaf yield increased upto a certain extent of 1093°C. The maximum leaf yield recorded was 699 g/plant @ GDD: 1072℃ under 3'×3' spacing and 436 g/plant @ GDD: 1063℃ under 2'×2' spacing; leaf yield was higher in summer and monsoon as compared to winter season. The lower cumulative GDD (494°C) observed in winter season resulted less leaf yield (3'×3': 325 and 2'×2': 238 g/plant). The relationship between the accumulated GDD and mulberry leaf yield (g/plant) was

found significant and best-fit model is being proposed. The coefficients of determination (R^2) confirm the fitness of the models with 74% (in 3'×3' spacing) and 77% (in 2'×2' spacing).



Several environment factors play an important role in crop growth and development, especially temperature which is defined as growing degree day (GDD). Mulberry requires on an average 1072°C cumulative GDD to obtain maximum leaf yield and cumulative GDD registered (528°C) in winter season resulted in lesser leaf yield. Mulberry leaf yield linearly increased with increasing cumulative GDD from date of bio fixation upto 70 days in winter and 60 days in summer and rainy seasons.

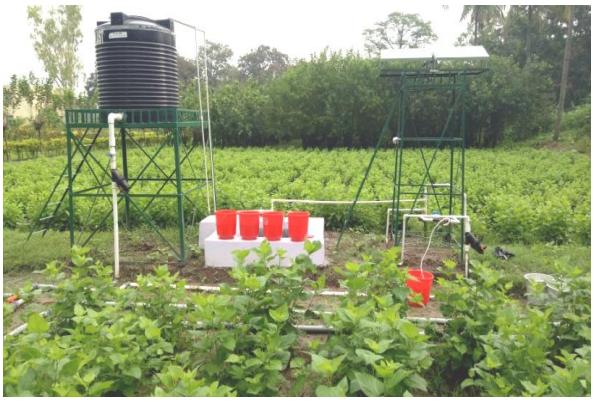
Inference: GDD is one of the important factors regulating the growth and development of mulberry and GDD based yield forecasting models would be useful to predict mulberry leaf yields in the field.

PPA 3588: Evaluation of low cost drip fertigation systems on yield and quality of mulberry leaves [Oct 2016 - Mar 2019]

R. Mahesh (PI), V. Vijay and A. Pappachan, M. Chaudhuri (Co-ordinator; upto Dec 2017)

Objectives

- To evaluate the comparative performance of drip tape fertigation (DTF) & drum kit fertigation (DKF) systems under 2' ×2' & 3' × 3' spacings on yield & quality of mulberry leaves
- To optimize the fertigation schedule for higher mulberry leaf productivity
- To evaluate the DTF and DKF systems on water use & fertilizer use efficiency of mulberry leaves
- To compute economics of DTF and DKF systems in mulberry cultivation



Efficient water and nutrient managements are essential to enhance leaf productivity and quality in mulberry. Drip fertigation is an innovative technology to improve water and nutrient use efficiency in various crops. The study was carried out at CSRTI-Berhampore (latitude 24°05'N & longitude 88°15'E), West Bengal utilizing a 12 year-old S1635 mulberry garden (3'x3' & 2'x2' spacing) in RBD (7 treatments in 3 replications). The treatments were drip tape fertigation (DTF) and drumkit drip fertigation (DKF) in different quantum of RDF (recommended fertilizer dose; 336kg N, 180 kg P_2O_5 & 112 kg K_2O per ha). The plot with surface irrigation with soil application of 100% RDF (single dose; 15th DAP) was maintained as control. Fertigation was followed in T_1-T_6 treatments in 6 split doses starting from 15th to 49th DAP at 7 days interval. Urea, DAP and MOP were used as source of fertilizers. Drip irrigation was scheduled on alternate days with 100% Pan Evaporation. Surface irrigation was applied once in ten days @ 4.5 ha cm. The mulberry garden was pruned

15-20cm above the ground level for every crop. All the plots were maintained following standard recommended package of practices.

Treatments	Leaf yield (t ac^{-1} yr^{-1})		TSP (mg g^{-1} of leaf)	
	3′×3′	2′×2′	3′×3′	2′×2′
T_1 DTF:100% RDF	14.72	16.19	32.2	26.1
T_2 DTF:75% RDF	13.48	15.12	30.1	23.9
T_3 DTF:50% RDF	11.79	13.15	24.0	19.2
T_4 DKF:100% RDF	14.75	15.96	31.7	25.4
T_5 DKF:75% RDF	13.74	14.84	30.5	22.6
T_6 DKF:50% RDF	11.70	12.60	26.0	18.9
T_7 Control	10.79	11.32	19.3	16.9
SE(d)±	0.57	0.74	1.9	1.49
CD @ 5%	1.22	1.59	4.2	3.10

Low-cost drip tape laterals (16mm dia with 250 micron wall thickness) and conventional drip laterals (12mm dia) were laid at 15cm below the soil surface, respectively in DTF and DKF systems. Venturi system was used to inject the supernatant fertilizer solution as per treatments under DTF. The required fertilizer solution was prepared and poured into water tank during irrigation in DKF. Eight crops data were collected on plant growth and leaf yield parameters 70 days after pruning. Data on growth and yield parameters were analysed statistically. Significantly higher growth and yield parameters were recorded in 100% RDF which was on par with 75% RDF under low-cost drip fertigation systems in both 3′×3′ and 2′×2′ spacing. No significant variation was found between DKF and DTF with respect to leaf yield and quality. 100% RDF (32.2 mg g^{-1} leaf) recorded significantly higher total soluble protein (TSP) as compared to control (19.3 mg g^{-1} leaf) and 50% RDF under lowcost drip fertigation systems. Further, 75% RDF recorded at par TSP (30.1 mg g^{-1} leaf).

Annual total quantity of irrigation water used for drip system and surface irrigation were 1204 & 1575 mm, respectively revealing that drip system could save 24% irrigation water. Drip irrigation registered increased water use efficiency (WUE) over surface irrigation in both the spacings. Maximum WUE (DTF: 12.2; DKF: 12.3; SI: 6.7 kg leaf yield/acre/mm) was recorded at 100% RDF. Drip fertigation recorded higher NUE than soil application and 50% RDF registered maximum NUE. 75% RDF (DTF: 71.5 & DKF: 72.9 kg leaf yield/kg NPK) resulted higher NUE than soil application control (43 kg leaf yield/kg NPK).

Treatments	Leaf yield (kg)			
	WUE (per ac/mm)		NUE (per kg NPK)	
	3′×3′	2′×2′	3′×3′	2′×2′
T_1 DTF:100% RDF	12.2	13.5	58.6	64.4
T_2 DTF:75% RDF	11.2	12.6	71.5	80.3
T_3 DTF:50% RDF	9.8	10.9	93.9	104.7
T_4 DKF:100% RDF	12.3	13.3	58.7	63.6
T_5 DKF:75% RDF	11.4	12.3	72.9	78.8
T_6 DKF:50% RDF	9.70	10.5	93.2	100.3
T_7 Control	6.70	7.20	43.0	45.1
SE(d)±	0.49	0.53	3.59	4.12
CD @ 5%	1.04	1.13	7.70	8.83

The economic analysis of low cost drip fertigation (DTF) for mulberry is beneficial to the sericulture farmers. The cost of cultivation was lesser at 75% RDF (Rs. 34651 ac^{-1}) and 50% RDF (Rs. 33092 ac^{-1}) under DTF than control (Rs. 35339 ac^{-1}). The gross returns were higher in 100% RDF (DTF: Rs. 73591 & DTF: Rs. 73749 ac^{-1} yr^{-1}) followed by 75% RDF (DTF: Rs. 67394 & DKF: Rs. 68712 ac^{-1} yr^{-1}); while surface irrigation registered lesser gross returns (Rs. 53950 ac^{-1} yr^{-1}). Benefit cost ratio

Treatments	Cost of cultivation (Rs. ac^{-1})		Gross income (Rs. ac^{-1})		B:C ratio (Rs. ac^{-1})	
	3′×3′	2′×2′	3′×3′	2′×2′	3′×3′	2′×2′
T_1 DTF:100% RDF	36234	40375	73591	80948	2.03	2.00
T_2 DTF:75% RDF	34651	38792	67394	75620	1.94	1.95
T_3 DTF:50% RDF	33092	37233	58950	65769	1.78	1.77
T_4 DKF:100% RDF	39572	45417	73749	79819	1.86	1.76
T_5 DKF:75% RDF	37989	43834	68712	74210	1.81	1.69
T_6 DKF:50% RDF	36430	42275	58524	63000	1.61	1.49
T_7 Control	35339	35339	53950	56600	1.53	1.60
SE(d)±	3422	1760	3590	3135	0.08	0.10
CD @ 5%	1595	3776	7700	6724	0.17	0.22

Note: Selling cost of mulberry leaf is considered as Rs.5/kg

(BCR) was higher in 100% RDF i.e., 2.03:1 (DTF) & 1.86:1(DKF) and 75% RDF (DTF: 1.94:1 and DKF:1.81:1) than control (1.53:1).

Drip fertigation has the potential to improve quality of mulberry leaf as water and nutrients are directly supplied to the root zone. Each plant receives right amount of water and nutrients at regular intervals. The traditional methods of flood irrigation with soil application, in practice generally over/under irrigate and imbalanced fertilizer application occurs. 100% RDF is at par with 75% RDF under low-cost drip fertigation systems with respect to leaf yield and quality. Drip fertigation resulted 26-32% yield improvement at 75% RDF in 3'×3' and 2'×2' spacing. This resulted significant income rise in 75% RDF with DTF. Water saving up to 24% could be achieved with drip systems. 67-75% higher WUE and 66-78% higher NUE at 75% RDF was recorded as compared to control in 3'×3' and 2'×2' spacing.

Low-cost drip fertigation systems with 75% RDF provides additional leaf yield of about 2.69 (DTF) & 2.95 (DKF) t ac^{-1} yr^{-1} leading to additional net gross returns of Rs.13444 (DTF) and Rs. 14762 (DKF) ac^{-1} yr^{-1}. Benefit-cost ratio of mulberry crop under drip fertigation at 75% RDF is profitable to the farmers than the surface irrigation method.

Inference

Lowcost drip fertigation technology optimizes water and fertilizer use efficiency enabling to harness higher leaf yield and improved quality. 75% RDF with drip fertigation could be recommended for mulberry for further popularization under ToT programmes.

Ongoing Projects

PPS 3600: Soil health card preparation for mulberry growing soils in E & NE India [Nov 2016 - Oct 2019]

PI: V. Sivaprasad (from Jan 2019), Chandana Majee (from Aug 2018 – Dec 2018), K. Trivedi (upto July 2018)

CI: D. Chakravarty (from Jan 2018), M. Chaudhuri (upto Dec 2017), Vijay, V., R. Mahesh, A. Pappachan, Suresh, K. (from Jan 18), R. Kar (upto Oct 2018), Zakir H (from Nov 2018), S.K. Mishra (upto June 2019), K. Alam (from July 2019) S.N. Gogoi (upto Aug 2018), P. Kumaresan (from July 2018), R. Luikham (upto July 18), U.C. Boruah (upto July 18), L. Somen Singh, N. Ibotombi Singh (from Aug 2018), S.T. Lepcha, Satyabrata Dey (upto May 2018), Ghanshyam Singh, B.K. Basumatary, C.Z. Renthlei, B.N. Choudhury, L. Pachuau, G.B. Singh (upto Aug 18), Anukul Borah (upto 31 May 2018), Satadal Chakraborty (from July 18)

Objective: To analyze the soil parameters (pH, EC, OC, available N, P, K, S, Zn, Fe, Cu, Mn & B) of mulberry growing soils for preparation and distribution of SHC to the seri-farmers in Eastern and N-E India

Soil analysis is an effective method to detect nutrient deficiency in the soils to deliver exact doses of nutrients through Soil-Test-Based-Dose (STBD) approach obtaining desired quality mulberry leaf yield by maintaining or improving soil health. Considering the importance of soil health for longer duration to achieve targeted yield, Government of India launched a flagship scheme in the International Year of Soils-2015 to analyse soils of farmer's fields and distribute soil health card along with recommendation of STBD of nutrients to be applied. The soil health card scheme is implemented for the benefit of sericulture farmers in Eastern and North Eastern India by CSRTI-Berhampore. During the current year, 1952 soil samples were collected for 11796 sericulture farmers following 2.5 hectare grid scale in coordination with the respective nested units. The samples were processed further and analysed for SHC components at CSRTI-Berhampore & RSRS- Imphal. Soil Health Cards were generated and distributed to the stakeholders in different states by conducting special awareness programmes.

Results show that nutrient status of soil samples varied. The mulberry growing soils of West Bengal, Tripura, Jharkhand, Odisha and Assam were mostly (i.e. >50% samples) acidic, not-saline and with high to medium OC. Most of Tripura and Assam soils were deficient in available N (50; 50%), P (67; 96%) and K (68; 88%). Majority of Odisha samples were deficient in available P (63%) and K (75%). 63% West Bengal soils were low in available potassium. Tripura (68%), Jharkhand (64%), Odisha (61%) and Assam (50%) soils were high in sulphur; while 39% West Bengal soils were low in sulphur. With respect to micronutrient status, 21% Odisha soil samples were found to be deficient in boron. 16% Assam, 6% West Bengal & Jharkhand soils have insufficient zinc. Some Assam soils also showed scarcity of Cu (11%) & Mn (13%). In addition to Zn, 7% West Bengal soils were deficient in Mn. The SHCs with STBD recommendation were generated and distributed for the benefit of 17,436 sericulture farmers.

States	Farmers		
	2017-18	2018-19	Total
West Bengal (WB)	5068	9347	14415
Tripura (TR)		1134	1134
Jharkhand (JH)		48	48
Odisha (OR)		101	101
Assam (AS)	100	113	213
Manipur (MN)	472	671	1143
Meghalaya (ML)		176	176
Mizoram (MZ)		206	206
Total	5640	11796	17436

Status of mulberry growing soil samples for fertility levels (%)

State	Samples (n)	pH			EC (dS/m)	OC (%)		
		Acidic (< 6.5)	Neutral (6.5-7.5)	Alkaline (>7.5)	Not-Saline (<2)	Low (<0.5)	Medium (0.5 – 0.75)	High (> 0.75)
WB	1141	65	20	15	100	24.8	25.1	50.1
TR	266	97	3	0	100	37.0	23.5	39.5
JH	48	88	10	2	100	27.1	8.3	64.6
OR	101	100	0	0	100	15.8	8.9	75.3
AS	113	100	0	0	100	37.2	20.3	42.5

Status of available macro & micro nutrients in mulberry growing soils (%)

Nutrients	Range	WB (n=1141)	TR (n=266)	JH (n=48)	OR (n=101)	AS (n=113)
N	Low (<280)	36.1	50.2	37.5	24.8	50.4
	Medium (280–450)	52.4	40.5	41.7	67.3	41.6
	High (>450)	11.6	9.3	20.8	7.9	7.9
P_2O_5	L (<45)	27.3	67.1	41.7	63.4	95.6
	M (45-90)	21.5	23	27.1	19.8	4.4
	H (>90)	51.2	9.9	31.3	16.8	0
K_2O	L (<200)	62.9	68	31.3	75.3	88.5
	M (200-350)	30.4	23.2	47.9	21.8	1.8
	H (>350)	6.6	8.7	20.8	2.9	9.7
S	L (<10)	38.8	16.3	16.7	9.9	28.3
	M (10-15)	15.7	15.5	18.8	28.7	21.2
	H (>15)	45.5	68.2	64.6	61.4	50.4
Zn	Sufficient (>0.6)	93.7	99	93.8	100	84.1
	Insufficient (<0.6)	6.3	1	6.3	0	15.9
B	Sufficient (>0.06)	97.1	97.4	100	79.2	98.2
	Insufficient (<0.06)	2.9	2.6	0	20.8	1.8
Fe	Sufficient (>4.5)	97.9	100	100	99	96.5
	Insufficient (<4.5)	2.1	0	0	1	3.5
Cu	Sufficient (>0.2)	99.2	99.8	100	96	89.4
	Insufficient (<0.2)	0.8	0.2	0	4	10.6
Mn	Sufficient (>1)	92.8	97.8	100	96	86.7
	Insufficient (<1)	7.2	2.2	0	4	13.3

MULBERRY PATHOLOGY

Continuous/Other Activity:

Forewarning of mulberry diseases of Eastern and North Eastern India

Anil Pappachan (PI), G. R. Manjunatha; I/C REC-Kamnagar, REC-Mothabari, RSRS-Kalimpong, RSRS-Koraput, REC-M.P. Raj, REC-Bhandra, RSRS-Jorhat, REC-Agartala, REC-Mamring, REC-Sille, REC-Dimapur, REC-Aizawal, REC-Imphal & REC-Shillong.

Objectives

- To collect disease incidence and meteorological data of Eastern and North Eastern India
- To develop data base for disease and meteorology of Eastern and North Eastern India
- To fine tune the existing forecasting models and existing disease calendar

Data on mulberry disease incidence was collected at weekly intervals across Eastern and North Eastern India. Prevalence of major foliar diseases *viz.*, Bacterial leaf spot (BLS), *Myrothecium* leaf spot (MLS), *Pseudocercospora* leaf spot (PLS), Powdery mildew (PMLD) and Brown leaf rust (BLR) were recorded in terms of Percent Disease Index (PDI).

State	Location	BLS	MLS	PLS	PMLD	BLR
West Bengal	CSRTI, Berhampore	4.84 (July)	4.95 (November)	3.90 (November)	5.20 (November)	
	Murshidabad	3.43 (September)	2.85 (November)			
	Malda	0.95 (July)	3.95 (August)	2.62 (August)	0.23 (February)	0.41 (July)
	Kalimpong				3.91 (September)	5.46 (September)
Odisha	Koraput	4.41 (September)		4.58 (October)	4.24 (November)	4.83 (April)
Jharkhand	MP Raj	3.08 (June)		2.78 (June)		
Assam	Jorhat					0.30 (April & June)
	Mangaldoi	1.80 (June)	3.88 (November)		5.99 (September)	5.21 (November)
Tripura	Agartala	0.90 (June)	3.70 (July)			
Mizoram	Aizawl				3.32 (September)	
Nagaland	Dimapur					3.37 (June)
Manipur	Imphal				7.17 (June)	1.04 (April)
Meghalaya	Shillong					
A.Pradesh	Sille				0.60 (June)	2.10 (May & June)
Sikkim	Mamring				2.05 (September)	2.25 (September)

BIOTECHNOLOGY

Concluded Research Project

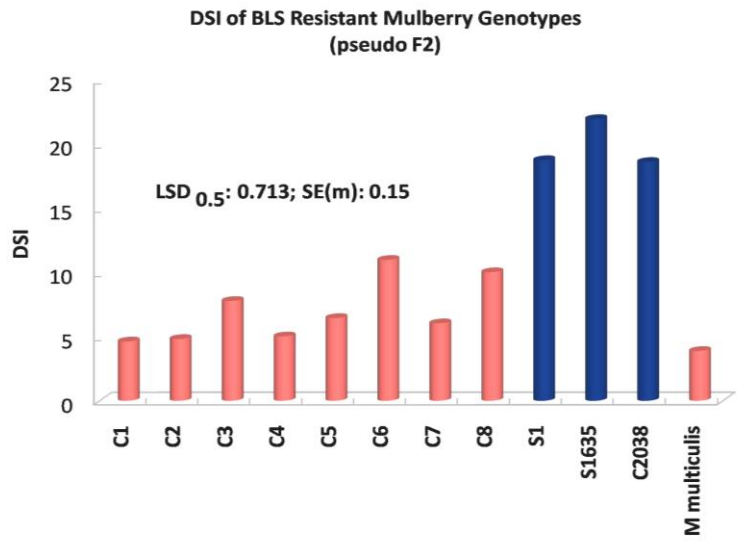
PIB 3548: Evaluation of bacterial leaf spot resistant improved progenies of mulberry for field utilization (Jan 2016 - Dec 2018)

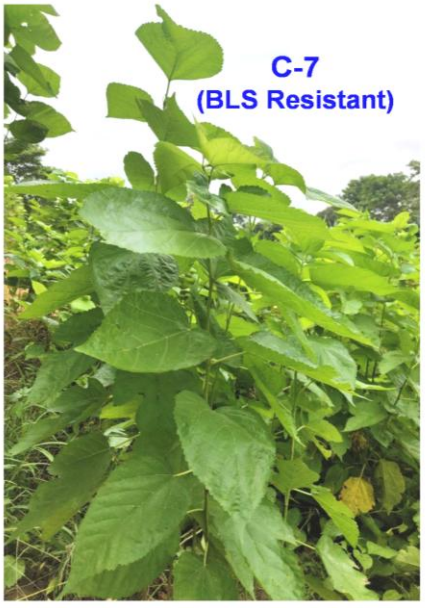
S Chattopadhyay (PI) and Pooja Makwana

Objectives

- Evaluation of bacterial leaf spot (BLS) resistant improved lines for foliage biomass and associated agronomic traits under RBD
- Silkworm bioassay of the promising lines for prospective commercial utilization
- Trait refinement of promising lines through sib-mating and development of third generation (F_2)
- Evaluation of bacterial leaf spot resistance of developed progeny (F_2) using identified SSRs to establish marker-trait link for MAS based utilization

Eight promising BLS resistant F_1 (Pseudo F_2) genotypes along with parental clones and popular cultivars (S-1635 & C-2038) were established under RBD for evaluation of disease responsiveness, foliage biomass and ancillary traits including survival, morpho-physiological and biochemical parameters. Five rounds of disease scoring were conducted (from the onset of natural incidence of BLS to the commercial silkworm rearing seasons, Shravani: June & Aswina: Sept). Genotypes were evaluated for BLS disease reaction ~60d after bottom pruning and resistant genotypes exhibited 61-72% lesser DSI values as compared to the susceptible superior parent S_1 (DSI: 23.1).





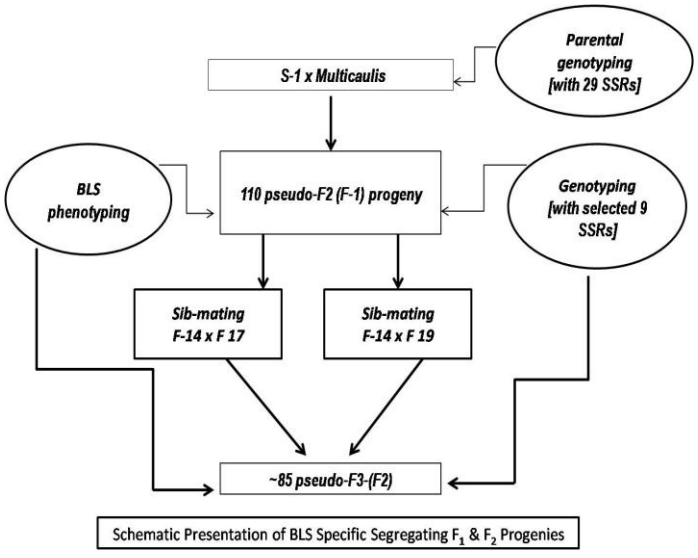
Leaf biomass potential of BLS resistant genotypes was evaluated (54 plants/genotype). Significant variability was observed among the genotypes and C2 (0.3%) and C7 (3.1%) showed slightly better leaf yield than the check variety (C-2038); however, C-7 performance was consistent across the seasons. Different physiological and biochemical parameters were also estimated from leaf tissues of BLS resistant genotypes.

Around 4% thicker leaf lamina with better plastidial pigments and 9% higher soluble sugars observed seems to contribute for the better performance of C-7 as compared to C-2038. C-7 showed significantly higher total phenol content. Seasonal rearing (Baisakhi/March-April 2018) was conducted utilizing bivoltine silkworm foundation cross (B.Con1 x B.Con4) with C7 and C-2038 foliages and non-significant data was recorded for larval, cocoon and silk characteristics over the check variety.

BLS Resistant Genotype	Leaf biomass	
	gm plant^{-1}	kg ha^{-1}year^{-1}
C-1	298.9	41523
C-2	387.0	53748
C-3	324.8	45111
C-4	340.1	47220
C-5	351.6	48832
C-6	322.2	44748
C-7	397.5	55354
C-8	321.5	44652
C-2038	386.4	53679
S-1635	324.2	45032
S-1	222.2	30860
CD @ 5%	6.85	

Values represent mean of 11 seasons

Segregating F_2 (pseudo F_3) progenies were developed through sib-mating of three promising pseudoF_2 progenies and established in a nursery. DNA isolated from BLS trait refined F_2 descendants (~85 Nos) and ~118 F_1 (pseudo F_2) derived from the cross of *M. multicaulis* x S1 and *M. multicaulis* x C-2028 along with parents were used. These three generations were also used for phenotyping of BLS disease reaction. Two SSRs (NGS 263: 200bp; MM37: 250bp) identified earlier were employed along with 28 other CCMB developed mulberry specific SSRs for determining the possible association with BLS resistance in mulberry utilizing five resistant and seven susceptible genotypes/progenies. Nine SSRs showed parental polymorphism and these were further utilized for DNA profiling of BLS specific segregating (118 F_1 and 85 F_2) progenies. Based on three generation-BLS specific DNA profiling data, molecular mass of major allelic bands was determined using Bio1D software and correlated with phenotypic BLS disease severity index (DSI). In F_1 and F_2 populations, DSI variations were 7.8-folds and 8.6-folds, respectively. Two SSRs viz., MM17 (~181bp) and NGS263 (~286bp) exhibited strong association with phenotypic resistance reaction. Moreover, genotypic association with BLS reaction significantly increased in F_2 over F_1 progenies. Correlation increased with trait refinement from F_1 to F_2 (76% to 83% in MM17; 79% to 89% in NGS263) indicating possible association with BLS resistance in mulberry.

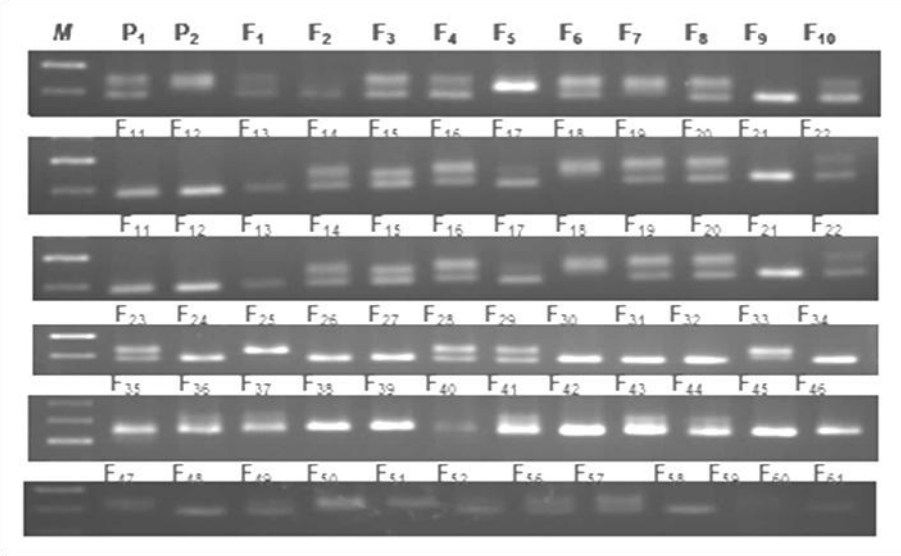


Schematic Presentation of BLS Specific Segregating F_1 & F_2 Progenies

Seasonal leaf productivity in BLS resistant genotypes

Genotype	Leaf biomass (kg ha^{-1}crop^{-1})					
	Jan-Feb	Mar-Apr	June- July	Aug-Sept	Oct-Nov	CV (%)
C-7	10458	11236	11558	11367	10735	6.7
S-1635	8905	8946	9261	8999	8921	7.8
C-2038	10567	10657	10891	10883	10681	6.3
SEd (±)	543	478	673	541	424	

Representative amplification of BLS responsive primer (MM-68) on F_1 mulberry progeny (3% agarose gel; M= 50bp marker P1= resistant parent; P2 =Susceptible and F_{1-n} = F1 progenies)



Association of promising markers with BLS resistance

SSR	Segregating alleles (bp)		Gen	Disease reaction	Association with DSI (%)		Potential as marker link
	Resistant recipient	Susceptible donor			212bp	181bp	
MM-17	181 212	181	F_1	R	65.3	76.5	181bp allele++
				S	85.7	25.3	
			F_2	R	71.8	82.9	
				S	74.1	30.7	
NGS-					303bp	286bp	
	286 303	286	F_1	R	39.4	78.8	284bp allele+++
				S	54.8	31.3	
			F_2	R	41.2	87.2	
				S	59.5	14.2	

Inference

- BLS resistant genotype, C-7 exhibited significantly higher resistance response (61-72%) than commercial /pipeline cultivars viz., S-1, C-2028, S-1635 & C-2038
- Annual leaf biomass potential (kg ha^{-1} $crop^{-1}$) of C-7 was significantly higher (10458-11558) than C-2038
- Two allelic bands of SSRs viz., MM17 (182bp) and NGS 263 (286bp) showed very strong correlation with phenotypic disease reaction over three generations.

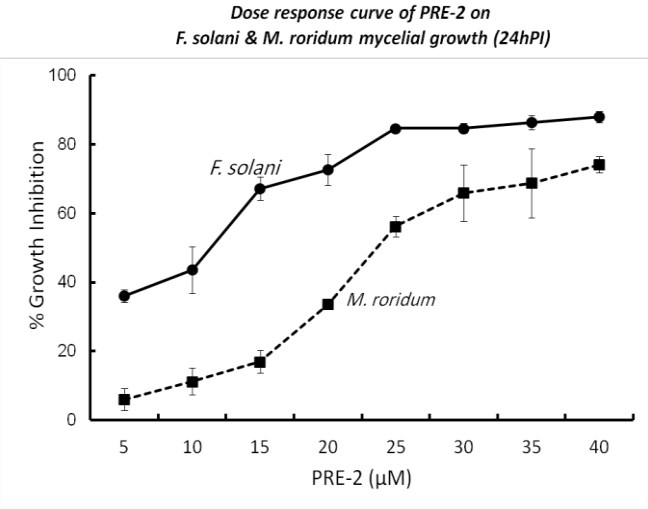
Ongoing Project

PRE 3589: Assessment of designed antimicrobial peptides for mulberry protection against brown leaf spot and root rot: a biotechnological approach [Oct 2016 - Sept 2019]

S. Chattopadhyay (PI), R Banerjee (upto June 2017), P Makwana and A. Pappachan (from Jan 2019)

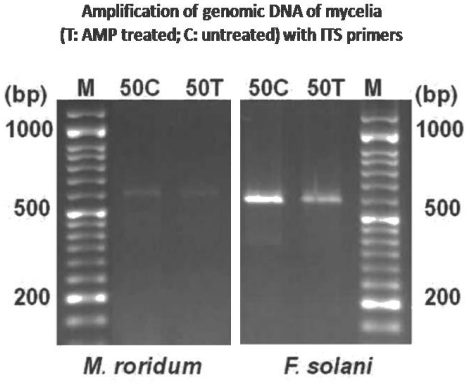
Objectives

- Assessment of disease protection potential of synthetic antimicrobial peptides (AMPs) against *Myrothecium* leaf spot (MLS) and *Fusarium* root root (FRR) of mulberry *in vitro*
- Assessment of disease protection potential of selected AMPs against MLS and FRR *ex-vivo*
- Determination of disease suppression ability of selected AMPs using quantitative PCR
- Determination of the hemolytic activity of the selected AMPs against silkworm



The disease protection potential of selective AMPs against *Myrothecium* leaf spot (MLS) and *Fusarium* root rot pathogens (FRR) was undertaken at different concentrations (10-175µM) through incubation with spore suspension(s) in a microwell plate for 0-72h *in vitro*. The absorbance values (A_{450}) were recorded with a plate reader at every 18h interval. Inhibition of spore growth ranged from 11- 100% with increase in AMP conc. Minimum inhibitory concentration (MIC_{50}) of most effective PRE-2 was 14.6µM against *F solani* and 23µM against *M roridum* after 24h of incubation.

Pathogenicity of *M. roridum* and *F. solani* was confirmed by inoculation of healthy mulberry roots with spore solution. The efficacy of PRE-2 to suppress mycelial growth of both the fungal pathogens was partially confirmed by respective pathogen-specific primers. For determining the MLS disease suppression abilities of PRE-2 *ex vivo,* 55 ± 5 day old-potted mulberry (S-1635) plants were inoculated with *M. roridum* (~ $1x10^5$ conidia mL^{-1}) for development of MLS symptoms. Replicated sets (n=5) were maintained for each treatment. Post-MLS symptom development, PRE-2 was sprayed on and MLS score10 and 20 DAI were recorded.



Saplings were incubated with viable *F. solani* (~ $1x10^5$ conidia mL^{-1}) for ~24h and transplanted in earthen pots and maintained under standard conditions. FRR symptoms appeared ~45 DAI and subsequently, a set of infected plants (n=5) were administered with 100µM of PRE-2 (~60 DAI) for recording the apparent difference of plant health condition. Further, the experiments are under progress.

SILKWORM BREEDING & GENETICS

Ongoing Projects

AIB 3602: Development of thermo-tolerant bivoltine breeds/hybrids of silkworm through marker assisted selection [Nov 2016 - April 2021]

N. Chandrakanth, V. Lakshmanan, A. K. Verma, V. S. Raviraj (from March 2019) and N. B. Kar (upto Jan 2019)

Objective: To develop the thermotolerant bivoltine silkworm breeds/hybrids through DNA marker assisted selection and their evaluation

Eight breeding lines were developed utilizing SK4C and BHR3 as thermo-tolerant bivoltine donor parents and GEN-3 and D6 (M) as productive bivoltine parents. As per the breeding plan, six generations of repeated backcrossing has to be conducted with the respective productive parent on exposure to high temperature (36°C) at alternative generations. In each generation, the female moths (after oviposition) were screened for heterozygous banding pattern with the SSR markers linked to thermo-tolerance (S0803 & S0816). During the previous year, two generations of backcrossing was completed and three more generations of backcrossing with MAS was completed to reach BC_5 generation during the year. In each generation, female mother moths screened for amplification of S0803 & S0816. The broods with heterozygous banding pattern for SSR markers were selected and reared in the next generation. The performance of BC_3 populations at normal temperature (25°C) was recorded. BC_4 populations were reared under normal and high temperature conditions (from V instar 3rd day to till spinning at 36°C). WB3 and WB4 (dumbbell) and WB7 and WB8 (oval) lines performed better in terms of pupation rate under high temperature conditions. BC_5 generation rearing was conducted in normal conditions only and the performance was recorded. Further breeding process will be continued employing MAS.

Performance of BC3 populations at normal temperature (March-April 2018)

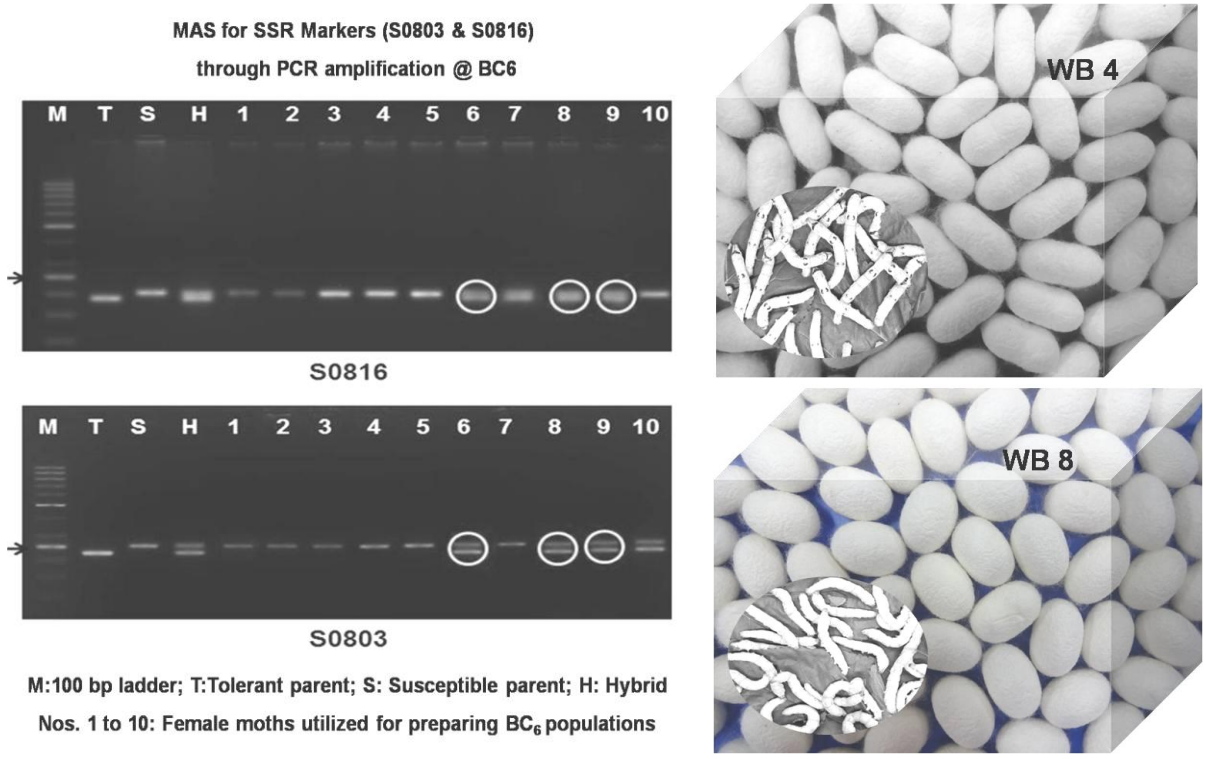
Lines @ BC3	Cocoon Type	Fec. (No.)	Hatching (%)	ERR (No.)	ERR by wt. (kg.)	Cocoon Wt. (g)	Shell Wt. (g)	Shell (%)
WB1	Dumbbell	488	92	7727	12.36	1.362	0.236	17.33
WB2		492	98	9425	11.10	1.329	0.246	18.51
WB3		502	97	8629	11.09	1.308	0.233	17.81
WB4		478	96	7367	10.07	1.367	0.278	20.34
WB5	Oval	424	97	9500	13.23	1.418	0.274	19.32
WB6		509	99	8450	11.10	1.344	0.277	20.61
WB7		521	97	7889	11.56	1.414	0.306	21.64
WB8		537	98	8600	11.72	1.321	0.266	20.14
	Mean	519	97	8448	11.53	1.358	0.265	19.48
	t stat @ 1%	24.2**	129.0**	31.1**	34.2**	93.7**	30.1**	37.0**

Performance of BC_4 populations at normal (25°C) & high temperature (36°C)
May-June 2018

Lines @ BC4	Cocoon Type	Fec. (No.)	Hatching (%)	ERR (No.)	ERR by wt. (kg.)	Cocoon Wt. (g)	Shell Wt. (g)	Shell (%)
WB1	Dumbbell	485	90	82/65	12.900 /8.067	1.371 /1.241	0.234 /0.216	17.07 /17.01
WB2		499	98	94/61	13.100 /7.387	1.317 /1.211	0.245 /0.206	18.60 /17.01
WB3		512	95	86/68	12.800 /8.200	1.308 /1.250	0.231 /0.224	17.66 /17.92
WB4		485	96	89/68	13.100 /8.996	1.381 /1.323	0.266 /0.238	19.26 /17.99
WB5	Oval	422	91	95/65	14.100 /8.619	1.402 /1.326	0.264 /0.222	18.83 /16.74
WB6		498	92	85/55	12.300 /6.738	1.345 /1.225	0.267 /0.213	19.85 /17.39
WB7		502	93	80/71	12.900 /9.628	1.442 /1.356	0.298 /0.239	20.67 /17.63
WB8		516	98	87/80	12.100 /9.782	1.331 /1.295	0.276 /0.239	20.74 /18.46
	Mean	490	94	85/67	12.500 /8.464	1.362 /1.278	0.260 /0.225	19.08 /17.57
	t stat @ 1%	24.2**	129.0**	31.1** /25.7**	34.2** /20.7**	93.7** /67.3**	30.1** /49.4**	37.0** /89.5**

Performance of BC_5 populations at normal temperature
Aug-Sept 2018

Lines @ BC5	Cocoon Type	Fec. (No.)	Hatching (%)	ERR (No.)	ERR by wt. (kg.)	Cocoon Wt. (g)	Shell Wt. (g)	Shell (%)
WB1	Dumbbell	489	92	8237	12.59	1.342	0.248	18.48
WB2		498	88	8300	12.07	1.315	0.254	19.32
WB3		502	90	8431	13.01	1.419	0.266	18.75
WB4		512	94	8781	13.14	1.428	0.257	18
WB5	Oval	477	95	8344	12.24	1.303	0.224	17.19
WB6		483	85	8071	11.40	1.325	0.244	18.42
WB7		499	93	8563	12.88	1.395	0.265	19
WB8		505	90	8978	13.71	1.319	0.25	18.95
	Mean	495	90.87	8463	12.63	1.356	0.251	18.51
	t stat @ 1%	41.95**	101.06**	78.86**	40.15**	33.35**	45.51**	55.60**



AIB 3617: Identification of region specific bivoltine hybrids suitable for highly fluctuating and seasonally variable climatic conditions of E & NE India, (Phase-II of AIB 3466), [April 2017 - March 2020]

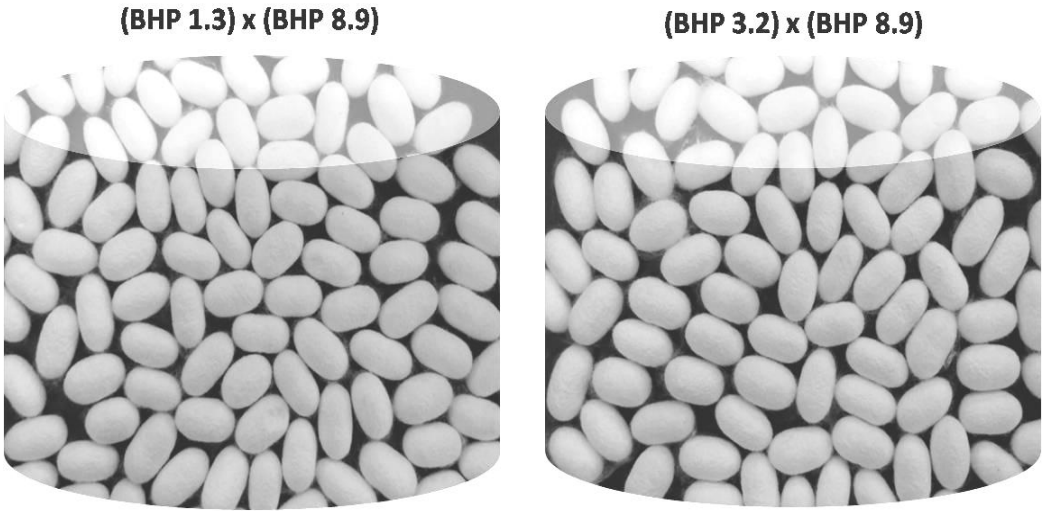
V.Lakshmanan (PI), N.Chandrakanth, V.S.Raviraj and N. B. Kar (upto Jan 2019), Gautam Mitra (from Feb 2019), I/c of REC-Bhandra, RSRS-Jorhat, RSRS-Koraput, RSRS-Kalimpong and REC-Shillong

Objective: To identify new bivoltine hybrids with genetic plasticity to buffer against adverse climatic conditions of Eastern and North-Eastern India

Five BHP breeds viz., BHP1, BHP2, BHP3, BHP8 and BHP9 were maintained for four generations in Agrahayani, Falghuni, Jyestha, Bhaduri seasons (3-5 cellular batches; 300 larvae out of III moult) and five BHP breeds such as BHP4, BHP5, BHP6, BHP7 and BHP10 were culled out due to inferior overall performance. The short-listed BHP lines were utilized for hybrid evaluation (double hybrids) studies involving five BHP parental stocks and four popular foundation crosses in E & NE India. The double hybrids were evaluated thrice in Agrahayani, Falghuni & Bhaduri seasons (3 composite batches; 300 larvae out of III

Breed	Fec (No)	ERR (No)	ERR Wt (Kg)	Cocoon wt (g)	Shell wt (g)	Shell (%)
BHP 1	547	7908	10.050	1.265	0.253	20.00
BHP 2	586	8919	12.710	1.422	0.271	19.00
BHP 3	585	8173	10.300	1.254	0.231	18.86
BHP 8	484	8233	11.580	1.403	0.272	19.33
BHP 9	501	7383	10.080	1.364	0.254	18.57
SK6	541	8286	10.964	1.308	0.222	16.94
SK7	538	8964	11.993	1.304	0.220	16.87
BCon 1	632	8630	11.300	1.308	0.226	17.25
BCon 4	529	7397	9.480	1.277	0.222	17.38
CD @ 5%	35	446	0.809	0.046	0.116	0.89
CV%	8.31	7.06	9.62	4.55	8.87	6.32

moult) for overall performance including reeling and silk characteristics. Two combinations viz., BHP 1.3 x BHP 8.9 and BHP 3.2 x BHP 8.9 were identified as most promising. The hybrid combinations with popular dumbbell foundation crosses (SK 6.7 & BCon1.4) were as controls. The OST/OFT of promising hybrids is under progress.



Evaluation of BHP double hybrids

Hybrid	Fec (No)	ERR (No)	ERR Wt (Kg)	Cocoon wt (g)	Shell wt (g)	Shell (%)	Fil. length (m)	Raw Silk (%)
BHP 1.3 x BHP 8.9	553	9184	14.02	1.492	0.270	18.09	751	13.2
BHP 1.3 x SK 6.7	536	8600	12.90	1.439	0.248	17.23	692	12.2
BHP 1.3 x BCon 1.4	502	8140	12.65	1.454	0.250	17.19	675	12.0
BHP 3.2 x BHP 8.9	570	9152	15.40	1.590	0.308	19.37	769	14.0
BHP 3.2 x SK 6.7	522	9160	13.97	1.438	0.246	17.10	662	12.0
BHP 3.2 x BCon 1.4	546	8440	13.24	1.510	0.260	17.21	655	12.1
SK 6.7	508	9520	14.20	1.407	0.230	16.34	640	11.4
BCon 1.4	511	9100	14.08	1.478	0.252	17.05	670	12.0
CD @ 5%	20	390	0.731	0.048	0.019	0.76	39	0.69
CV%	4.56	5.22	6.31	3.84	9.00	5.21	6.74	6.70

AIB3616: On-farm Trial of multivoltine silkworm breeds/hybrids developed for high shell percentage and neatness of silk filament (Sept 2017 - Dec 2019)

A.K.Verma (PI), N.Chandrakanth, T.Renjita Devi (from March 2019), N.B.Kar (Upto Jan 2019), G. Mitra (from Feb 2019), S. Chakraborty, P. Kumareshan and S. K. Misro

Objectives

- To test the potentiality of the new improved multivoltine breeds/ hybrids developed in AIB 3501
- To identify season specific silkworm hybrids for the plains of West Bengal, Jharkhand, Odisha and North-East states

Comparative performance of hybrids in E & NE states (2018-19)

Hybrid	Location	Yield/ 100 dfls (kg)	Cocoon Wt. (g)	Shell Wt (g)	Shell (%)	% increase in yield over CTRL
8 (W) x SK6. SK7	West Bengal	51.27	1.511	0.261	17.25	6.79
	Jharkhand	49.11	1.392	0.243	17.48	-3.82
	Odisha	55.01	1.802	0.275	15.28	-2.48
	Assam	47.17	1.458	0.255	17.49	10.44
	CV (%)	22.23	15.49	22.15	10.24	
12(Y) x BCon1. BCon4	West Bengal	58.35	1.504	0.265	17.62	21.54
	Jharkhand	54.12	1.526	0.233	15.29	5.99
	Odisha	58.20	1.539	0.249	16.22	3.17
	Assam	47.75	1.372	0.245	17.88	10.39
	CV (%)	27.20	8.96	9.16	5.30	
21(Y) x BCon1. BCon4	West Bengal	58.59	1.470	0.260	17.70	21.87
	Jharkhand	52.73	1.489	0.242	16.23	3.27
	Odisha	52.11	1.745	0.272	15.57	-7.62
	Assam	47.31	1.409	0.246	17.43	10.77
	CV (%)	16.63	2.28	7.64	6.00	
N x SK6. SK7 Control	West Bengal	48.01	1.429	0.223	15.58	
	Jharkhand	51.06	1.485	0.213	14.34	
	Odisha	56.41	1.72	0.264	15.35	
	Assam	42.71	1.399	0.225	16.08	
	CV (%)	22.50	19.86	24.38	9.06	

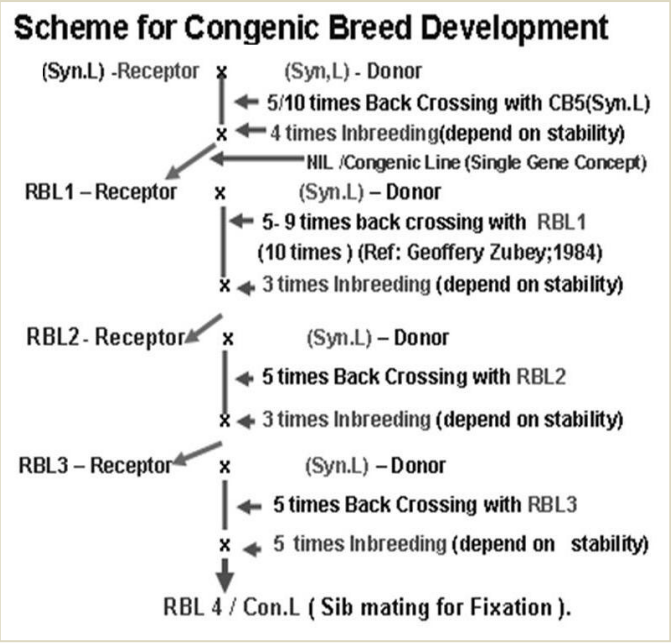
OFT of three multi bi hybrids *viz.*, 8(W) x SK6.7; 12(Y) x BCon1.4; 21(Y) x BCon1.4 was conducted in West Bengal, RSRS-Jorhat, RSRS-Koraput and REC-Bhandra. The three crops (Aug 2018, Nov 2018 & Feb 2019; 1000 dfls/crop/hybrid) data along with the control hybrid (N x SK6.7) was recorded analyzed. The performance of 12(Y) x BCon1.4 was comparatively better at RSRS-Jorhat, RSRS-Koraput and REC- Bhandra; whereas the performance of 21(Y) x BCon1.4 was consistent in various districts of West Bengal. The most promising hybrids would be further evaluated in different seasons.

AIB3619: Development of Bombyx mori congenic breeds from a gene pool with higher genetic plasticity (Phase-II; July 2017 - June 2020)

A.K.Verma (PI), N.Chandrakanth, T.R.Devi (from March 2019), N.B.Kar (upto Jan 2019) and G. Mitra (from Feb 2019)

Objective: To develop Congenic multivoltine and bivoltine breed from developed six way converged gene pool as parent for high cocoon shell weight and horizontal tolerance respectively

Project AIB-3480 (Phase I) resulted in the development of two bivoltine and three multivoltine six-way convergent lines. Phase-II project focuses to develop congenic breeds with targeted traits of high survival in bivoltines and high shell weight in multivoltines utilizing the convergent lines as receptor and donors as per the following breeding plan. Till date RBL2 development is completed and third crossing with donor parent is conducted. Further work involves back crossing and sib-mating for RBL3 development.



Performance of multivoltine RBL-M1 & RBL-M2 lines vis-à-vis targets

Line	Trait	Target	BC_4 (Aug 18)	BC_5 (Nov 18)	BC_5-S_1 (Feb 19)
RBL-M1	Cocoon Colour	Yellow	Yellow	Yellow	Yellow
	Shell Wt (g)	>0.22	0.260	0.262	0.260
	Shell (%)	>15.00	15.94	16.24	18.98
	Pupation (%)	>90.00	90.33	94.00	96.00
RBL-M2	Cocoon Colour	White	White	White	White
	Shell Wt (g)	>0.22	0.2555	0.280	0.270
	Shell (%)	>15.00	18.55	18.30	16.82
	Pupation (%)	>90.00	90.67	94.67	95.67

Performance of bivoltine RBL-B1 & RBL-B2 lines vis-à-vis targets

Line	Trait	Target	BC_4 (Aug 18)	BC_5 (Nov 18)	BC_5-S_1 (Feb 19)
RBL-B1	Cocoon Colour	White	White	White	White
	Shell Wt (g)	>0.24	0.255	0.280	0.245
	Shell (%)	>17.00	17.71	18.54	19.60
	Pupation (%)	>90.00	88.33	93.00	95.67
RBL-B2	Cocoon Colour	White	White	White	White
	Shell Wt (g)	>0.24	0.265	0.259	0.250
	Shell (%)	>17.00	17.10	17.60	19.92
	Pupation (%)	>90.00	89.00	95.33	95.00

All the RB lines are being maintained through sib-mating as back-up stocks. After sib-mating (RBL1, BC_5-S_1), the target character gradually decreased and it might further decrease in BC_5-S_2; therefore, number of sib-matings would be undertaken as per the requirement corresponding to the targeted traits for developing the envisaged congenic lines. Further, RB lines would be evaluated for their stability for the targeted traits in the upcoming generations (favourable and unfavourable seasons) during next year.

Continuous/Other Activities

Maintenance of Bivoltine Germplasm Stocks

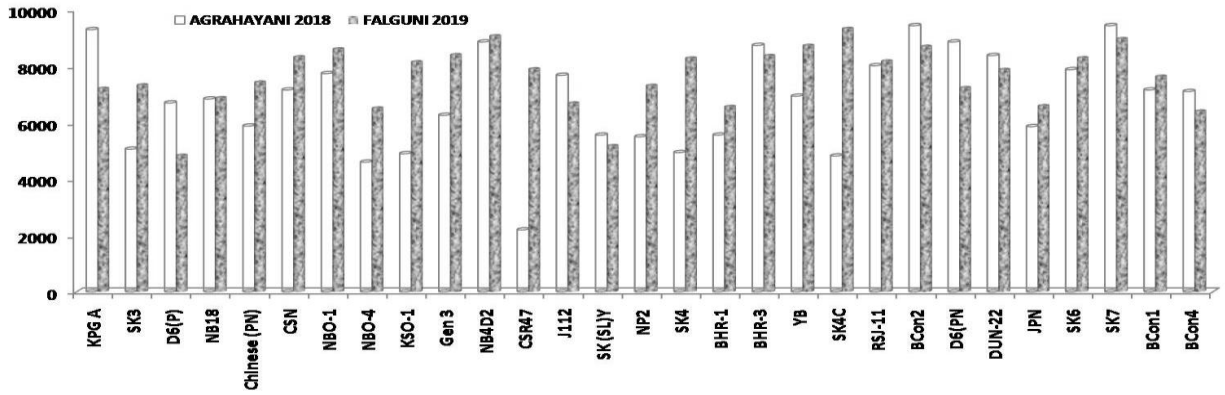
Twenty nine bivoltine silkworm germplasm stocks are maintained at CSRTI-Berhampore. These batches are reared in Agrahayani 2018 and Falguni 2019 (3 cellular batches; 300 larvae out of III moult) following standard rearing conditions. The cocoons conforming to original breed characteristics were selected for oviposition and dfls were produced. The layings were preserved under various hibernation schedules as per requirement for all the experimental purposes. Some of the selected germplasm along with the identified or short-listed hybrids parental stocks would also be maintained at RSRS-Kalimpong in the spring season.

The variations observed in ERR by number among the bivoltine germplasm breeds in Agrahayani and Falguni seasons are presented in graphical form revealing seasonal effects on survival. The breeds which are performing better in respective seasons could become future breeding programems. The rearing performance of Agrahayani 2018 and silk fibre parameters assessed during Falguni season are presented below:

Rearing performance of bivoltine germplasm stocks (2018-19)

Race/ Breed	Fec. (Nos)	ERR by No.	ERR by wt. (kg)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)	FIL (m)	Dnr	Reel-ability (%)	Ren-ditta	Neat-ness (%)
KPG-A	488	9300	13.300	1.417	0.228	16.10	741	1.99	76	7.89	80
SK3	402	5060	6.760	1.326	0.239	17.99	595	2.38	76	7.49	78
D6(P)	422	6700	9.600	1.566	0.279	17.78	611	2.38	78	6.89	78
NB18	433	6840	9.900	1.372	0.235	17.16	477	2.51	81	7.76	80
CHINESE (PN)	442	5880	8.200	1.516	0.273	18.03	716	2.13	75	7.32	78
CSN	408	7160	10.200	1.447	0.256	17.71	667	2.38	78	7.09	81
NBO-1	422	7740	11.500	1.502	0.261	17.39	663	2.05	74	7.64	79
NBO-4	442	4600	6.940	1.447	0.280	19.35	675	2.16	76	7.07	80
Gen-3	472	6260	9.100	1.478	0.283	19.15	682	2.12	72	7.42	80
NB4D2	425	8860	12.000	1.436	0.248	17.27	697	2.17	74	7.62	79
CSR47	413	2200	2.600	1.563	0.285	18.23	623	2.31	81	6.94	80
J112	456	7680	8.160	1.320	0.231	17.77	693	2.22	76	8.16	78
SK(SL)Y	340	5560	7.300	1.389	0.234	16.84	697	2.17	79	8.12	79
NP2	441	5500	7.700	1.442	0.265	18.41	618	2.29	81	6.94	80
SK4	422	4940	6.980	1.439	0.247	17.18	567	2.66	74	7.31	81
BHR-1	488	5560	7.200	1.409	0.245	17.39	610	2.28	75	8.51	79
BHR-3	495	8740	13.200	1.583	0.277	17.51	635	2.44	78	7.08	78
YB	452	6940	11.200	1.454	0.237	16.33	646	2.45	80	7.59	80
SK4C	402	4820	6.700	1.452	0.252	17.36	661	2.32	79	6.7	79
RSJ11	465	8020	10.700	1.565	0.294	18.81	679	2.32	78	7.36	80
B.Con.2	416	9440	11.200	1.122	0.189	16.88	635	2.34	77	7.78	78
D6(P)N	438	8860	12.200	1.334	0.218	16.34	713	2.19	76	7.85	79
DUN22	460	8380	11.800	1.634	0.291	17.79	684	2.34	78	6.67	79
JPN	465	5860	7.910	1.364	0.260	19.06	560	2.79	79	7.09	80
SK6	471	7880	10.933	1.313	0.208	15.80	612	2.16	72	7.84	81
SK7	480	9440	12.533	1.229	0.189	15.37	602	2.12	74	7.9	80
B.Con-1	482	7160	9.760	1.286	0.210	16.30	582	2.56	74	8.12	78
B.Con-4	418	7104	9.840	1.344	0.218	16.24	604	2.66	72	8.18	79

Seasonal Performance (ERR by Number) of Bivoltine Germplasm Stocks (2018-19)



Maintenance of Multivoltine Germplasm Stocks

Twenty eight multivoltine silkworm germplasm stocks are maintained at CSRTI-Berhampore. These batches are reared for five crops (3 cellular batches; 300 larvae out of III moult) during the year following standard rearing conditions. The cocoons conforming to original breed characteristics were selected for oviposition and dfls produced were utilized for further maintenance.

Rearing performance of multivoltine germplasm stocks (2018-19)

Race/ Breed	Fec-undity (Nos)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)	ERR by No.	ERR by wt. (kg)	FIL (m)	NBFL (m)	Denier
NISTARI (M)	383	1.127	0.136	12.07	9367	10.47	358	358	2.61
NISTARI (P)	422	1.364	0.179	13.12	9233	12.50	367	367	2.27
NISTARI (Chalsa)	405	1.282	0.199	15.52	9133	11.63	337	281	2.19
NISTARI (Debra)	434	1.388	0.190	13.69	9367	12.93	349	291	2.27
NISTARI (w)	379	1.320	0.189	14.32	9200	12.07	354	295	2.55
NISTARI (SL)	401	1.357	0.190	13.68	9367	12.63	374	315	2.66
M.Con-1	452	1.120	0.183	16.34	9200	10.27	493	493	2.67
Cambodg	345	1.109	0.140	12.62	9400	10.33	328	273	2.00
CB5	495	1.312	0.211	16.08	9467	12.37	411	342	2.23
M12W	405	1.372	0.177	12.90	9033	12.30	383	319	2.11
M6M81	468	1.429	0.223	15.61	9067	12.87	448	448	2.62
M6DPC	412	1.192	0.162	13.59	9300	11.00	420	420	2.18
OS-616	512	1.471	0.221	15.02	9533	13.93	551	551	2.81
M.Con4	504	1.533	0.248	16.18	9167	13.97	507	507	2.55
M2	406	1.271	0.182	14.32	9100	11.47	582	485	2.50
G	492	1.456	0.210	14.42	9433	13.67	461	384	2.20
PM	362	1.110	0.124	11.17	9500	10.47	319	319	2.31
O	476	1.561	0.241	15.44	9267	14.37	457	457	2.61
M15	493	1.221	0.159	13.02	8967	10.87	416	346	2.16
M6DPE	465	1.539	0.225	14.62	9133	13.97	484	404	2.78
M9A	408	1.511	0.222	14.69	9233	13.87	519	519	2.25
M6DPC(Gr)	398	1.085	0.154	14.19	9033	9.73	375	375	2.58
S2	476	1.302	0.163	12.52	9267	11.97	501	418	1.93
Sarupat	397	1.240	0.172	13.87	9300	11.43	430	430	1.96
M12W(+P)	384	1.157	0.165	14.26	9167	10.57	345	345	2.24
MH1	483	1.452	0.218	15.01	8933	12.90	531	531	2.25
BL67	521	1.623	0.277	17.07	8767	14.13	687	687	2.29
ND7	550	1.608	0.264	16.42	8467	13.53	582	582	2.38

Values represent mean of five crops (3 cellular batches/crop)

REELING & SPINNING

Pilot study /Other Activities

Studies on the effect of preservation of dried cocoon on reeling efficiency and yarn quality parameters [Oct 2018 - Sept 2019]

G. Mitra (PI; from Feb 2019], N.B.Kar (PI; upto Jan 2019], and S. Mazumdar (RSTRS-Malda)

Objectives

- Optimization of storage duration of mulberry cocoon
- Optimizing the preservation period and finding out the critical limit of quality deterioration
- Finding out the right packing material for storage

Commercial multi x bi hybrid cocoons (Nistari x SK6.SK7) were procured during Agrahayani 2018 (favourable season) and hot air-dried followed by segregation in 13 lots each (20Kg green wt.) for seven treatments (including control). The lots were reeled under standard conditions: after preservation of 0 day (control) and followed by the schedule for remaining six treatments 15d (T2), 30d (T3), 45d (T4), 60d (T5), 75d (T6) and 90d (T7) days preservation in Hessian (H) and LDPE bags. The reeling work was carried out on cottage reeling basin through out-sourcing to a progressive reeler in Malda.

Reeling performance (Agrahayani crop, 2018)

Treatment	Reelability (%)	Renditta	Silk Recovery (%)	Waste on Silk Wt. (%)
T1 (Control)	80	8.10	77.10	29.70
T2 (H/ LDPE)	80/79	8.10/8.43	76.29/76.49	31.08/30.73
T3 (H/ LDPE)	78/78	8.34/8.51	75.92/76.54	31.71/30.66
T4 (H/ LDPE)	80/79	8.35/8.08	77.47/75.78	29.08/31.95
T5 (H/ LDPE)	78/81	8.36/8.68	77.07/75.98	29.75/31.22
T6 (H/ LDPE)	79/77	8.65/8.75	77.48/76.96	29.06/29.94
T7 (H/ LDPE)	81/75	8.43/9.39	77.63/74.95	28.81/33.42

Silk yarn quality (Agrahayani crop, 2018)

Treatments	Av. Size (denier)	Tenacity (gms/ denier)	Elongation (%)	Size Deviation	Evenness Variation-I	Cleanness (%)	Neatness (%)	Winding Breaks	Grade
T1 (Control)	25.48	3.6	18	2.93	25	83.0	83	10	C
T2 (H/ LDPE)	24.35/22.30	3.5/3.4	20/19	1.60/2.10	30/39	82.5/82	85/86	10/11	C
T3 (H/ LDPE)	22.94/23.30	3.5/3.4	19/18	2.32/2.36	38/37	81.5/81	86/87	11/10	C
T4 (H/ LDPE)	24.98/24.52	3.4/3.3	20/19	2.36/2.94	35/37	80.5/80.5	85/86	10/10	C
T5 (H/ LDPE)	23.70/24.15	3.4/3.3	19/19	2.82/2.36	39/36	80.0/80.5	85/84	11/11	C
T6 (H/ LDPE)	21.77/24.29	3.5/3.5	18/19	2.01/1.74	33/39	81.0/79.5	86/85	10/10	C
T7 (H/ LDPE)	23.14/25.98	3.4/3.5	18/19	1.85/1.84	38/35	79.5/80	85/86	10/10	C

No significant variations were observed in the reeling as well as yarn quality parameters in the Agrahayani crop (2018) cocoons among the treatments except T7 (LDPE), which resulted in slightly higher renditta and waste; might be due to moisture formaton in LDPE bag after 90 days storage. These results would be compared with the cocoons procured from Bhaduri crop (unfavourable season) in 2019.

Continuous/Other activities

Evaluation of experimental cocoon lots

A total of 365 cocoon lots (multi x bi: 238; bi: 127) received from different laboratories under various programmes evaluated for post-cocoon parameters. Further, single cocoon reeling assessment was carried out for 58 cocoon lots received from bivoltine & multivoltine breeding and biotechnology labs to study filament length, denier etc. The reeling/silk quality performance reports were submitted to the respective laboratories.

Development of 'Suvarna' & Souroneer

Modified version of 'Katghai' (traditional charkha), 'Suvarna' (motorized charkha) with 'Souroneer' (solar water heating unit) was developed in the institute. The unit was demonstrated in the Resham Krishi Mela held at Berhampore, which was appreciated by the concerned stakeholders and sericulture personnel. Utilization of these two units together would reduce the cost on manpower/fuel by almost 50% as one-manpower (turner) in reeling operation becomes obsolete and fuel consumption is reduced because of souroneer. This also helps in the drudgery reduction and improvement of Cost-Benefit Ratio (BCR) and yarn quality. Souroneer units are currently being utilized by the reelers for cocoon processing. The institute aims to propose for establishment of Suvarna (motorized charkha) and Souroneer (solar water heating unit) units in the field under ToT programme during the year 2019-20.


Katghai
(traditional charkha)


Souroneer
(solar water heating unit)


Suvarna
(motorized charkha)

Economics of Suvarna with Souroneer				
Particulars	Reeling by Katghai (charkha)		Reeling by Suvarna with Souroneer	
	Qty	Cost (Rs)	Qty	Cost (Rs)
Expenditure				
Cocoons (kg)	16	2400	16	2400
Electricity (units)			4	16
Coal (kg)	15	165	7.5	82.5
Manpower				
Reeling (No)	1	450	1	450
Turner (No)	1	350		
Installation & Maintenance	10 year life span	40	10 year life span	82
Total		3405		3030.5
Returns				
Raw silk (kg)	2	4400	2	4600
Silk waste (kg)	0.75	112.5	0.75	112.5
Total		4512.50		4712.5
Net Returns		1107.50		1682
BCR		1.33		1.56
Note: Machine cost with installation [Katghai:10000/- & Suvarna with Souroneer: 52000/-]				

SILKWORM PATHOLOGY

Concluded Research Project

ARP3522: Isolation, cloning and characterization of antibacterial protein (s) from silkworm, Bombyx mori. (A collaborative project with SBRL-Kodathi- Bangalore; May 2015 - June 2018)

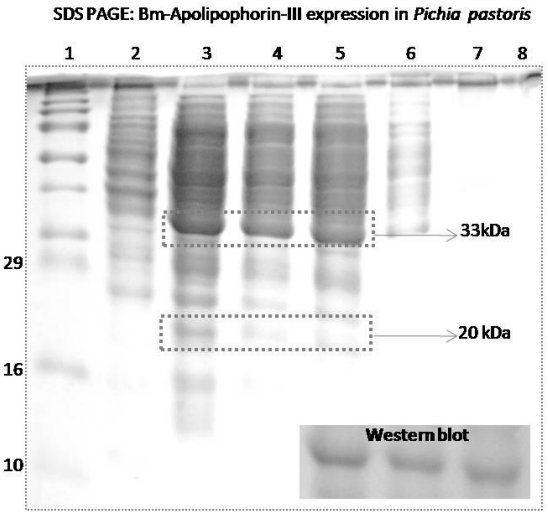
K.Rahul, (PI-from Aug 2016), G. Ravikumar (SBRL-Kodathi-Bangalore) and S. Chakrabarty (upto June 2016), Z. Hossain (Aug 2016 - May 2018) and Gourab Roy (JRF/SRF)

Objectives

- To isolate and characterize bacterial strains and study their pathogenicity [CSRTI-Berhampore]
- To isolate, purify and characterize antibacterial protein fractions elicited against bacterial strain [CSRTI-Berhampore]
- Molecular cloning and full length sequence for mass production of antibacterial protein [SBRL-Kodathi & CSRTI-Berhampore]

Flacherie in silkworms is defined as state of larval health which is caused by various bacterial and viral pathogens. Bacterial pathogens are often associated with silkworm flacherie and the research work was undertaken to identify native anti-bacterial proteins in silkworm for utilization as therapeutic agents. Bacterial strains were isolated and purified from flacherie infected worms by standard plating technique. The bacterial strains were identified by 16S rRNA gene sequencing analysis and their pathogenicity was ascertained following Koch postulates. Proteins elicited upon infection in silkworm larvae were identified by mass spectrometric analysis. RNA was extracted; first-strand cDNA was synthesized; target antibacterial genes were PCR amplified; cloned in sequencing pJET plasmid; and recombinant plasmids were transformed using *E. coli* (Dh5α). Full length cloning of antibacterial gene was carried out using RACE kit (Takara) & recombinant gene was expressed in *Pichia pastoris* expression system (Invitrogen). Presence of expressed recombinant protein was confirmed by Western blot and mass spectrometry. *in vitro* assay was conducted to assess the efficacy of recombinant protein against Gram +ve and -ve bacteria by disc diffusion assay.

Three bacterial strains causing flacherie in silkworm were isolated and identified belonging to the genera: *Staphylococccus*, *Escherichia* and *Providencia*. Specific polypeptides detected in the haemolymph samples post-infection with the bacterial strains were subjected to peptide analysis by mass spectrometry. Based on MS data analysis, genes coding for uncharacterized protein (~12kDa), gloverin 4-like protein (~14kDa), lysozyme (~7kDa) and lipoprotein (~20kDa) were partially cloned and sequenced. NCBI BLAST analysis exhibited similarities with Gloverin-1 (98%), Gloverin-4 like protein (99%), Lysozyme (99%) and *Bombyx mori* Apolipophorin III (94%), respectively. Bm-Apolp-III was identified for expression in *Pichia pastoris* system.



1: marker; 2: without insert; 3-5: *Pichia*-ApoLpIII recombinant protein after 24h, 48h & 72h harvests; 6-8: *Pichia*-ApoLpIII recombinant protein after 24h, 48h & 72h culture supernatants

5' UTR and 3' UTR of Apolipophorin III gene was amplified, cloned in pJET blunt end cloning vector, which was confirmed by colony PCR. Full length gene sequence of Apolipophorin III was obtained using standard procedures. Bm-Apolp-III was expressed in *Pichia pastoris* and confirmed by Western blot and mass-spectrometry analysis. 250ml *P. pastoris* culture yielded ~800ng recombinant Bm-Apolp-III. The recombinant protein exhibited antibacterial activity against Gram-positive and -negative bacteria.

Inference

Antimicrobial protein, Bm-Apolipophorin-III was cloned and expressed in *Pichia pastoris*. The recombinant protein exhibited antibacterial activity against *Staphylococcus* sp. and *Providencia* sp.; however, the expression system was not good enough to continue any further experimentation and needs further work to identify the best expression system.

On going Projects

ARP3590: Studies on the efficacy of phototrophic bacterial extracts as feed supplement for management of diseases in silkworm [Oct 2016 - Sept 2019]

K.Rahul (PI), Zakir Hossain (upto May, 2018) and M.Rabha (from March 2019)

Objectives: To screen the efficacy of phototrophic bacterial extracts as feed supplements for disease management in silkworm

Feed supplements (FS) were identified through systematic studies. Toxicity and impact of feed supplements were assessed *in vivo* utilizing silkworms (SK6xSK7). No toxic effects were observed with feed supplement from phototrophic bacterium, *Rhodopseudomonas* sp. Further, no significant differences with respect to rearing and reeling parameters were observed. The survivability was found to be 16% higher in batches that were inoculated with *Staphylococcus* sp. and supplemented by FS in comparison to normal diet. FS was found to be not effective against *Bm*NPV & *B.bassiana*.

Effect of Feed Supplements on Silkworm Rearing (ERR%)

Diet	*BmNPV*	*Staphylococcus*	*B. bassiana*
Normal	54 (0.83)	52 (0.38)	43 (0.96)
Fortified	57 (1.46)	60 (0.51)	41 (0.69)
t-stat (P value)	0.11	0.001	0.12
Sig @ 1%	NS	**	NS

Note:: Values in () indicates standard error; NS: non-significant

Effect of Feed Supplements on Cocoon Assessment

Treatment	ERR (%)	Cocoon Wt. (g)	Shell Wt. (g)	Shell (%)	FL (m)	Denier
Control	91	1.41	0.24	17.02	740	2.89
FS@0.5%	93	1.40	0.24	17.14	738	2.46
FS@1%	91	1.51	0.26	17.22	753	2.63
FS@2%	91	1.39	0.24	17.27	736	2.49
SEm ±	5.556	0.089	0.014	1.044	45.279	0.161
CD @ 1%	Non-significant					

ARP3630: Evaluation of new room and silkworm bed disinfectants
(June 2018 - May 2021)

K.Rahul (PI) and M.Rabha (from March 2019)

Objectives:

- To screen potential eco-friendly chemicals for their efficacy in controlling microbial diseases
- To develop a broad spectrum room disinfectant for eradication of pathogens causing silkworm diseases
- To develop a silkworm bed disinfectant having synergistic action in controlling all microbial diseases

Four eco-friendly chemicals (Citric acid, Iodine, Glyoxal & Peracetic acid @ 1-5% were utilized to determine their efficacy against silkworm pathogens (*Bm*NPV, *N. bombycis*, *B. thuringiensis*, *Staphylococcus* & *B. bassiana*) using *in vivo* & *in vitro* techniques. Citric acid was not effective against any of the silkworm pathogens; glyoxal was effective only against *Staphylococcus*; Iodine was effective against *Staphylococcus* & *B. bassiana*; peracetic acid was effective against all the pathogens except sporulating *B. thuringiensis* and *N. bombycis*. Further screening of eco-friendly chemicals/substances against silkworm pathogens is under progress.

Continuous/Other Activities
Survey, surveillance and monitoring of silkworm diseases in seed and commercial crops in Eastern and North Eastern India (in collaboration with DOS-WB and NSSO; April 2016 - March 2019)

Executive Authority: Director-CSRTI-Berhampore

CSRTI-Berhampore: K. Rahul (PI from May 2018; April 2016 - April 2018), Z. Hossain (PI from July 2016-April 2018; April-June 2016 & May 2018), S. Chakrabarty (PI: April-June 2016; CI: upto March 2018), S. K. Dutta (April-Sept 2016), S. Chanda (March-Dec 2018), C. Maji (April 2016-March 2018), T.D.Biswas (Sept 2016-March 2018), V. Lakshmanan (March-June 2018), A.K.Verma (April 2016-March 2017), S. Chattopadhyay (April 2016-March 2018), D. Pandit (April 2016-March 2017), G.C.Das (April 2016), S.Sarkar (Sept 2016-March 2019) & Incharges of RSRS-Koraput & RSRS-Jorhat; Incharges of RECs @ Shillong-Meghalya, Dimapur-Nagaland, Agartala-Tripura, Aizawl-Mizoram, Imphal-Manipur, Mangaldoi-Assam & Bhandra-Jharkhand

NSSO-Bangalore: ZSSO Malda; Incharges of SSPCs @ Berhampore, D.B.Pur & Kalitha; Incharges of BSFs @ Ambarifalakata, Karnasubarna & Dhubulia

DoT(Seri)-West Bengal: Rafikul Islam Molla (Murshidabad), S. K. Mallik (Birbhum), Jamal S K (Nadia), Santosh Kumar (Malda), Manas Gupta (U.Dinajpur), A. Ghosh (D.Dinajpur), P. K. Saha (Jalpaiguri), S. Mandal (Cooch behar), K. Khawas (Darjeeling) & A. Chakraborty (Midnapore)

Objectives

- To identify diseases responsible for crop loss at DoS, NSSO & farmers' (seed & commercial crops)
- To suggest effective remedial measures to farmers'/farms' to prevent / management of the diseases and forewarn the farmers' for ensuing seed and commercial crops
- To collect the meteorological and crop yield data for analysis
- To prepare database on the incidence of various diseases of silkworm, *Bombyx mori* during seed and commercial crops in Eastern and NE India

The programme to monitor silkworm disease incidence across Eastern and NE India was undertaken with an aim to manage the incidence of silkworm disease in the seed crops. Total coordination of all the involved agencies viz., Central Silk Board (CSRTI-Berhampore; NSSO-Bangalore) and respective state Department of Sericulture was achieved. The meteorological conditions prevailing during the period are also recorded. A total of 5724 samples were examined in seed crops reared during 2016-2019 across different regions of West Bengal. Mortality due to grasserie was highest in almost all the crops followed by flacherie. Pebrine incidence remained <3% in all the crops, except Falguni-P1 (9.3%). The crop losses in West Bengal was majorly due to grasserie and flacherie (<5%); except summer and rainy seasons (10%). The basic seed farms were suggested for undertaking appropriate preventive and remedial measures to minimize the disease incidence/spread and prevent outbreak(s) in the particular crop as well as next season crops.

The disease incidence recorded was <5% in crops reared during the seasons (Nov-March), where the environmental conditions were conducive to silkworm rearing; whereas the same increased (upto 15%) due to unfavorable climatic conditions (April-Oct). Mortality due to grasserie and flacherie was high in seasons where high temperature (>35°C) coupled with high humidity (>85%) prevailed. Low temperature with high humidity, especially during Nov-April was conducive for the incidence of fungal disease, muscardine.

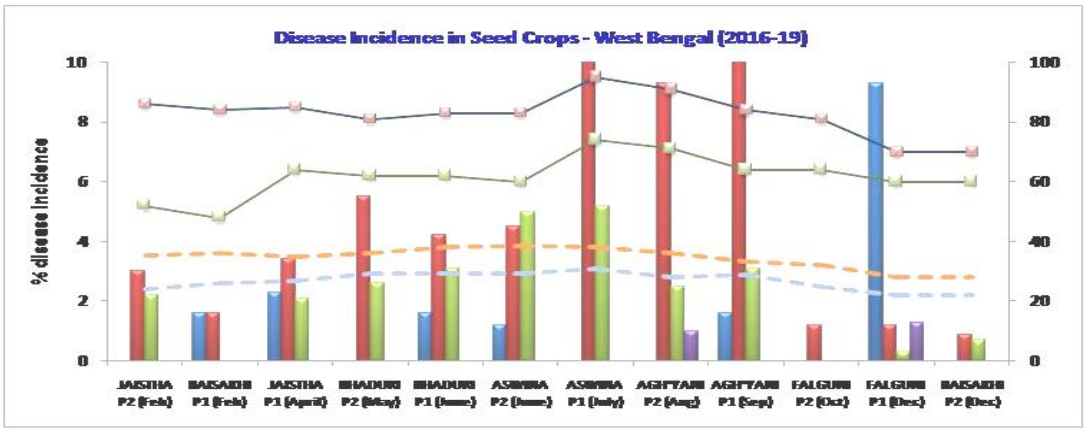
The average incidence of silkworm diseases in different states viz., Assam, Nagaland, Manipur, Mizoram, Tripura, Meghalaya & Sikkim during spring and autumn crops (2016-19) were recorded. The mortality due to grasserie was <5% during spring crop and ~7% in autumn crop. The average incidence of silkworm diseases in Jharkhand and Odisha during 2016-19 was also recorded. Grasserie, flacherie and gattine were the major diseases across all the seasons in Jharkhand; whereas the crop loss was majorly due to grasserie and flacherie in Odisha. Preventive/remedial measures to minimize/control the crop losses due to silkworm diseases were regularly advocated to the stakeholders for the effective management of diseases.

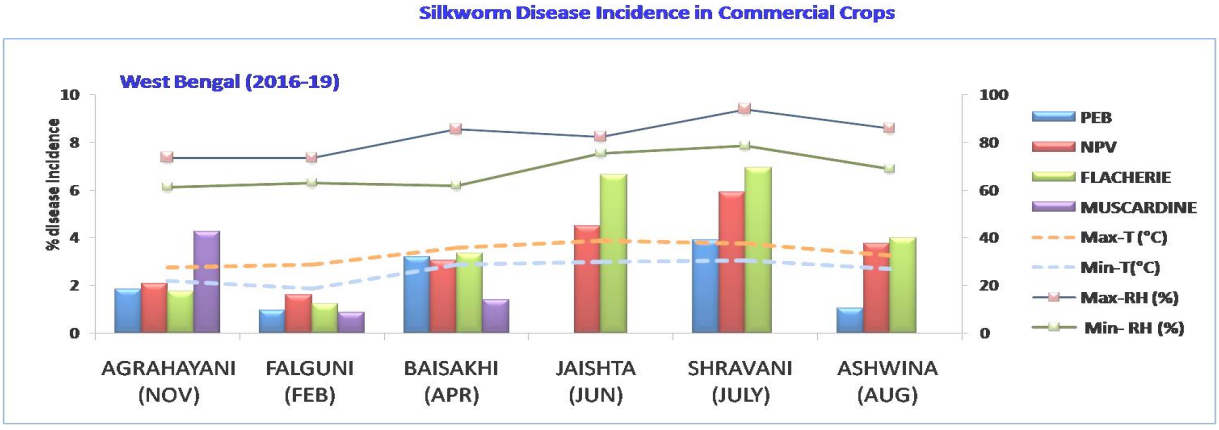
Based on regular disease monitoring survey, the stakeholders are suggested for undertaking appropriate preventive and remedial measures to minimize the disease incidence/spread and prevent outbreak(s). Especially during Nov-April months, farmers were advised essential preventive measures (dusting of bed disinfectant, Sericillin in recommended schedule and quantity; proper regulation of bed/room humidity by dusting slaked lime powder during moult etc.) for minimizing the muscardine incidence <5%.

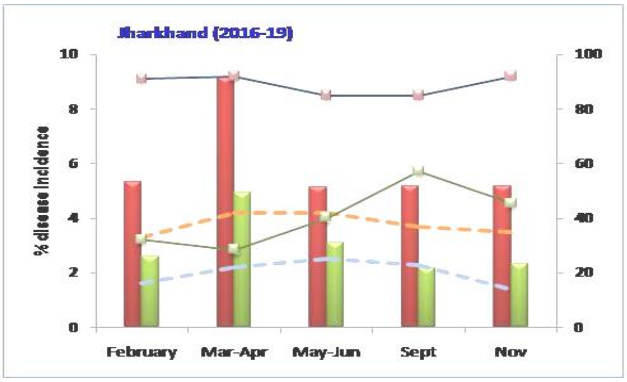
The data on disease incidence and weather parameters (2016-19) was presented in graphical form separately for seed crops in West Bengal; Commercial cocoon crops in West Bengal, Odisha, Jharkhand & North East states (spring & autumn seasons).

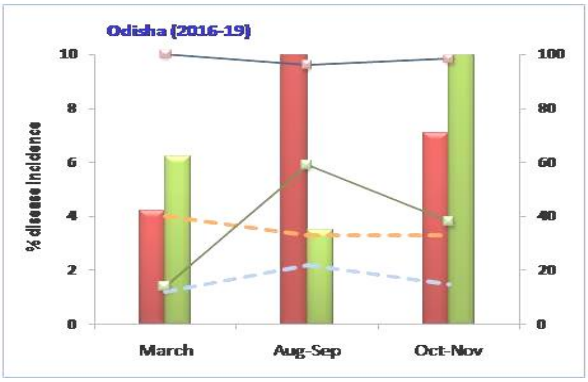
Pebrine monitoring in Eastern & North Eastern India

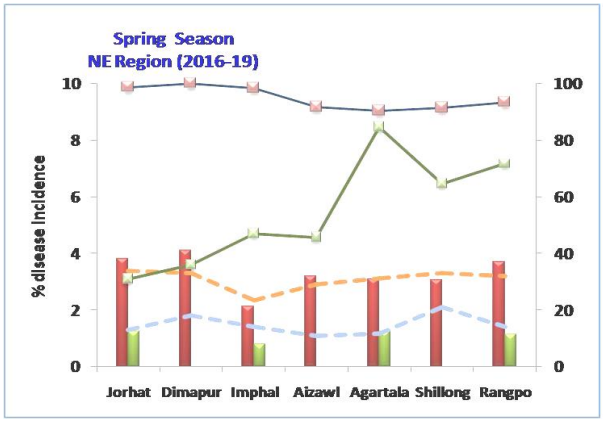
Each crop of Breeder's stocks of silkworm genetic resources (Bivoltine & Multivoltine) at CSRTI-Berhampore and RSRS-Kalimpong, Seed multiplication units (14 BSFs; CSB & DoS) and other rearings of CSRTI-Berhampore laboratories regularly were monitored systematically following prescribed schedules. Besides, samples recieved from DoS farms & seed/commercial rearers were examined for pebrine incidence. Among the 766 samples tested, 84 samples were found infected with *N. bombycis* during the current year. The necessary eradicative and preventive measures were suggested to the concerned and further monitored for Pebrine incidence in the respective units.

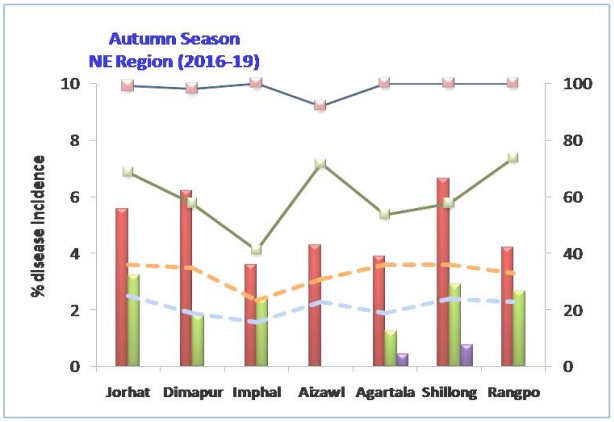

Disease Incidence in Seed Crops - West Bengal (2016-19)
% disease Incidence
JAISTHA P2 (Feb)
BAISAKHI P1 (Feb)
JAISTHA P1 (April)
BHADURI P2 (May)
BHADURI P1 (June)
ASHWINA P2 (June)
ASHWINA P1 (July)
AGHTANI P2 (Aug)
AGHTANI P1 (Sep)
FALGUNI P2 (Oct)
FALGUNI P1 (Dec)
BAISAKHI P2 (Dec)


Silkworm Disease Incidence in Commercial Crops
West Bengal (2016-19)
% disease Incidence
PEB
NPV
FLACHERIE
MUSCARDINE
Max-T (°C)
Min-T(°C)
Max-RH (%)
Min- RH (%)
AGRAHAYANI (NOV)
FALGUNI (FEB)
BAISAKHI (APR)
JAISHTA (JUN)
SHRAVANI (JULY)
ASHWINA (AUG)


Jharkhand (2016-19)
% disease Incidence
February
Mar-Apr
May-Jun
Sept
Nov


Odisha (2016-19)
% disease Incidence
March
Aug-Sep
Oct-Nov


Spring Season
NE Region (2016-19)
% disease Incidence
Jorhat
Dimapur
Imphal
Aizawl
Agartala
Shillong
Rangpo


Autumn Season
NE Region (2016-19)
% disease Incidence
Jorhat
Dimapur
Imphal
Aizawl
Agartala
Shillong
Rangpo

ENTOMOLOGY

Continuous/Other Activities

Mass multiplication and maintenance of biocontrol agent – Scymnus pallidicolli and its popularization at farmers' level (ToT: Phase II-PRE 3508) [June 2018 - May 2021]

Radha M B (PI; from Jan 2019), S.Chanda (PI; upto Dec 2018), Sukhobrata Sarkar and Manjunatha G.R

Objectives

- To conserve and multiply *Scymnus pallidicolli* for management of mealy bug on mulberry
- To study the efficacy of *S. pallidicolli* in farmers' field for management of mealy bug
- To impart training to the farmers on mass multiplication and maintenance of *S. pallidicolli*

Approx. 10,000 predators were produced with mealy bug cultured on sprouted potatoes and pumpkins. The biocontrol agents are relaeased in four districts of West Bengal (Malda, Murshidabad, Birbhum & Nadia) in 100 farmers' mulberry gardens. Periodical studies (every fortnightly) were conducted to record the efficacy of *S. pallidicolli* at farmers' field. 60 farmers were trained on mass multiplication and maintenance of *S. pallidicolli* for the management of mealybug infestation. Release of *S. pallidicolli* in farmers' mulberry garden resulted in the reduction of 75.67% egg colonies, 66.66% nymphs and 76.02% adult populations of mealybug.

Efficacy of Scymnus beetles against mealy bug management at farmer's fields

District	Before release of BCA			After release of BCA			Reduction of pest (%)		
	Egg	Nymph	Adult	Egg	Nymph	Adult	Egg	Nymph	Adult
Murshidabad	12	5	4	3	2	1	75.00	60	75
Bhirbum	9	10	2	2	3	1	77.77	70	50
Nadia	5	4	3	1	1	0	80.00	75	100
Malda	11	5	4	3	2	1	72.72	60	75
Mean	9.25	6	3.25	2.25	2	0.75	75.67	66.25	75

Survey and Surveillance of Mulberry Pests in the Eastern and NE regions of India [June 2016 - May 2021]

Radha M B (PI; from Jan 2019), S.Chanda (PI; upto Dec 2018), D. Das (upto April 2018), ManjunathaG.R. and In-charges of 3 RSRSs and 8 RECs of CSRTI-Berhampore

Objectives

- To generate and widen the database on pest incidence and climatic factors of the different agro-eco zones of the Eastern & North Eastern India
- To establish correlation between weather factors and pest incidence
- To develop weather based forecasting models for major mulberry pests

Data on pest incidence was collected from mulberry genotypes cultivated across E & NE India. Data were collected from ten randomly selected plants/sample and the seasonal incidence of major mulberry pests *viz.*, thrips (*Pseudodendrothrips mori*), mealy bug (*Maconellicoccus hirsutus*) and whitefly (*Dialeuropora decempuncta* & *Aleuroclava pentatuberculata*) and root mealy bug (*Paraputo* spp.) were recorded at weekly intervals along with meteorological data. From each plant three twigs (shoots) were selected for recording the data and from each twig, number of thrips per leaf (top 4th, 5th, 6th, 7th) was counted, adult & nymph population of whiteflies were recorded from top, middle & bottom of two leaves. To record Tukra incidence, percentage of shoots damaged in ten plants per holding were assessed. Five affected shoots per holding were collected from the field for counting egg masses, nymphs & adults of mealy bug. Root mealybug infestation was recorded in Kalimpong.

Seasonal occurrence of in mulberry pests in mulberry ecosystem (2018-2019)

Area	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Range
Thrips (no. /leaf)													
CSRTI-BHP	14.23	21.4	14.38	7	5.2	2.75					4.2	19	0 - 21.40
Murshidabad	15.7	14.4	35.28	20.73									0 - 35.28
Malda	0.19		7.63	5.60	2.34						1.0		0 - 7.63
Mamring		1.12											0 - 1.12
Koraput	5.41	5.41			2.5		4.16	4.34	4.48			2.65	0 - 5.41
Jorhat						2.5							0 - 2.5
Agartala			18.5	5.5									0 -18.5
Tukra (%)													
CSRTI-BHP		4.5	9	7	4.3	3.28							0 - 9
Murshidabad			8.7	11.05									0 -11.05
Malda			11	5.12	4.34			1.0					0 - 5.12
Kalimpong*	0.46	0.31	1.05	4.44	5.20	7.71	6.18	2.52	1.5		1.05		0 -7.71
Mamring		2.75	1.98										0 -2.75
Koraput	6.14	5.3			1.0		4.38	5.46	5.19		4.9	6.31	0 - 6.31
Jorhat										0.53	0.53		0 -2.34
Agartala													
Whitefly (no./leaf)													
CSRTI-BHP						9	4.9	15	4.63	1.91	1.85		0 -15
Murshidabad					9.75	4.35	1.12	31					0 -9.75
Malda							2.39	5.59					0 -5.59
Koraput	3.98	3.28			2		4.67	4.46	4.41		2.52	3.57	0 -4.67
Jorhat													
Imphal	0.3	0.87	2.87	2.8		0.37	0.63	4.07	1				0 -2.87

*Root mealybug incidence at Kalimpong

SILKWORM PHYSIOLOGY - RTI - BIVOLTINE CELL

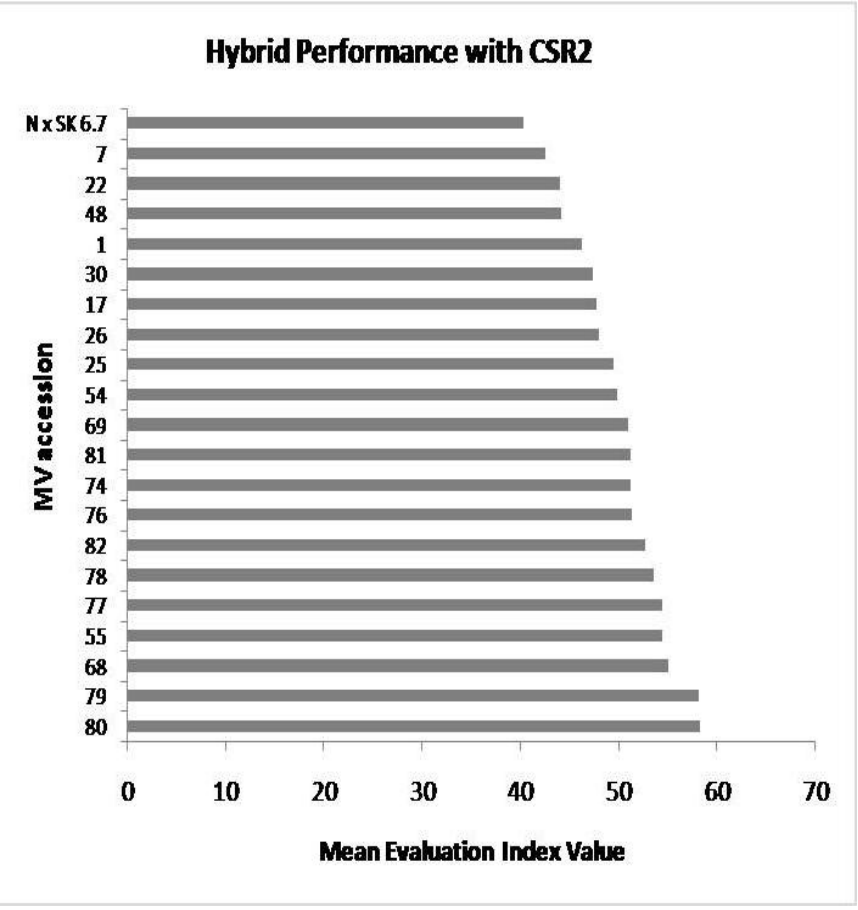
Concluded Research Project

AIB3577: Evaluation of multivoltine germplasm to identify potential parents for developing cross breeds suitable for Southern and Eastern India

(Collaborative project with CSGRC-Hosur, CSRTI-Mysore & CSRTI-Pampore***; April 2017 - March 2019)***
CSRTI-Berhampore: Gopal Chandra Das (PI) and Chandrakanth, N; CSGRC-Hosur: G. Punithavati, D.S. Somaprakash and Jameela Khatoon

Objective: To evaluate multivoltine germplasm accessions for the identification of crossbreeds suitable for Southern and Eastern Zones

Central Sericultural Germplasm Resources Centre (CSGRC)-Hosur conserves 466 silkworm accessions including 81 multivoltine (69 indigenous & 12 exotic). With an objective to identify best performing multivoltine genetic resources in different agro-climatic zones in India through pre-breeding approaches i.e., hybrid performance with a common male parent (CSR2) was undertaken at CSRTI-Mysore (South) & CSRTI-Berhampore (East & North East). Twenty promising MV breeds were short listed based on rearing and reproductive performance in rainy, winter & summer seasons.The hybrid dfls were supplied by CSGRC-Hosur and the popular hybrid in respective zones was maintained as control.



Six evaluation trial rearings (3 trials during favourable & 3 during unfavourable seasons) were conducted during Nov 2017 to March 2019 at CSRTI-Berhampore. Season-wise rearing and reeling performances were documented to analyze overall performance of multivoltine accession interms of hybrid performance with CSR2. The evaluation indices for important traits (rearing & reeling) were computed for identifying the best-performing MV accessions. The multivoltine accessions viz., 80, 79 and 68 performed better and ranked top three positions in comparision to Nistari x SK6.7.

Performance of multivoltine hybrids (2017-19)

Accession in Combination with CSR2	Fec. (No.)	ERR by No.	ERR by wt. (kg)	SCW (g)	SSW (g)	Shell (%)	FIL (m)	NBFL (m)	Dnr (d)	Ren-ditta	Reel-ability (%)	Reco-very (%)	Neat ness (%)	Even-ness (%)
1	430	8161	12.673	1.391	0.240	17.14	587	498	2.38	9.58	78	80	77	77
7	477	6206	9.336	1.337	0.249	18.65	562	439	2.18	9.49	70	75	71	75
17	384	7757	10.884	1.365	0.249	18.30	612	546	2.51	10.33	77	77	79	79
22	418	6398	9.315	1.404	0.257	18.40	674	521	2.46	10.81	69	76	68	73
25	432	7397	11.334	1.487	0.268	18.06	701	630	2.43	8.35	68	73	70	70
26	451	7878	11.405	1.427	0.247	17.33	625	599	2.27	8.68	72	74	75	75
30	415	5703	8.237	1.433	0.266	18.55	685	641	2.33	8.94	72	75	68	72
48	475	5984	9.305	1.536	0.283	18.39	583	537	2.33	10.79	64	67	64	66
54	409	7010	10.454	1.469	0.270	18.41	650	518	2.41	9.75	77	78	76	75
55	420	7234	10.253	1.454	0.263	18.14	672	624	2.43	8.66	79	79	81	80
68	401	7457	11.432	1.455	0.271	18.62	685	616	2.47	10.15	78	80	79	81
69	403	8449	12.645	1.423	0.259	18.18	666	557	2.30	8.89	77	80	78	77
74	469	7346	10.926	1.445	0.266	18.35	643	587	2.46	9.78	73	76	74	76
76	432	6729	9.638	1.420	0.271	19.02	722	614	2.37	8.97	70	81	74	74
77	461	7131	10.651	1.452	0.280	19.00	699	572	2.50	8.95	77	77	74	76
78	484	5018	7.674	1.418	0.271	19.05	642	583	2.45	10.22	83	82	77	79
79	480	8318	12.779	1.487	0.282	18.93	652	591	2.51	9.33	78	79	79	80
80	499	7891	12.018	1.497	0.290	19.42	679	538	2.42	9.66	74	80	78	79
81	473	4184	6.219	1.514	0.282	18.63	686	606	2.52	10.25	69	79	71	77
82	423	6867	10.140	1.463	0.265	18.16	655	560	2.60	10.18	80	79	79	80
N x SK 6.7	427	8158	10.960	1.321	0.212	16.03	540	440	2.45	9.67	81	77	76	79

Values represent mean values of 6 crops

Comparative Yield Potential (kg/100 dfls) of Top - Ranked MV Accesion Hyrbids with CSR2

Hybrid Combination	Oct 2017	Feb 2018	April 2018	June 2018	Nov 2018	March 2019	Mean	CV (%)
80 x CSR2	42.98	52.85	42.97	52.63	51.05	45.93	48.07	8.87
79 x CSR2	49.56	44.21	60.02	59.42	48.40	45.09	51.11	12.42
68 x CSR2	44.25	47.02	46.42	43.46	54.11	39.10	45.73	9.92
N x SK6.7 (Control)	47.82	49.18	51.95	44.64	39.40	30.11	43.85	16.63

Inference

- Multivoltine accessions viz., 80, 79 & 68 ranked 1st, 2nd & 3$^{rd.}$ for overall performance in comparison to Nistari x SK6.7 at CSRTI-Berhampore for East & North Eastern region

Ongoing Projects

AIB-3578: Evaluation of exotic bivoltine silkworm breeds to identify promising parental genetic resources (June 2016 - Sept 2019; Collaborative project with CSGRC-Hosur; CSRTI-Mysore; CSRTI-Pampore)

CSRTI- Berhampore: G. C. Das (PI) and A. K. Verma; CSGRC-Hosur: M. Maheswari, G. Lokesh, D.S. Somaprakash and Jameela Khatoon

Objective: To identify bivoltine silkworm germplasm for specific qualitative and quantitative traits

Central Sericultural Germplasm Resources Centre-Hosur conserves 466 silkworm resources including 365 bivoltine (exotic & indigenous) accessions. All the exotic accessions were not utilized by the R&D institutions. With an objective to utilize best performing exotic bivoltine accessions in different agro-climatic zones in India through pre-breeding approaches *i.e.*, hybrid performance with popular parental breeds i.e., CSR4 for oval & CSR2 for dumbbell type was undertaken at CSRTI-Mysore (South), CSRTI-Pampore (North & North West) and CSRTI-Berhampore (East & North East).

Performance of bivoltine hybrids (2018-19)

Hybrids	Fec.	ERR (No.)	ERR Wt. (kg)	SCW (g)	SSW (g)	Shell (%)	FIL (m)	NBFL	DNR	Rend-itta	Reela-Bility (%)	Reco-very (%)	Neat-ness (%)	Even-ness (%)
5x290	491	5643	7.516	1.385	0.261	18.81	734	584	2.53	8.17	71	71	84	85
13x290	502	3922	5.876	1.414	0.282	19.97	739	739	2.75	8.44	78	68	82	84
43x290	567	5338	8.389	1.458	0.272	18.70	707	641	2.67	8.47	75	71	84	84
154x290	486	4719	7.300	1.466	0.304	20.42	799	774	2.68	8.30	72	71	82	84
163x290	583	5591	8.341	1.484	0.292	19.60	773	747	2.60	8.42	74	70	83	84
201x290	520	6461	9.388	1.428	0.297	20.84	810	663	2.50	8.58	72	70	79	79
225x290	444	5348	7.927	1.404	0.298	21.30	771	615	2.66	8.56	74	68	82	85
232x290	491	6079	8.884	1.478	0.297	20.02	822	780	2.76	8.18	74	68	80	82
329x290	542	2802	4.249	1.242	0.233	18.18	857	805	2.54	8.22	74	74	82	83
35x291	508	5335	8.646	1.534	0.286	18.37	733	517	2.68	8.68	76	67	81	85
50x291	476	6444	9.341	1.457	0.286	19.53	879	648	2.47	8.12	70	69	81	82
143x291	530	3937	5.759	1.404	0.261	18.47	686	650	2.80	9.10	74	68	80	78
155x291	538	6359	8.902	1.384	0.275	19.66	733	733	2.50	8.51	71	69	82	84
164x291	572	5596	8.566	1.485	0.292	19.58	766	743	2.56	8.95	75	70	83	84
169x291	537	5414	7.922	1.443	0.295	20.43	881	757	2.41	7.78	71	70	81	82
177x291	484	6047	8.850	1.433	0.291	20.34	855	686	2.63	8.81	71	67	82	83
197x291	529	5108	7.522	1.482	0.315	21.19	847	847	2.84	7.88	69	68	81	83
266x291	482	5185	7.866	1.470	0.291	19.74	874	874	2.53	8.05	77	68	82	84
267x291	569	5750	8.584	1.417	0.289	20.44	845	722	2.48	7.83	73	70	78	85
268x291	520	5417	8.127	1.458	0.274	18.84	842	842	2.41	8.28	71	70	81	84
290x291 (Control)	520	6776	9.978	1.389	0.283	20.29	777	777	2.48	8.20	73	68	82	83
SK6xSK7 (Zonal CTRL)	462	7160	10.247	1.429	0.252	17.60	722	641	2.45	8.80	77	66	81	86

Twenty promising exotic bivoltine breeds were short-listed based on rearing and reproductive performance in rainy, winter & summer seasons.The hybrid dfls were supplied by CSGRC-Hosur and the popular bivoltine hybrid in respective zones was maintained as control. Four evaluation trial rearings were conducted at CSRTI-Berhampore during favourable (Agrahayani & Falguni) seasons. Rearing and reeling performances were documented for bivoltine accession interms of hybrid performance with CSR2 & CSR4. The popular bivoltine foundation cross, SK6 x SK7 was maintained as control in East & North Eastern zone.

ARP 3605: Validation of the DNA markers in silkworm breed developed by introgression of DNA markers associated with NPV resistance using Marker Assisted Selection breeding and large scale field trial of the breed (April 2017 - March 2020; DBT funded Collaborative Project with SBRL-Bangalore, CSRTI-Mysore & CSRTI-Pampore)

Coordinator: V. Sivaprasad (Director)

CSRTI-Berhampore: Gopal Chandra Das (PI) & Chandrakanth, N; CSRTI-Mysore: S. M. Moorthy (PI) & B. Mohan; SBRL-Bangalore: A. R. Pradeep (PI) & K. M. Ponnuvel; CSRTI-Pampore: S. Singh (PI @ Jammu), P. Tiwari (PI @ Sahaspur) & Md. Aslam

Objectives

- Validation of DNA markers for NPV resistance and stress tolerance in selected lines for field trial
- Continuous maintenance of MAS-N Lines
- Co-ordination and statistical analysis of observation from lines reared at different stations

Three BmNPV resistance bivoltine breeds viz., MASN 4, MASN6 & MASN 7 were evaluated in different seasons across India including East & North Eastern region at CSRTI-Berhampore. Six trials (cellular rearing/3 replications) of MAS-N lines along with control, CSR2 were conducted during 2017-2019. MASN lines were successfully reared and performed similarly in both the seasons; while the CSR2 (control) could not survive at all during unfavourable season.

Rearing performance of MASN breeds

Season	Breed	Fec.	Hatch. (%)	ERR		SCW (g)	SSW (g)	Shell (%)
				No.	Wt. (kg)			
April-May 2018	MASN-4	567	98.83	6320	8.020	1.238	0.242	19.548
	MASN-6	499	98.62	6060	7.521	1.245	0.246	19.759
	MASN-7	596	96.57	5460	7.325	1.238	0.237	19.144
Nov-Dec 2018	MASN-4	556	97.83	8720	13.141	1.507	0.314	20.842
	MASN-6	537	96.27	8120	11.838	1.462	0.299	20.455
	MASN-7	528	97.39	7160	10.362	1.434	0.286	19.933

The MASN hybrds (Bi x Bi: MASN 4 x CSR4; Multi x Bi: Nistari x MASN 4) were evaluated during Nov 2018 and February 2019 crops at farmers' level. A total of 22500 dfls bivoltine hybrids (MASN4 x CSR4) & 8000 dfls Multi x Bi (N x MASN4) were reared during Oct-Nov 2018 and Feb-March 2019 at farmers' field in

four seri-districts of West Bengal. MASN bivoltine hybrids performed better than SK6 x SK7 with reagrd to yield and cocoon quality; while SK6 x SK7 hybrids recorded higher survival. Incase of Multi x Bi hybrids, MASN hybrids performed with regard to yield and cocoon quality better than ruling hybrid, Nistari x (SK6.SK7).

Performance of MASN Hybrids at Laboratory Level

Hybrids		Fec. (No)	Hatch-ing (%)	Yield/100 dfls (kg)	SCW (g)	SSW (g)	Shell (%)	Season
Bi x Bi	MASN4 x CSR4	610	82.97	52.82	1.572	0.331	21.06	A 2018
		595	93.45	66.60	1.858	0.358	19.29	F 2019
	Mean	602	88.21	59.71	1.715	0.345	20.18	
	SK6xSK7 (Control)	522	87.88	49.88	1.437	0.275	19.14	A 2018
		497	95.24	54.32	1.472	0.240	16.32	F 2019
	Mean	509	91.56	52.10	1.454	0.257	17.73	
	BCon1 x BCon4 (New Hybrid)	476	88.44	55.72	1.679	0.282	16.76	F 2019
Multi x Bi	Nistari x MASN4	480	96.04	64.28	1.779	0.317	17.83	F 2019
	Nistari x (SK6.7) (Control)	455	95.80	59.40	1.506	0.246	16.32	F 2019
	M6DPC x BCon 1.4 (New Hybrid)	431	96.15	61.60	1.560	0.253	16.24	F 2019

A: Agrahayani; F: Falguni

MASN Hybrid Performance at Farmers Level

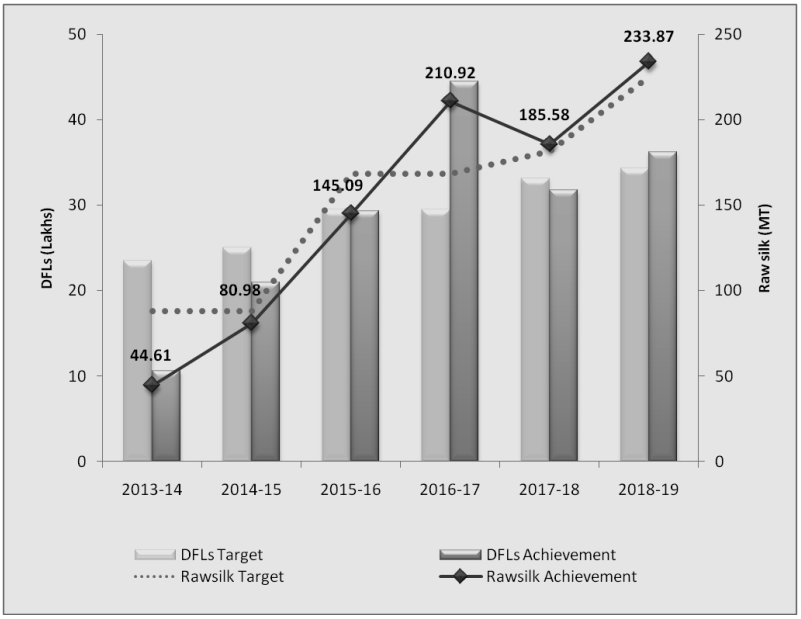
Hybrids		Fec.	Hatch-ing %	Yield/100 dfls (kg)	SCW (g)	SSW (g)	Shell (%)	Season
Bi x Bi	MASN x CSR4	610	82.87	52.75 (25-61)	1.889	0.382	20.22	A 2018
	SK6xSK7	490	88.00	50.00 (48-54)	1.487	0.274	18.43	
	MASN x CSR 4	600	94.0	61.00 (56-65)	1.593	0.344	21.57	F 2019
	SK6 x SK7	497	96.0	55.00 (52-58)	1.474	0.233	15.79	
Multi x Bi	N x MASN	480	96.0	53.00 (50-55)	1.604	0.268	16.73	
	N x (SK6 x SK7)	455	95.8	50.00 (46-53)	1.497	0.246	16.44	

Cluster Promotion Programme (CPP) in Eastern & North-Eastern India

Cluster Promotion Programme which was implemented by Central Silk Board during XII plan in collaboration with state sericulture departments of E & NE states (2012-2017) was extended upto 2020 with an objective to produce 8500MT import substitute silk. In Eastern & North Eastern zone, CPP is implemented in 15 clusters of West Bengal, Odisha, Bihar, Assam & BTC, Manipur, Mizoram, Nagaland and Tripura. Each cluster is directly monitored by two cluster development facilitators (CDFs); one each nominated by CSB and state DOS. The clusters in E & NE region are coordinated and monitored by CSRTI-Berhampore for effective implementation. The cluster/ state-wise monthly progress elicited from the CDFs is analysed & inferred.

Particulars of CPP CDFs of E & NE clusters for the year 2018-19		
Clusters	CSB	DoS
West Bengal		
Malda	Dr. S. Chakraborty, Sci-C, REC-Mothabari; satadal.chak@gmail.com; 9474580417	Mr. Manoj Kr. Baidya, DD(T), Malda; malseri2@gmail.com;9434723094
Murshidabad	Dr. T. D. Biswas, Sci-D, CSRTI-Berhampore; tdattabiswas@rediffmail.com; 9126331586	Mr. Manoj Kr. Baidya, DD(T), BHP; berseri1@gmail.com;9434723095
Birbhum	Dr. Manoja Patnaik, Sci-D, SSPC-Kalitha manoja_ctp@rediffmail.com; 9434747385	Mr. S. K. Das, DD(T), Birbhum; birseri@gmail.com; 9434723134
Nadia	Mr.G. C. Das, Sci-D,CSRTI-Berhampore; gopaldascsb@rediffmail.com; 9434229425	Mr. Supratim Das, AD(T), Nadia; nadiseri@gmail.com; 9434723249
Bihar		
Kishanganj	Mr. Bimal C. Ray, Sci-D, CSRTI-Berhampore; bimalmitali@rediffmail.com;9434056081	Mr. N. P. Verma, AD-Purnea; 7870144800
Odisha		
Kashipur	Dr. S.K.Misra, Sci-C, RSRS-Koraput; rsrskoraput@gmail.com; 9437204142	Mr. B. K. Mishra; AD (Seri)-Koraput; 9438470533
Ghatagaon	Dr. N.B. Chowdhury,Sci-D, REC-Dkota; 9449994014	Mr. Laxman Munda, AD (Seri)-Keonjhar; adskeonjhar@yahoo.com; 9437454580
Assam & BTC		
Darrang	Dr. B. K. Basumatary, Sci-D, REC-Darrang, basumatary.bene@yahoo.com; 9435304453	Mr. Jagesh C. Talukder, ADS-Mangaldoi, adsofficemld@gmail.com; 9101407835
Jorhat	Dr. P. Kumaresan, Sci-C, RSRS-Jorhat; rsrsjor.cdsb@nic.in; 8903264292	Mr. Gobin Kolitha, Extension Officer-Jorhat; 9435518260
Udalguri	Mr. B.N. Chowdhuri, Sci-D, RO-Guwahati; bidyutnc10@yahoo.com;9435054191	Mr. H. K. Hazarika, AD(Seri)-Udalguri; 9435184587
Mizoram		
Aizawl	Dr. L. Pachuau, Sci-C, REC-Aizawl; thlatea@rediffmail.com; 9435087588	Mr. Lalremsiama, DD-Chaltlang; 9436199948
Manipur		
Ukhrul	Dr. L. Somen Singh, Sci-D, REC-Imphal; somenlaishram@yahoo.com;9436033596	Mr. John Lakshang, AD-Ukhrul; 8416096202
Churachandpur	Dr. L. Somen Singh, Sci-D, REC-Imphal; somenlaishram@yahoo.com;9436033596	Mr. G. Vunglian, AD-Churachandpur; 9862113806
Nagaland		
Paren	Imti Nokchung, TA, REC-Dimapur; imtinukchung2013@gmail.com; 7085055608	Mr. Yashimeren, DSO-Dimapur, yashilongchar@gmail.com;9436436237
West Tripura		
Champaknagar	Dr. G.B. Singh, Sci-D,REC-Agartala; sgbcrsti@rediffmail.com;9615179959	Mr. Jyoti Bikash Chakma, SS-Agartala; 9436509681

Perfomance of clusters: E & NE zone clusters recorded 233.87MT (105.38%) raw silk production (BV & ICB) against the target of 224.91MT; which is 48.29MT (26%) increase as compared to the previous year, 2017-18.



Crop performance: A total 36.193 lakh dfls (BV: 16.78; ICB: 19.41) were distributed to the farmers against the taget of 34.25 lakhs (BV: 25.55 & ICB: 8.70). The over all achievment in dfls brushing was ~105% revealing higher share for ICB and BV share stood at 65%. 814.37MT (47.92%) bivoltine hybrid cocoons and 885.08MT (52.08%) ICB cocoons were produced. This is an annual increase of 31% as compared to the previous year (1524.52MT). The average cocoon yield recorded in West Bengal was 46kg (ICB) and 52kg (BV) per 100 dfls.

Perfomance of ICB raw silk production in Eastern zone (2018-19)

Cluster	Dfls (Lakh)		Cocoon Yield (MT)	Yield/ 100 dfls (kg)	Raw silk (MT)			
	Target	Ach.			Target	Ach.	% Ach.	% IO 2017-18
West Bengal								
Malda	2.00	4.984	239.92	48.14	8.00	31.99	399.87	73.82
Murshidabad	2.00	2.720	132.92	48.87	8.00	17.72	221.53	26.86
Birbhum	2.00	7.284	331.89	45.56	8.00	44.25	553.15	63.09
Nadia	2.00	3.176	145.15	45.70	8.00	19.35	241.92	45.69
Total/Avg.	8.00	18.164	849.88	46.79	32.00	113.32	354.12	32.71
Odisha								
Ghatgaon	0.25	0.055	0.162	2.94	0.80	0.018	2.25	-91.43
Kashipur	0.25	0.000			1.00			-100.00
Total/Avg.	0.50	0.055	0.162	2.94	1.80	0.018	1.00	-92.04
Bihar								
Kishanganj	0.20	1.196	35.04	29.31	0.80	4.672	583.95	239.29
Grand Total/ Mean.	8.70	19.415	885.08	45.59	34.6	118.01	341.06	35.66

A total of 121 ECPs (field day, awareness, group discussion, audio-visual, exhibition) were conducted on various improved sericultural technologies to sensitise 5647 farmers in the 15 clusters. The crop-wise data (farmers profile, mulbery acreage, cocoon production etc.) for 6983 farmers covering 4590 acres were uploaded in Seri5k portal.

Perfomance of Bivoltine raw silk production in Eastern & North Eastern zone (2018-19)								
Cluster	Dfls (Lakh)		Cocoon Production (MT)	Yield/ 100 Dfls (kg)	Raw silk (MT)			
	Target	Ach.			Target	Ach.	% Ach.	% IO 2017-18
West Bengal								
Malda	2.25	2.479	119.55	48.23	20.77	17.08	82.23	26.51
Murshidabad	2.00	1.600	91.18	56.99	18.46	13.03	70.56	3.30
Birbhum	0.90	0.565	30.90	54.69	8.31	4.41	53.12	8.32
Nadia	0.90	0.755	41.47	54.93	8.31	5.93	71.29	24.37
Total/Avg.	6.05	5.399	283.10	52.44	55.85	40.44	72.41	15.72
Odisha								
Ghatgaon	0.75				3.88			-100.00
Kashipur	0.75	0.047	1.80	38.26	3.88	0.26	6.62	-39.81
Total/Avg.	1.50	0.047	1.80	38.26	7.76	0.26	3.31	-52.55
Bihar								
Kishanganj	0.50	0.100	2.87	28.70	4.04	0.41	10.13	-86.86
Total/Avg. (Eastern Zone)	8.05	5.546	287.77	51.89	67.65	41.11	60.77	6.86
Assam & BTC								
Darrang	2.25	1.870	89.90	48.07	15.88	12.84	80.87	19.33
Jorhat	2.00	0.783	36.75	46.93	14.12	5.25	37.18	22.38
Udalguri	2.00	1.518	72.46	47.73	14.12	10.35	73.31	88.18
Total/Avg.	6.25	4.171	199.11	47.19	44.12	28.44	64.47	53.32
Mizoram								
Aizawl	2.50	1.150	55.30	48.09	16.18	7.90	48.83	-24.47
Nagaland								
Peren	2.00	1.202	49.48	41.17	14.12	7.07	50.06	36.20
Manipur								
Churach'pur	2.50	1.800	86.70	48.17	17.65	12.39	70.17	15.36
Ukhrul	2.50	1.750	86.15	49.23	17.65	12.31	69.73	24.85
Total/Avg.	5.00	3.550	172.85	48.39	35.30	24.69	69.95	19.85
Tripura								
West Tripura	2.00	1.159	49.86	43.02	12.94	6.65	51.38	24.77
Total/Avg. (NE Zone)	17.50	11.232	526.60	46.88	122.66	74.75	60.94	24.33
Grand Total/ Avg.	25.55	16.778	814.37	48.54	190.31	115.86	60.88	17.51

North East Region Textile Promotion Scheme (NERTPS)

NERTPS, an Umbrella Scheme of Ministry of Textiles-Govt. of India have approved several sericulture projects in the North Eastern States in the identified potential districts under two broad categories viz., Integrated Sericulture Development Project (ISDP) & Intensive Bivoltine Sericulture Development Project (IBSDP) to provide special thrust for consolidation and expansion of mulberry, eri and muga sericulture. The project envisages holistic development of seri-industry in all spheres from plantation to fabric production with value addition at every stage. The projects are proposed to bring around 38,170 acres of plantation under mulberry, eri and muga sectors and contribute additional production of 2650 MT raw silk and generate employment for 3.16 lakh persons.

ISDP: Sixteen projects are currently being implemented in Assam including BTC, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. This includes setting up of Silk Printing & Processing unit for Tripura, Soil to Silk for BTC (Assam) and Post Cocoon Technology for Nagaland. Most of these projects are being implementated by State Sericulture Departments, except the creation of seed infrastructure by CSB.

IBSDP: Eight projects are being implemented for production of import substitute bivoltine silk in NE states covering 500 acres in 2 blocks of each district involving approx 1100 women sericulturists /state.

Further, considering the potentialities for sericulture development in NE, Ministry of Textiles approved fourteen new projects. These include aspirational districts, eri, oak tasar and muga developmental as well as infra-structure establishments.

CSRTI-Berhampore formed committees headed by a nodal officer along with personnel from RO-Guwahati and RECs for survey, monitoring and evaluation of NERTPS activities as per the advice of the competent authority. Accrodingly, nodal officers from CSRTI-Berhampore visited the NERTPS project locations and quarterly reports were communicated to the CSB.

State	Monitoring Committee
Mizoram & Assam with BTC	Shri G. C. Das, Scientist-D (CSRTI-Berhampore) - Nodal Officer Dr L. Pachau, Scintist-C (REC-Aizawl-Mizoram) Dr. B. K. Basumatary, Scientist-D (REC-Mangaldoi-Assam & BTC)
Manipur	Dr. S. Chattopadhyay, Scientist-D (CSRTI-Berhampore) - Nodal Officer Dr. L. Somen Singh, Scientist-D (REC-Imphal)
Meghalaya & Arunachal Pradesh	Zakir Hossain, Scientist-D (RSRS-Kalimpong) - Nodal Officer Dr. C.Z. Renthlei, Scientist-D (REC-Shillong-Meghalaya) Shri Lohit Sonowal, Scientist-C (REC-Sille-Arunachal Pradesh)
Nagaland	Dr. S. Chakrabarty, Scientist-D (REC-Mothabari) - Nodal Officer I/C REC-Dimapur
Tripura	Dr. AK Verma, Scientist-D (CSRTI-Berhampore) - Nodal Officer I/C REC-Agartala
Sikkim	Dr. V. Lakshmanan, Scientist-D (CSRTI-Berhampore) - Nodal Officer Shri Zakir Hossain Scientist-D (RSRS-Kalimpong) Shri ST Lepcha, Scientist-D (REC-Mamring)

SOCIAL SCIENCES

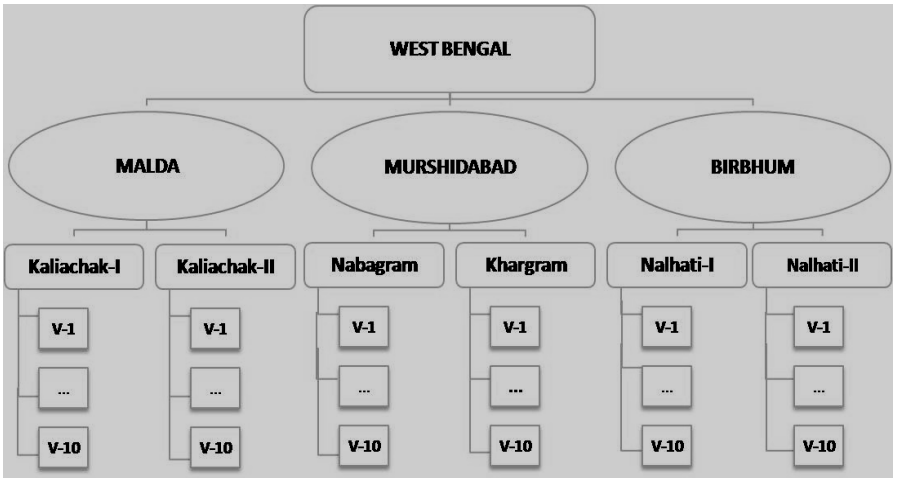
Concluded Research Project

MTS-3599: Study on mulberry sericulture production in West Bengal: A Statistical Approach (Nov 2016 - April 2018)

Manjunatha, G. R (PI), Shafi Afroz (upto Jan 2018), Dipesh Pandit, T. D. Biswas and S. Chanda

Objectives

- To analyze the trends in mulberry cocoon production in West Bengal
- To estimate costs and returns of mulberry cocoon production
- To assess resource use pattern and resource use efficiency of sericulture farmers



To accomplish the set objectives, primary data pertaining to socio-economic status of farmers, mulberry variety, breed/hybrids, inputs, technology, cost & returns etc. was collected from the selected respondents using pre-tested structured schedule under multi-stage purposive random sampling design. Three traditional districts (Malda, Murshidabad & Birbhum) with a sample size of 240 respondents. The secondary data pertaining to mulberry acreage, cocoon & raw silk production was collected from authenticated sources (DoS, Govt. of WB) for the period from 1989-2018. Different parametric trend models, budgeting techniques (using cost concepts) & data envelopment analysis (DEA) etc. were performed for data interpretation.

The mulberry area in West Bengal over the years has recorded a declining trend (-1.38); while positive trend for cocoon (2.35) and raw silk (3.72) production. This could be attributed to the technology interventions undertaken/ implemented for higher productivity. Majority of the farmers practicing mulberry cultivation belonged to marginal category (85%) and the rest were small (15%).

Class	Avg. Holding (acres)	Farmers No/%
Marginal (<2.5 acre)	0.66 (0.25-1.00)	204/85
Small (2.5-5 acre)	1.50 (1.01-2.50)	36/15

Trends for mulberry acreage, cocoon & raw silk production in WB (1989 -2018)

Variable	Model Fit	R^2	Trend	CGR
Mulberry Area	$y = 4.7314x^3 - 28433x^2 + 6E+07x - 4E+10$	0.78	Cubic	-1.38**
Cocoon Production	$y = 9E-17e^{0.0232x}$	0.95	Exponential	2.35**
Raw Silk Production	$y = 2E-29e^{0.0365x}$	0.86		3.72**

*** significant @ 1%; CG:R-compound growth rate; R^2: co-efficient of determination*

Cost of mulberry cocoon production for marginal & small farmers (five rearings/year) was arrived at employing standard cost concepts. Total cost incurred towards cocoon production was Rs. 1,23,053 (marginal farmers) and Rs.2,00,926 (small farmers). The gross returns from cocoon production was Rs. 1,81,203 in case marginal farmers and Rs. 3,14,466 with small farmers. Return per rupee investment for cocoon production was higher with small farmers (1:1.58) as compared to marginal famers (1:1.47). This clearly reflects the existence of scale economies. To improve the returns per rupee of investment for marginal farmers it is being suggested for the formation of multipurpose sericulture farmer's co-operatives. The cost A1 component included cost of human labour, dfls, mulberry leaves, disinfectants and opportunity cost of working capital. The Cost B included the cost A1, interest on fixed asset and rental value of owned rearing room. Likewise, Cost C included the cost B and imputed family labour. The major expenditure was on mulberry leaves (~23%) followed by imputed family labour (22%) and hired human labour (13%) in both small and marginal farmers. Sericulture being a labour intensive enterprise could be made profitable through reduced reliance on human labour or through modified mechanization. Further, majority of the farmers perceived rearing Multi x Bi/Multi x Multi hybrids with minimum risk factor(s) as compared to with Bi x Bi hybrids during unfavourable seasons *viz.*, Baisakhi (April), Shravani/Jaitha (June-July) & Aswina (Sept).

Cost & Returns of Cocoon Production

#	Particulars	Marginal Farmers			Small Farmers		
		Qty.	Value (Rs.)	% of total cost	Qty.	Value (Rs.)	% of total cost
	Human Labour (Hired Mandays)	60	15000.00	12.19	108	27000.00	13.44
	DFLs (no.)	850	4450.00	3.62	1600	7825.00	3.89
	Mulberry leaves (kg)	7700	27637.95	22.46	17890	49723.44	24.75
	Disinfectants		3800.00	3.09		4700.00	2.34
	Electric Charges		1216.00	0.99		2000.00	1.00
	Marketing fee		750.00	0.61		1000.00	0.50
	Interest on working capital@12%/ Yr		7910.39	6.43		13949.84	6.94
	Rearing house revenue		150.00	0.12		240.00	0.12
	Depreciation		12604.00	10.24		14638.00	7.29
I	Cost A1		73518.34	59.75		121076.2	60.26
	Interest on fixed asset (8% /annum)		18285.12	14.86		25600.00	12.74
	Rental Value of owned rearing house		5000.00	4.06		7000.00	3.48
II	Cost B		96803.46	78.67		153676.20	76.48
	Imputed family labour (Mandays)	105	26250.00	21.33	189	47250.00	23.52
III	Cost C		123053.4	100.00		200926.2	100.0
	Returns						
	Cocoon or Output (kg)		435.00			839.92	
	Yield per 100 DFLs (kg)		45.79			42.00	
	Cost per kg of cocoon [Cost A1 (Rs.)]		169.01			144.15	
	Cost per kg of cocoon [Cost B (Rs.)]		222.54			182.97	
	Cost per kg of cocoon [Cost C (Rs.)]		282.88			239.22	
	Gross returns (Rs.)		181203.68			314466.67	
	BCR (Cost A1)		1: 2.46			1: 2.64	
	BCR (Cost B)		1: 1.87			1: 2.05	
	BCR (Cost C)		1: 1.47			1: 1.58	

Efficiency pattern with seri-farmers (n=240)			
Class (score)	Technical (no.)	Allocative (no.)	Economic (no.)
0.2-0.3	3	-	3
0.3-0.4	9	-	18
0.4-0.5	3	3	18
0.5-0.6	12	6	18
0.6-0.7	3	18	66
0.7-0.8	39	81	42
0.8-0.9	75	15	48
0.9-1.0	96	117	27
Mean	0.83	0.84	0.70

The efficiency analysis (DEA) of sericulture farms revealed that 70% farmers were economically efficient and the rest found to be relatively inefficient. The inefficiency might be due to technical inefficiency/allocative inefficiency. The possible reasons for inefficiency include allocative inefficiency among farmers due to violation of marginal principle (MVP=MIC) in allocation of resources, technical inefficiency indicating inability of farmers to convert input (human labour, dfls & mulberry leaves) into desired level of output (cocoon yield).

Inference

- Vertical growth in productivity of mulberry & cocoon was due to intervention of technologies and social impact assessment of technologies should be conducted periodical intervals
- Economies of scale were visible and could be improved further through formation of Multipurpose Seri. Farmers Co-operatives
- Economic efficiency of sericulture farmers could still be further improved through R&D efforts focussing on mechanization of operations (eg. duster, leaf cutter, shoot harvester, deflosser etc.) to decrease drudgery and labour dependency

Future workplan: Data base could be utilized for policy interventions for sericulture industry development in West Bengal.

MOT 3601: Skill gap analysis and capacity building of sericulture extension workers and farmers in traditional and non-traditional states (Nov 2016 - April 2018)

Manjunatha, G. R (PI: from Feb 2018; CI: upto Jan 2018), Shafi Afroz (PI; upto Jan 2018), Dipesh Pandit, T. D. Biswas (from Dec 16), S. Chanda (upto Nov 16) and Bimal Chandra Ray

Objectives

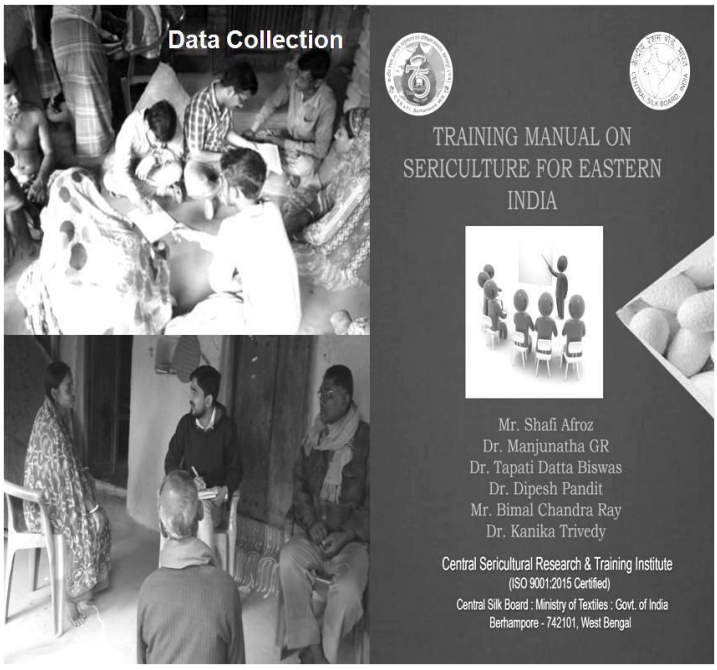
- To document job profile of the extension workers involved in sericulture activities and their engagement for each of the activity
- To identify the skill requirements for the extension workers and farmers for each activity
- To determine the skill gap of the extension workers and farmers involved in sericulture activities
- To design capacity development programme to target the skill requirements of the extension workers and farmers

With an aim to measure skill gap(s) of sericulture extension workers and farmers directly, the studies were undertaken in West Bengal, Bihar and Jharkhand monitored by CSRTI-Berhampore. Two districts each from traditional and non-traditional states were selected purposefully where mulberry sericulture is under practice. Fifty technical assistants working in CSB units were interviewed randomly as extension workers, besides 200 farmers from traditional state and 100 from non-traditional states. Primary data were elicited from 350 respondents using pre-tested & semi-structured questionnaire. Suitable statistical analysis (descriptive, Garrett ranking, Likert scale, tabular analysis etc.) was performed for data interpretation. Likert scale (5-point continuum) was used to study the skill gaps, where respondent with a ≥3.5 score were skill-competent and <3.5 as skill-deficient.

Dynamic roles for extension workers were determined and ranked using Garrett ranking technique & `frontline demonstration' ranked first. The identified roles of extension workers could be utilized for CSB units as well as DOS extension staff for coordinating industry development in a more meaningful manner. Known job profile(s) for the extension workers (an often overlooked instrument; another paper work) could lead to effective execution of roles/responsibilities impacting work quality.

Skills identified for mulberry cultivation as well as silkworm rearing were enlisted with the primary information elicited from experts at CSRTI-Berhmapore and reviewed further with secondary sources. The skill charts could be utilized effectively for training the farmers of Eastern India at Seri Resource Centres (SRCs), RSRSs and RECs.

Dynamic Roles - Extension	Mean	Rank
To conduct front-line demonstration of new technologies at farmers' level	65.4	I
To conduct survey of sericultural farmers' field and crops regularly	61.9	II
To act as resource person for creating awareness on modern technologies	58.8	III
To organize ECPs for new methods/ technologies	57.0	IV
To organize HRD programmes supporting current and future needs of farmers	46.0	V
To obtain feedback on technologies from farmers and re-conveying to the experts	44.7	VI
To coordinate with other departments for better working relationships	42.1	VII
To prepare technical report for all the conducted programmes and other activities	26.0	VIII



The skill levels of farmers & extension workers in mulberry cultivation & silkworm rearing was 11% for farmers (3-19%) and 80% for extension workers (72-90%). Further, farmers of traditional state still practicising the age-old practices. Majority of famers claimed to have learnt technical skills from their ancestors and generally resist change with modern practices advocated by extension workers. It is important that all the extension workers update their knowledge periodically through refresher training programmes on latest technologies.

Identified Skills in Mulberry sericulture

Mulberry Cultivation

Essential Skills	Particulars
Site Selection	– Location of mulberry farm – Soil requirements
Nursery Management	– Selection of cuttings – Cuttings treatment – Layout/bed preparation – Nursery plantation – Transplantation
Mulberry Plantation	– Suitable mulberry variety – Planting methods – Inter-cultural operations – Application of fertlizers – Gap filling
Irrigation Management	– Water requirements – Irrigation schedules – Irrigation method
Nutrient Management	– Soil testing – Nutrient requirement – Nutrient application – INM
Plantation Maintenance	– Knowledge of pruning – Weeding operations like methods and intervals – Inter-cultral operations
Disease Management	– Symptoms of diseases – Management practices – IDM – Application of chemicals
Pest Management	– Symptoms of pest attack – Management practices – IPM – Application of pesticides
Leaf Harvesting & Preservation	– Selection of leaf – Leaf harvesting schedule – Preservation of leaf

Silkworm Rearing

Essential Skills	Particulars
Disinfection Management	– Disinfection materials & schedules – Selection/quantity of disinfectant – Application method of disinfectants
Hygiene Management	– Personnel hygiene measures – Bed cleaning,Bed refuse & disposal – Discard of suspected disease worms
Rearing House Management	– Rearing house (RH) specifications – Importance of aeration & ventilation – Microclimate maintenance in RH
Incubation	– Indenting of hybrid/seed dfls – Transportation of eggs – Egg incubation methods/conditions – Black boxing & Brushing of worms
Young Age Silkworm Rearing	– Maintenance of environmental conditions – Infra-structure facilities of chawki centre – Mulberry leaf selection/feeding times – Essentials of spacing for young age worms – Moulting & resumption of feed schedules – Bed cleaning methods
Late Age Silkworm Rearing	– Maintenance of environmental conditions – Infra-structure facilities for late age raering – Mulberry leaf feeding schedules – Essentials of worm spacing; Bed cleaning – Moulting & resumption
Disease Management	– Symptoms of diseases – Disposal of diseased/unequal silkworms – Bed disinfectant application schedules
Mounting & Harvesting	– Identification of matured/spinning larvae – Proper mounting methods/conditions – Harvesting & sorting of cocoons
Record Keeping & Marketing	– Recording of temp. & relative humidity – DFL intake/crop and harvest details – Marketing facilities available – Documentation of economic returns/crop

Skill gap in mulberry cultivation

Skills	Farmers						Extension Workers		
	Traditional			Non-traditional					
	Avg.	<3.5	>3.5	Avg.	<3.5	>3.5	Avg.	<3.5	>3.5
Site selection	3.2	85%	15%	3.4	81%	19%	3.8	20%	80%
Nursery Management	1.9	85%	15%	2.3	82%	18%	3.6	21%	79%
Mulberry Plantation	2.6	87%	13%	2.9	81%	19%	3.8	22%	78%
Irrigation Management	2.7	96%	4%	3.1	92%	8%	3.6	25%	75%
Nutrient Management	2.4	94%	6%	2.7	90%	10%	3.9	19%	81%
Intercultural Operation	3.0	87%	13%	3.2	83%	17%	3.6	20%	80%
Disease Management	2.4	98%	2%	2.6	92%	8%	3.6	19%	81%
Pest Management	2.5	95%	5%	2.8	90%	10%	3.7	18%	82%
Leaf Harv. Management	3.3	84%	16%	3.4	88%	12%	3.8	21%	79%

Skill gap in silkworm rearing

Skills	Farmers						Extension Workers		
	Traditional			Non-traditional					
	Avg.	<3.5	>3.5	Avg.	<3.5	>3.5	Avg.	<3.5	>3.5
Disinfection Management	2.3	91%	9%	2.9	90%	10%	3.8	28%	72%
Hygiene Management	1.8	97%	3%	2.5	89%	11%	3.9	23%	77%
Rearing House Management	2.1	85%	15%	2.8	82%	18%	3.6	23%	77%
Incubation	2.2	87%	13%	2.3	85%	15%	3.7	21%	79%
Young Age rearing	2.4	95%	5%	2.7	91%	9%	3.9	19%	81%
Late Age Rearing	2.5	86%	14%	2.5	82%	18%	3.7	20%	80%
Disease Management	2.2	93%	7%	2.6	88%	12%	3.6	16%	84%
Mounting & Harvesting	2.9	91%	9%	3.2	83%	13%	3.7	18%	82%
Record keeping & Marketing	1.7	89%	11%	2.1	81%	19%	3.9	10%	90%

Poor skills development is considered as a hindrance to profitable sericulture enterprise. Training is an utmost requirement for the farmers as well as extension workers on regular basis. A training manual has been prepared by analysing the actual skill needs for sustainable sericulture practices

Inference:

Farmers were found to be skill deficient for mulberry cultivation as well as silkworm rearing. Besides extension workers were skilled, but require regular refresher training for technology updating. Training road map is described in the training manual.

Future work: Information generated would be utilized in respective skill upgradation CBT programmes.

EXTENSION

D. Das [upto May 2018], T. D. Biswas (from May 2019) and P. Naik, J (from March 2019)

Units/ Command area	Scientists	Tech. staff	TSFW/ SFW	Farm based units	
				Total (Acre)	Mulberry (Acre)
REC-Mothabari (West Bengal)	Dr. S. Chakrabarty Sci-D (I/c; from July 18)	12	6	1	0.5
REC-Bhandra (Jharkand)	Dr. Ghanshyam Singh Sci-D (I/c)	4	23	7	4.5

Transfer of Technology Programmes

Three technologies *viz.*, Popularization of package of practices of chwaki rearing; Popularization of Package of practices of late age rearing; Popularization of package of practices of mounting & harvesting were undertaken amongst 500 farmers through nested units including RSRS-Imphal across Eastern & NE region. Considerable improvement in cocoon yield was recorded with the farmers following all the three packages together and the overall productivity improvement was 35%, 30%, 26.9% & 19.2% in NE, rainfed-Eastern, Hilly region-Eastern & irrigated-Eastern regions, respectively.

Region	Yield/100 Dfls (kg) values in parentheses % improvement			
	Chawki rearing	Late age rearing	Mounting & Harvesting	Control
Eastern (Irrigated)	46.9 (12.7%)	48.3 (16.1%)	42.8 (2.9%)	41.6
Eastern (Rainfed)	43.4 (15.7%)	44.9 (19.9%)	40.6 (8.3%)	37.5
Eastern (Hilly)		44.1 (19.8%)	41.2 (11.9)	36.8
North-Eastern	43.91 (18.5%)	47.9 (29.3%)	38.1 (2.9%)	37.0

Popularization of new mulberry varieties

Units	Farmers		Area (Acres)		Mulberry Variety
	Target	Ach	Target	Ach	
CSRTI-Berhampore	20	52	10.0	10.96	S-1635
RSRS-Jorhat	10	10	5.0	5.0	
REC-Mothabari	20	31	10.0	10.23	
REC-M.P.Raj	5	5	2.5	2.5	
REC-Dhenkikote	10	10	5.0	10.0	
REC-Aizwal	10	10	5.0	5.0	
REC-Agartala	10	10	5.0	5.0	
REC-Shillong	10	10	5.0	5.0	
REC-Imphal	10	10	5.0	5.0	
REC-Dimapur	10	10	5.0	5.0	
REC-Mangaldoi	10	10	5.0	5.0	
REC-Bhandra	20	20	10.0	10.0	
REC-Sille	5	10	2.5	2.5	
RSRS-Koraput	10	10	5.0	10.0	S1635/C2038
RSRS-Kalimpong	5	10	2.5	2.5	$BC_2$59
REC-Mamring	5	5	2.5	2.5	
Total	170	223	85	96.19	

Extension Communication Programmes (ECPs)

Various nested units of CSRTI-Berhampore across different states conducted 250 ECPs as given below covering 13045 farmers on need-based technologies in mulberry and silkworm crop production, management and marketing.

State	Unit	AP		FD		FRD		GD		TD		Total	
		#	F	#	F	#	F	#	F	#	F	#	F
West Bengal	CSRTI-BHP	5	378	3	233	4	228	12	390	4	227	33*	2590*
	RSRS-Kalimpong	2	65	2	67	1	28	5	72	2	40	12	272
	REC- Mothabari	3	271	3	248	3	180	5	161	3	129	17	989
Jharkhand	REC- Bhandra	2	91	2	96	2	87	5	177	2	95	13	546
	REC- M.P.Raj	1	59	1	60	1	57	5	187	2	73	10	436
Odisha	RSRS- Koraput	2	87	2	88	2	81	5	162	2	85	13	503
	REC-DKote	2	109	2	100	2	77	5	165	2	76	13	527
Assam incl. BTC	RSRS-JHT	2	83	2	101	2	56	5	120	3	95	14	455
	REC- Mangaldoi	2	113	2	150	2	76	5	150	2	87	13	576
Sikkim	REC- Mamring	1	49	1	100	1	25	5	139	2	63	10	376
Mizoram	REC- Aizwal	2	120	2	65	2	52	5	71	2	74	13	382
Tripura	REC- Agartala	3	120	3	120	3	75	5	129	3	75	17	519
Mehgalaya	REC- Shillong	2	83	2	87	2	74	5	105	2	80	13	429
Manipur	REC- Imphal	3	141	3	130	2	99	5	140	3	111	16	621
Nagaland	REC- Dimapur	2	100	2	100	2	65	5	115	2	80	13	460
Ar. Pradesh	REC- Sille	2	91	2	88	2	53	5	113	2	62	13	407
	Total	36	1960	34	1833	33	1313	87	2396	38	1452	233	10088

*#: events; F: farmers; AP: awareness, FD: field day; FRD: farmers' day, GD: group discussion; TD:technology demos; *Exhibitions (#5; 1134F)*

Resham Krishi Mela (2018 - 2019)

State	Unit	Date	Farmers	Events (F)
West Bengal	CSRTI-Berhampore	29. 01. 2019	705	3 (1032)
	RSRS-Kalimpong	21. 01. 2019	160	
	REC- Mothabari	08. 01. 2019	167	
Jharkhand	REC- Bhandra	13. 02. 2019	88	2 (178)
	REC- M.P.Raj	14. 11. 2018	90	
Odisha	RSRS- Koraput	07. 12. 2018	105	3 (478)
		19. 12. 2018	224	
	REC-DKote	28. 11. 2018	149	
Assam incl. BTC	RSRS-JHT	21. 12. 2018	200	2(425)
	REC- Mangaldoi	11. 01. 2019	225	
Sikkim	REC- Mamring	23. 01. 2019	83	1 (83)
Mizoram	REC- Aizwal	07. 03. 2019	65	1 (65)
Tripura	REC- Agartala	08. 02. 2019	250	1 (250)
Mehgalaya	REC- Shillong	08. 03. 2019	70	1 (70)
Manipur	REC- Imphal	23. 02. 2019	179	1 (179)
Nagaland	REC- Dimapur	22. 01. 2019	117	1 (117)
Arunachal Pradesh	REC- Sille	12. 02. 2019	80	1 (80)
		Total	2957	17

m-kisan

1402 farmers database from 7 States were created against the target of 1000. Against the target of 80 messages, 94 messages in 5 languages (Bengali, English, Hindi, Nepali & Oriya) were communicated covering 5253 farmers.

Seri Model Village (SMV)

With an objective to develop model village(s) which would adopt 100% technologies extended by CSR&TI Berhampore as a package module in 14 villages covering 1210 farmers (irrigated & rainfed areas) of Eastern & North-Eastern regions. A total of 1.46 lakhs dfls of ICB [Nx(SK6.7); M6DPC x (SK6. 7)] covering 730 farmers were reared under irrigated conditions in West Bengal and Jharkahand. The mulberry leaf yield improved by 8.59% and cocoon yield by 13.3% in comparision to non-SMV farmers. BixBi hybrids (FC1 x FC2; SK6 x SK7; BCon1 x BCon4) totaling 71500 dfls were reared by 460 farmers in different states. The cocoon yield improved by 9.12% and the leaf yield by 16.72% in comparision to non-SMV level. Under REC Dhenkikote 4000 ICB dfls covering 20 farmers were reared and all the crops were recorded as total failure.

State	Unit	Village	Farmers	Leaf yield		DFLs (lakh)	Yield/100 DFLs (kg)		Hybrid/ ICB
West Bengal	CSRTI-Berhampore	Balashpur	200	7.37	6.77	0.4	50.0	44.5	ICB
		Barbakpur	50	9.0	8.25	0.1	51.0	46.0	
		Sahebnagar	200	7.5	6.95	0.4	53.5	47.25	
	REC- Mothabari	Bangalgram	200	8.56	7.86	0.4	49.0	44.0	
Jharkhand	REC- M.P.Raj	Amritpur	80	6.48	6.0	0.16	48.10	40.28	
West Bengal	RSRS-Kalimpong	Mahakaldhara	25	3.55	3.3	0.025	39.5	36.25	BV
Assam incl. BTC	RSRS-JHT	Chapori	50	2.78	2.6	0.05	40.09		
	REC- Mangaldoi	Halda & Rowmari	60 + 65	4.73	2.88	0.25	48.87	41.30	
Mizoram	REC- Aizwal	Saitual	60	3.4	3.0	0.12	48.27	46.0	
Tripura	REC- Agartala	Chikancharra	30	3.25	2.98	0.03	45.25	37.4	
Mehgalaya	REC- Shillong	Ummulong & Wahiajer	50 + 50	2.8	2.65	0.1	47.9	43.85	
Manipur	REC- Imphal	Yumnamkhunou	70	4.40	4.0	0.14	47.4	45.0	

Adarsh Swachh Resham Gram Programme (April 2017 - March 2019)

N. Chandrakanth (from Feb 2018), Shafi Afroz (upto Jan 2018), T. D. Biswas and Debojit Das (upto May 2018)

Objectives:

- To create awareness about cleanliness and sanitation among the villagers for behavioral changes about health and hygiene in their homes as well as in the village
- To improve the socio-economic conditions of the farmers by improved sericulture technologies and practices for their sustainable livelihood development

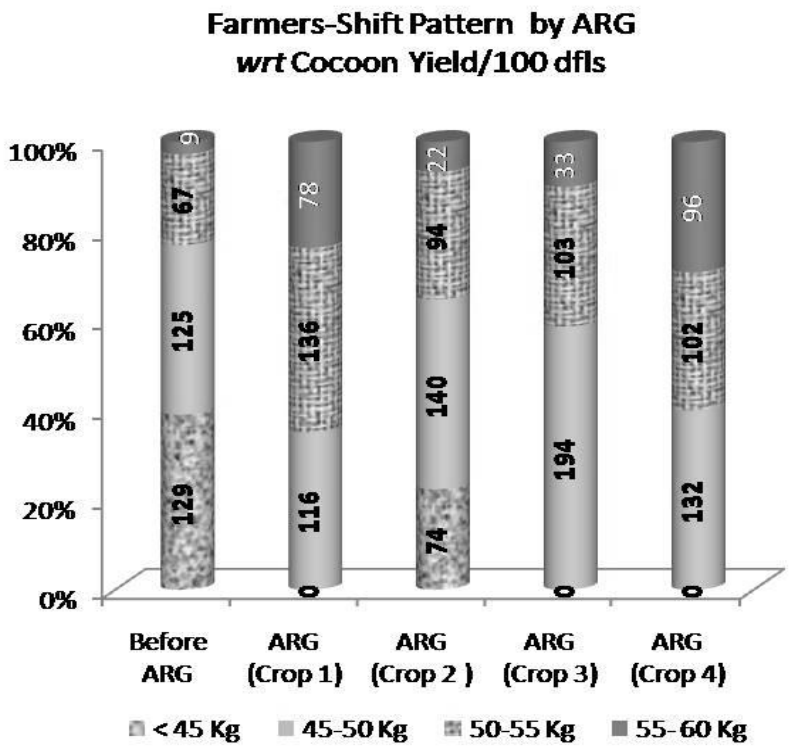
Mallickpur-Diara villages in Khragram block (Murshidabad district, West Bengal) was selected for Adarsh Swachh Resham Gram Programme in consultation with DoT (Seri), Murshidabad covering 330 female

sericulture farmers. The programme aims to create awareness on cleanliness and sanitation in the village for sustainable development through sericulture technologies.

Two cleanliness drives as well as four awareness programmes on significance of cleanliness-sanitation were conducted to educate the sericulture farmers. Thirty self-help groups (SHG) consisting of 11 farmers in each group were formed and two knapsack sprayers and masks were distributed to each SHG. Mobile phones with GREEN SIM card in collaboration with IFFCO-Kisan Sanchar Limited were distributed to all the farmers for daily communication (voice messages in Bengali) with the facilitator for redressing issues/challenges on day-to-day activities of sericulture. A bank account opening camp was also organized at the village to link all the farmers with financial services.

Four crops (Agrahayani 2017 & 2018, Falguni 2018 & 2019) were closely coordinated and monitored with improved sericulture technologies. The average cocoon yield recorded before the implementation of ARG programme was 45.25kg/100 dfls. A total of 1.32 lakh multi x bi dfls (N x SK6.SK7) were distributed among the 330 farmers (@100 dfls/farmer/crop). Thirty CRCs were organized in each crop under close supervision by the Institute.The chawki rearing charges borne by the institute and critical rearing inputs (paraffin paper, foam pad, bleaching powder, Labex etc.) were supplied for adopting the improved package of practices. An average gross income of Rs. 14305-16780/crop (@ Rs.330±50/kg) was achieved by the farmers under ARG.

Season	Yield/ 100 dfls (kg)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)	% Yiled improved
Agrhayani	51.35	1.85	0.32	17.00	13.48
Falguni	50.32	1.48	0.25	16.50	11.20
Mean	51.09	1.67	0.28	16.70	12.90



Adoption of improved package of practices of silkworm rearing helped farmers to achieve improved cocoon yields (51 kg/100 dfls). The positive changes in the sericultural practices rejuvenated farmers for maintaining cleanliness in and around the home as well as the village. Such an achievement of 330 Female Sericulture Farmers would serve as success story for other sericulture farmers.

ARG – Extension Communication Programmes







RESHAM KRISHI MELA
REGIONAL SERICULTURAL RESEARCH STATION
RKM @ Jorhat-Assam


RKM @Berhampore-W.Bengal


RKM @ Imphal-Manipur


RKM @ Kashipur-Odisha


RESHAM KRISHI MELA
RKM @ Dhenkikote-Odisha


Exhibition @ Sundarban


RKM @ Agartala-Tripura


RKM @ Mangaldoi-Assam


Awareness Programme
@ REC-Dimapur


Technology Demonstration
@ REC-Dhenkikote


Awareness Programme
@ Karimpur-Nadia


Awareness Programme
@ REC-Sille


Technology Demonstration
@ REC-Mangaldoi


Awareness Programme
@ REC-Aizwal


Awareness Programme
@ RSRS-Jorhat


Technology Demonstration
@ RSRS-Kalimpong


Induction training of Scientist-Bs
@ Field Visit
REDMI NOTE 5 PRO
MI DUAL CAMERA


Shri R R Okhandiar
@ rearing lab


Awareness programme
@ REC-Dimapur


Awareness programme
@ RSRS Jorhat


Rotable mountage
@ ToT-farmers-Jharkhand


Plastic mountage
@ ToT-farmers-WB


Technology demonstration
@ REC-Aizwal


Group Discussion
@ Kaliachak Market-WB


Awareness programme
@ REC-Bhandra


Group Discussion
@ REC- Mongoldoi


Awareness Programme
@ REC-Imphal


Awareness Programme
@ REC-Sille


Awareness Programme
@ REC-Agartal


Shoot Rearing Practice
@ Field


Bivoltine Cocoon Harvest
@ Field


Cocoon Sorting
@ Field

CAPACITY BUILDING & TRAINING

Chandana Maji (upto Jan 2019), S. Chottopadhyay (from Feb 2019) and S. Sarkar

Various human resource development (HRD) programmes were organized for capacity building of stakeholders and transfer of technology for sustainable development of sericulture in Eastern and North Eastern India. A total of 3096 candidates were trained through different programmes including farmers' skill training (FST), technology orientation (TOP), management development, post-cocoon technology, intensive training, exposure visits and other programmes (non-CBT & need based programmes). SeriResource Centre (SRCs) established under Samagra were monitored and coordinated by conducting requisite training programmes locally benefitting the farmers. Systematic training was imparted to the respective stakeholders on the critical activities of sericulture along with practical demonstrations and hands-on programmes. Further, structured long-term (15 months) course, viz., PGDS (affiliated to Kalyani University-Kalyani-West Bengal) was offered to the participants across the country.

Post Graduate Diploma in Sericulture (Mulberry)

The PGDS course is spread into two semesters (6 months each) and three-month course work utilizing well-planned and executed syllabus covering all aspects of mulberry sericulture in coordination with Kalyani University-Kalyani-West Bengal. The course includes 15 day exposure visit per semister to major mulberry & non-mulberry sericulture area. Applications for the course are invited through regular media advertisements/ correspondence. Majority of these students are sponsored by the DoS of various state governments and also self-funded individuals. The students are taught by the experienced scientific personnel working at CSRTI-Berhampore and other CSB units, honorary faculties. The students are evaluated through semister-end examinations including theory and practicals. Students undertake disseratation/practical course work for three months under the supervision of experienced faculty in various disciplines. The students need to submit a dissertation/report, which is again evaluated by set-examiner system. The students who have successfully completed the course were awarded PGDS and top three students were also felicitated by Central Silk Board (CSB-Banaglore) by conferring Gold, Silver & Bronze Medals (Besides Rs. 15,000 cash award provision to the toppers in 1st Semester).

States	Students	
	Sept 2018 Batch (20)	July 2018 Batch (37)
Manipur	9	4
Nagaland		1
Mizoram	2	7
Arunachal Pradesh	5	3
Telangana	1	
Odisha	1	
Jammu & Kashmir	2	
Assam		21
Jharkhand		1

Discipline	Farmers (No.)
Chawki Silkworm Rearing (10d)	51
Late Age Silkworm Rearing (10d)	85
Mulberry cultivation (5d)	33
IDPM (5d)	35
Post Cocoon Technology (3d)	34

Farmers Skill Training Programme

The objective of Farmers' Skill Training (FST) programme is of 5-10 days duration for upgrading the knowledge of sericulture farmers through theoretical and practical training classes and for enhanced income levels from sericulture. During the year, 238 farmers were trained in different aspects of mulberry cultivation, silkworm cocoon production and post-cocoon processes.

Technology Orientation Programme

Technology orientation programmes are of 3 days duration which aims to upgrade the knowledge of officers/officials from CSB and DoS in respect to technologies developed by the Institute for its effective translation in the farmers' field in their respective states and for promotion of enterprises to achieve the set targets. A total of 184 personnel were trained in various disciplines.

Management Development Programme

Management development programmes (one day) with an objective to orient and skill update the knowledge of officers/officials/farmers from NGOs & other SHGs with regard to need based technologies developed by the Institute for effective translation to the field. During the current year, 46 personnels were trained on different aspects.

Intensive Training Programme

Intensive training programmes (15-30 days) scheduled with an objective to impart basic training on different aspects of sericulture to CSB/DOS personnels and students. During the year, 80 personnels were trained on various deciplines.

Post Cocoon Technology

PCT programmes (3 days) aims to impart practical training to the stakeholders on latest aspects of post cocoon technologies and 34 personnels were trained in the current year.

Performance of Seri Resource Centre (2018-19)

SRC	District/ State	Training Details		Coordinators (SRC Owner)	Contact (Mobile)
		Batches (No.)	Farmers (No.)		
Bankipur	MSD	8	200	Anisur Rahaman	7407979087
Mollikpur		7	200	Md Rejaul Seikh	9735403222
Alinagar	Malda	10	200	Md Sufian Ali	9734016330
B.Hazitola		10	200	Md. Kased Ali	9734046100
Barbakpur	Nadia	12	260	Md Kalimuddin Seikh	7872870731
Panishal	Kissanganj	10	200	Md Lukman Ali	9382115825

Seri Resource Centre

SRCs established under Samagra in different region(s) were aimed to impart basic training on different aspects of sericultural technologies developed by the Institute for the region. The requiste training programmes are of 1 day duration conducted by SRC owner/lead farmer in the village in co-ordination with DoS and CSRTI-Berhampore for the benefit of seri-farmers. A total of 1260 personnels in 57 batches were covered under the programme.

Other Training Programmes

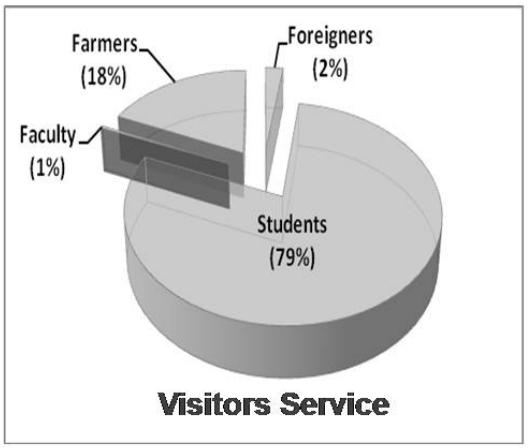
Non-CBT (10-30 days) and need based training (6-10 days) programmes have been conducted on demand with an aim to impart training on latest technologies developed by the Institute to the officers/officials/students/ stakeholders/unemployed youth on payment basis. A total of 786 personnel were trained under various programmes.

Exposure visit

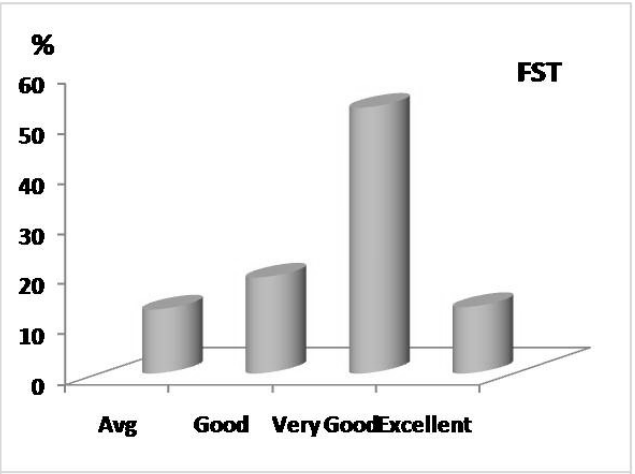
Exposure visits (2-3 days) aim to impart basic knowledge on sericulture on latest technologies to farmers, students & officials of concerned state and a total of 67 personnels utilized the programme.

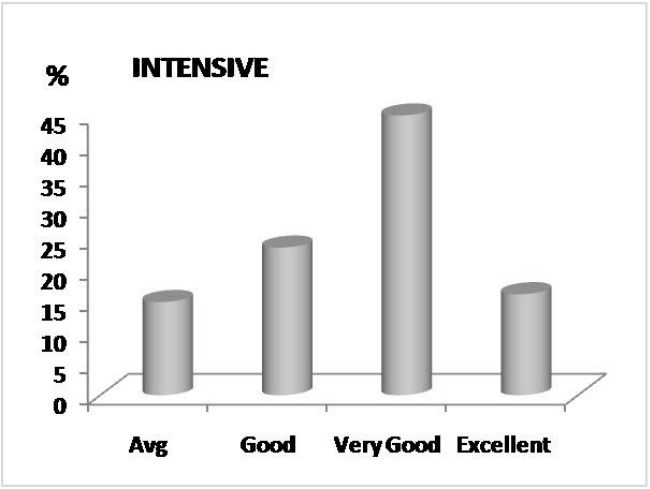
Visitors Service

A total of 541 visitors (students from universities/colleges/ schools/organizations; farmers; reelers etc) availed visitiors services (VS) from the institute on mulberry sericulture.



Feedback on Training Programmes by the Stakeholders





Special activities on women empowerment & development of SC/ST/weaker sections

Programme	Male					Female					Grand Total
	Gen	SC	ST	OBC	Total	Gen	SC	ST	OBC	Total	
PGDS (2017-18)	3		4	2	9	2	1	5	3	11	20
PGDS (2018-19)	1		9	1	11	1	1	16	8	26	37
FST	71	71	3	41	186	6	12			18	204
PCT	20	5		9	34						34
TOP	17	2			19	2				2	21
MDP	16			5	21	24			1	25	46
NBP	4	9		32	45	107	81	26	518	732	777
EV/ VS	144	33	17	46	240	224	67	7	79	377	617
ITP	14	7	5	8	34	13	3	22	8	46	80
SRC	288	59	18	210	575	344	37	12	292	685	1260
Total	578	186	56	354	1174	723	202	88	909	1922	3096


Exposure Visit @ CSRTI-BHP


Exposure Visit-Jeevika (Bihar) @ CSRTI-BHP


Chawki Rearing @ CSRTI-BHP


Scientist-B Training @ CSRTI-BHP


MDP @ CSRTI-BHP


PGDS Examinations @ CSRTI-BHP


Interaction with Faculty @ CSRTI-BHP


FTP @ Pemling (Kalimpong)

REGIONAL SERICULTURAL RESEARCH STATIONS (RSRS)

Regional Sericultural Research Stations (RSRS) are established to address the regional problems of sericulturists through research & extension support of sericulture technologies in varied agro-climatic regions. Their main objective includes undertaking validation trials & demonstration of new sericulture technologies evolved by the main institute to the sericulturists. The proven technologies are transferred further to the field through Research Extension Centres (RECs). CSRTI-Berhampore has three RSRSs viz., RSRS-Jorhat (Assam) covering North Eastern states; RSRS-Koraput (Odisha) covering Odisha state; RSRS-Kalimpong covering hilly districts of West Bengal & Sikkim state. The main institute coordinates all the R&D, Extension and Capacity building programmes in the command states.

RSRS-JORHAT

Units & Command Area	Scientists	Tech. Staff	Admin. & supp. Staff	TSFW/ SFW	Farm based Units	
					Total Area (Acres)	Mulberry (Acres)
RSRS-Jorhat (Assam)	Dr. S. N. Gogoi, Sci-D (I/c; upto Oct 2018) Dr. U. C. Baruah, Sci-D (upto July 2018) Ms. M. Pamegam, Sci-D (upto July 2018) Dr. P. Kumareshan, Sci-C (I/c; from Dec 2018) Mr. Chandan M, Sc-B (from March 2019)	12	5	20	12.10	7.5
RECs						
Agartala (Tripura)	Dr. G. B. Singh, Sci-D (I/c; upto Aug 2018) Mr. Haridhan Nama, TA (I/c; from Oct 2018)	3	-	3	1	0.5
Aizawl (Mizoram)	Dr. L. Pachuau, Sci-C (I/c)	3	1	-	-	-
Dimapur (Nagaland)	Dr. A. Borah, Sci-D (I/c; upto May 2018) Mr. Intimokchung, TA (I/c; from June 2018)	6	-	4	10	3.5
Mongaldoi (BTC)	Mr. B. K. Basumatary, Sci-D (I/c)	6	-	1	7	5.1
Shillong (Meghalaya)	Dr. Collins Z Renthil, Sci-D (I/c)	3	-	1	1.7	1.5
Sille (Arunalchal Pradesh)	Mr. S Pertin, TA (I/c; upto July 2018) Dr. Lohit Sonowal, Sci-C (I/c; from Aug 2018)	4	-	5	-	-
REC-Imphal (Manipur)	Dr. Reeta Luikham, Sci-D (I/c upto July 2018) Dr. L. Somen Singh, Sci-D	2	-	-	-	-

On-going Research Projects

PPA 3622: Popularization of high bush mulberry plantation technology in Majuli, River Island of Brahmaputra, Assam (Sept 2017 - Aug 2020)

M. Pamegham (upto July 2018), S.N. Gogoi (upto Oct 2018), P. Kumaresan (PI; from Nov 2018) and Chandan Maharana (from March 2019)

Objectives

- To assess growth characters, leaf yield of high bush mulberry plantations and cocoon productivity
- To assess the mulberry pest and diseases in different seasons
- To popularize the high bush mulberry plantation technique in Majuli to enhance leaf yield and cocoon production per unit area and its socio-economic impact of sericulture farmers

Farmers were identified in Majuli for establishing mulberry plantation and S1635 saplings were distributed. An awarenesss programem was conducted on mulberry cultivation technology and pest management. Few farmers also practicised intercropping with vegetables like Cowpea, Pumpkin etc. Below ETL incidence of *Pseudocercospora* leaf spot, powdery mildew and brown leaf rust was observed in the plantations. No pest infestation was observed.

PRE02001SI: Manamgement of Pink Mealy Bug - Maconellicoccus hirsutus (Green) of mulberry with barrier system (July 2018 - June 2021)

M. Pamegham (upto July 2018), S.N. Gogoi (upto Oct 2018), P. Kumaresan (PI; from Nov 2018) and Chandan Maharana (from March 2019)

Objectives

- To increase the silk production by reducing the mulberry crop loss due to infestation of pink mealy bug
- To find out the minimum strategy to combat against mealy bug without adverse effect on environment

Various barrier combinations were evaluated for the management of pink mealy bug in experimental layout (RBD; S1635; 3mt x 4mt plots; 20 plants/plot; four replications/ treatment). Mealy bug population density (nymphs & adults) was recorded at weekly intervals (5 plants-10 leaves/treatment). Barrier with neem cake + 0.3% chloropyriphos (T3) was eefctive.

Treat-ment	Barrier with	Mealybug Population Density
T1	lime powder + 0.3% Chloropyriphos-20EC	8.25±0.16
T2	Paddy husk ash + 0.3% Chloropyriphos-20EC	9.41±0.22
T3	Neem cake + 0.3% Chloropyriphos-20EC	6.98±0.14
T4	Sawdust + 0.3% Chloropyriphos-20EC	8.95±0.20
T5	No barrier + 0.3% Chloropyriphos-20EC	10.45±0.10
	SE(m)	0.182
	CD @ 5%	0.603

Continuous/Other Activities

Studies on mulberry germplasm in Agro climatic conditions in North-Eastern state, Assam (Sept 2017 – Aug 2020)

M. Pamegham (upto July 2018), S.N. Gogoi (upto Oct 2018), P. Kumaresan (PI; from Nov 2018) and Chandan Maharana (from March 2019)

Objectives

- To established mulberry field gene bank with the collections from Germplasm of CSGRC-Hosur
- To identify a promising mulberry accession for commercial utilization

Twenty accessions (MI-0024, MI-0038, MI-0069, MI-0072, MI-0101, MI-0110, MI-1050, MI-0170, MI-0206, MI-0209, MI-0341, MI-0345, MI-0361, MI-0377, MI-0395, MI-0403, MI-0142, MI-0149, MI-0188 & MI-0208 were collected from CSGRC-Hosur) and saplings were planted (6ft X 6ft spacing; 2 plants/replication). The survivability of cuttings ranged from 13.33% (MI-0072) to 100% (MI-0149). Standard package and practices were followed for maintenance of field gene bank at RSRS-Jorhat. The saplings survival was recorded after 10 months; MI-0069 recorded 100% survival, while five accessions (MI-0350, MI-0206, MI-0149, MI-0188 & MI-0208) recorded 100% mortality. The growth and leaf yield parameters would be measured on completion of 1 year.

Collaborative R&D Projects/Activities

RSRS-Jorhat has the following four collaborative projects and two continous activies with the main institute. The unit is involved in the collection of data from experiments/farmers/DoS and the respective information is reported discipline wise.

1. PIB 3576: Evaluation of new mulberry genotypes for improvement in productivity and quality
2. PPS 3600: Soil health card preparation for mulberry growing soils in E & NE India
3. AIB 3617: Identification of region specific bivoltine hybrids suitable for highly fluctuating and seasonally variable climatic conditions of E & NE India
4. AIB3616: On-farm Trial of multivoltine silkworm breeds/hybrids developed for high shell percentage and neatness of silk filament
5. Forewarning of mulberry pest & diseases of Eastern and North Eastern India
6. Survey, surveillance and monitoring of silkworm diseases in seed and commercial crops

EXTENSION ACTIVITIES

Popularization of improved mulberry varieties: A total of 0.82 lakh mulberry saplings have been raised with high yielding varieties S1635, C2038 etc. and 39.5 acres new plantation (79 farmers) was established. RSRS-Jorhat facilitated supply of mulberry cuttings to Samvrudhi for eatblishing mulberry plantation in Nagaland.

Transfer of Technology Programmes: Three ToT programmes involving 12 CRCs, 240 farmers with SK6 x SK7 bivoltine hybrids were conducted in Popularization of package of practices of chawki rearing (upto 56kg/100 dfls) & Popularization of package of practices of late age rearing (an average cocoon yield of 54kg/100 dfls)and Popularization of mounting and harvesting technology.

ECPs: RSRS-Jorhat and its nested units organized a total of 120 Extension Communication Programmes (Awareness, Field day, Audio-Visual, Exhibition, Group Discussion, Technology Demonstration, Resham Krishi Mela cum Exhibition) and sensitized 5035 farmers on various sericulture technologies.

Seri model village (SMV): Eight villages (435 farmers) were adopted under SMV (RSRS-Jorhat & RECs-Imphal, Aizawl, Shillong, Mangaldoi & Agartala). A total of 71500 bivoltine hybrid (SK & BCon series) dfls were reared and 31.06-53.23kg cocoon yield/100 dfls was recorded in comparision to non-SMV farmers (19.50-45 kg) in autumn & spring seasons. Similarly, mulberry leaf yield of 2.78-4.4 MT/ha/crop was recorded as compared to control farmers (2.42-4.0).

CPP: A total of 5.79 lakh dfls of bivoltine hybrids were distributed to 3206 farmers under five clusters *i.e.* Assam: Darrang & Jorhat, Nagaland: Peren, Mizoram: Aizawl & Tripura: West Tripura in spring and autumn crops including a late autumn crop. The average cocoon yield recorded was 44.64kg/100 dfls (30.41MT bivoltine raw silk).

Unit	Target	Achievement (Farmers)
RSRS-Jorhat	3	3 (70)
REC-Agartala	5	5 (125)
REC-Aizawl	5	5 (148)
REC-Dimapur	5	5 (167)
REC-Shillong	5	5 (154)
REC-Mangaldoi	5	5 (161)
REC-Sille	2	2 (100)
Total	30	30 (925)

CBT Programmes: Ten officials/personnel from DOS-Assam were trained under one-day Trainers Training Programme in sericulture at RSRS. A total of 925 farmers were trained through Farmers Skill Training Programme (FST) on latest technologies in silkworm rearing and mulberry cultivation by RSRS-Jorhat and its nested RECs.

RSRS-KALIMPONG

Units & Command area	Scientists	Tech. staff	Admin & Supp. staff	TSFW/ SFW	Farm based units	
					Total area (Acre)	Mulberry (Acre)
RSRS-Kalimpong (Hilly districs of West Bengal)	Dr. Ranjit Kar Sci-D (I/c; Upto Sept 2018) Mr. Zakir Hosaain Sci-D (from June 2018; I/c Oct 2018) Dr. Harish Babu S Sci-B (from March 2019)	15	6	19	30.36	11.22
REC Mamring/ Rangpo (Sikkim)	Mr. S. T. Lepcha, Sci-D (I/c)	5	-	-	-	-

Collaborative R&D Projects/Activities

RSRS-Kalimpong has the following three collaborative projects and two continous activies with the main institute. The unit is involved in the collection of data from experiments/farmers/DoS and the respective information is reported discipline wise.

1. PPS3598: Arsenic contamination in mulberry sericulture of Bengal plain and its alleviation through application of zinc in soil
2. PPS 3600: Soil health card preparation for mulberry growing soils in E & NE India
3. AIB 3617: Identification of region specific bivoltine hybrids suitable for highly fluctuating and seasonally variable climatic conditions of E & NE India
4. Forewarning of mulberry pest & diseases of Eastern and North Eastern India
5. Survey, surveillance and monitoring of silkworm diseases in seed and commercial crops

Continuous/Other Activities

Maintenance of Bivoltine Silkworm Germplasm Breeds [April 2015 - March 2019]

Z. Hossain (from Nov 2018), R. Kar (upto Sept 2018), S. Chatterjee (upto Nov 2016) & C. Maji (upto June 2016)

Objective: To maintain the bivoltine silkworm breeds true to their original racial character and to study their qualitative and quantitative traits

Bivoltine germplasm breeds collected from various sources maintained at RSRS-Kalimpong were reared during spring (April-May) & autumn (August September) crops in two cellualar beds each. The rearing was conducted following standard rearing technology/conditions. The data on rearing performance and cocoon characteristics were documented and verified against the passport data. The selected cocoons were utilized for producing next generation dfls and preserved in hibernation schedules.

Extension Activities

Transfer of Technology Programmes: Three ToT programmes involving 15 farmers with SK6 x SK7 bivoltine hybrids were conducted in Popularization of package of practices of chawki rearing (1.2% more cocoon yield as compared control) & Popularization of package of practices of late age rearing (18.4% more cocoon yield as compared control) and Popularization of mounting and harvesting technology (11.9% more cocoon weight as compared control).

ECPs: RSRS-Kalimpong and REC-Mamring organized a total of 24 ECPs (Awareness, Field day, Audio-Visual, Exhibition, Group Discussion, Technology Demonstration, Resham Krishi Mela cum Exhibition) and sensitized 891 farmers on various sericulture technologies.

Seri Model Village (SMV): Mahakaldhara village was adopted under SMV (RSRS-Kalimpong) with 25 farmers. A total of 2495 dfls bivoltine hybrids (SK & BCon series) were reared and 39.5kg average cocoon yield/100 dfls was recorded in comparision to non-SMV farmers (36.3 kg) in autumn & spring seasons. Similarly, mulberry leaf yield of 3.57 MT/ha/crop was recorded as compared to control farmers (3.32).

CBT Programmes: A total of 113 officials/personnel were trained under one Trainers Training and 3 Farmers Training Programmes on latest technologies in silkworm rearing and mulberry cultivation by RSRS-Kalimpong.

Muga Cocoon production: Consequent to the merger of MSSO P3-Kalimpong unit with RSRS-Kalimpong, 200 Muga dfls (supplied by P4-Mendipathar) were reared for Kotia commercial crop (April-May 2018; P3 muga) and 10404 cocoons were produced with dfl cocoon ratio of 1:52.

Performance of Bivoltine Silkworm Genetic Resources
Spring 2018 @ RSRS-Kalimpong

Breed	Fec. (No.)	ERR (No.)	ERR by wt (kg)	SCW (g)	SSW (g)	Shell (%)
B. Con-1	516	9400	16.283	1.810	0.306	16.90
B. Con-4	525	8767	16.750	1.771	0.303	17.10
B.G. (W)	380	8600	11.833	1.377	0.185	13.44
BHR-1	484	8850	16.500	1.791	0.331	18.48
BHR-2	433	9250	15.900	1.620	0.294	18.19
BHR-3	460	9150	17.733	1.705	0.312	18.30
BL-1	511	7450	14.083	1.753	0.288	16.43
BP(Black)	484	8450	12.350	1.390	0.193	13.88
BP(Chowk)	465	9366	14.017	1.411	0.218	15.45
Changnang	550	8733	17.633	1.770	0.336	18.98
Chinese-PN	469	8666	16.033	1.665	0.303	18.20
CSR-18	472	3233	4.650	1.403	0.270	19.24
CSR-19	470	7917	11.567	1.503	0.301	20.03
CSR-2	473	3317	5.467	1.876	0.400	21.32
CSR-26	486	8317	12.567	1.536	0.290	18.88
CSR-27	464	3900	5.533	1.534	0.302	19.69
CSR-46	497	9066	13.183	1.652	0.319	19.31
CSR-47	444	3633	5.100	1.451	0.272	18.75
CSR-5	387	517	0.867	1.676	0.324	19.33
CSR-50	555	1333	2.000	1.610	0.336	20.87
CSR-51	456	4750	7.833	1.627	0.341	20.96
CSR-52	510	4233	7.583	1.730	0.363	20.98
CSR-53	507	1133	2.200	1.883	0.380	20.18
CSR-6	476	6550	10.550	1.707	0.337	19.74
D-4	485	8617	15.700	1.640	0.300	18.29
D-5	370	8600	14.267	1.506	0.290	19.26
D6(M)	485	9217	15.916	1.634	0.287	17.56
D6(P)	428	9150	16.333	1.671	0.306	18.31
J-122	526	8650	16.100	1.740	0.321	18.45
JD-6	493	7233	12.217	1.724	0.313	18.16
KPG-11	470	9583	14.433	1.447	0.257	17.76
KPG-3	490	6867	11.650	1.638	0.300	18.32
KPG-4	471	6483	10.250	1.585	0.282	17.79
KPG-5	469	6650	10.533	1.608	0.295	18.35
KPG-7	468	8483	16.100	1.792	0.344	19.20
KPG-A	475	7450	13.383	1.698	0.307	18.08
KPG-B	468	8966	15.466	1.628	0.291	17.87
MC-1	392	6666	10.483	1.515	0.290	19.14
MC-2	443	9250	16.516	1.790	0.321	17.93
MC4(O)	355	8517	12.800	1.515	0.247	16.30
MJ-1	520	9267	16.050	1.598	0.291	18.21
MJ-2	443	9183	16.950	1.706	0.294	17.23
NB18	439	9350	16.750	1.732	0.316	18.24
NB4D2	532	8617	14.567	1.761	0.320	18.17
P5	514	8083	13.616	1.751	0.317	18.10
Pam105	504	9216	14.633	1.596	0.280	17.54
SF-19	505	8566	14.900	1.707	0.306	17.93
SH-6	510	8383	16.500	1.937	0.364	18.79
SK-4	460	9400	16.433	1.709	0.304	17.79
SK-4 (II)	524	8900	17.516	1.743	0.332	19.04
SK-6	476	9283	16.717	1.695	0.309	18.23
SK-7	528	9283	16.767	1.785	0.326	18.26

Performance of Bivoltine Silkworm Genetic Resources Autumn 2018 @ RSRS-Kalimpong

Breed	Fec. (No.)	ERR (No.)	ERR by wt (kg)	SCW (g)	SSW (g)	Shell (%)
B.Con-1	510	8280	10.02	1.324	0.226	17.07
B.Con-4	503	8940	10.78	1.357	0.258	19.01
BHR-1	518	9760	12.78	1.401	0.244	17.42
BHR-2	522	8900	12.24	1.388	0.237	17.07
BHR-3	496	9000	11.34	1.315	0.225	17.11
Changnang	491	7040	10.04	1.435	0.249	17.35
CSR-2	500	5640	7.46	1.333	0.237	17.78
CSR-26	420	4120	4.90	1.491	0.279	18.71
CSR-27	497	5380	6.74	1.353	0.287	21.21
CSR-6	498	7040	8.52	1.293	0.24	18.56
D-4	482	9100	12.00	1.340	0.231	17.24
D6(m)	513	9560	12.24	1.304	0.226	17.33
D6(P)	515	7860	9.70	1.402	0.241	17.19
J122	532	8800	10.72	1.293	0.226	17.48
JD-6	479	8020	10.14	1.388	0.238	17.15
KPG-11	541	7440	8.58	1.215	0.192	15.80
KPG-3	457	4100	5.24	1.290	0.218	16.90
KPG-4	509	6980	8.54	1.320	0.217	16.44
KPG-5	519	6360	8.46	1.412	0.252	17.85
KPG-7	506	7640	10.00	1.402	0.222	15.83
KPG-A	530	7640	9.12	1.339	0.242	18.07
KPG-B	499	7420	9.32	1.282	0.207	16.15
MC-1	483	6320	7.48	1.256	0.2	15.92
MC-2	506	8540	10.56	1.292	0.212	16.41
MJ-1	493	7320	8.80	1.335	0.222	16.63
MJ-2	525	9000	10.42	1.266	0.207	16.35
NB18	510	9580	12.04	1.266	0.212	16.75
NB4D2	530	9680	11.92	1.351	0.227	16.80
P5	500	7680	9.86	1.297	0.238	18.35
PAM-105	530	7840	9.48	1.297	0.212	16.35
SF-19	518	7480	9.62	1.44	0.249	17.29
SH-6	506	4100	6.70	1.355	0.231	17.05
SK4(II)	501	6920	8.68	1.409	0.254	18.03
SK-6	521	9260	11.68	1.295	0.211	16.29
SK-7	535	9320	11.70	1.302	0.213	16.36

RSRS-KORAPUT

Units (Command Area)	Scientists	Tech. staff	Admin & Supp. staff	TSFW/ SFW/MTS	Farm based units	
					Total area (Acre)	Mulberry (Acre)
RSRS-Koraput (Odisha)	K.C.Bramha, Sci-D (I/c; upto May 2018) Mr. S K Misro, Sci-C (I/c; from June 2018) Mr. Khasru Alam, Sci-B (from Jan 2019)	16	4	23	50	9
REC-Denkikote (Odisha)	Mr. S.B. Dey, Sci-C (I/c, upto April 2018) Dr. N.B. Chaudhury, Sci-D (I/c; from Aug 2018)	4	-	-	-	-

Concluded Research Projects

MOE 3604: Yield gap analysis in mulberry leaf and cocoon production – A study in Eastern ghat highland zones of Odisha [Dec 2016 - Nov 2018]

M.K.Ghosh (PI; upto Jan 2017), K.C.Bramha (PI; upto May 2018), S.K.Misro (PI; from June 2018), S.B. Dey (upto April 2018) and N.B. Chaudhury (from July 2018)

Objectives

- To assess the magnitude of Yield Gap in respect of mulberry leaf & cocoon productivity at farmers level
- To examine the nature of variation in Yield Gap across different socio-economic strata of the sericultural farmers
- To identify factors influencing for Yield Gap
- To suggest policy measures for reducing the gap

The study has been taken up in Koraput, Rayagada and Ghatagaon districts of Odisha. Both primary as well as secondary data regarding sericulture development has been collected through semi-structured questionnaire. Farmers' were selected through multi-stage purposive as well as random sampling method (Koraput: 25 farmers from 6 villages; Rayagada: 50 farmers from 10 villages; Keonjhar: 50 farmers from 8 villages). Data on yield was collected from 125 farmers (marginal: 48%; small: 47.2%; medium: 4.8%). The farmers are basically scheduled tribe category (90%) with 61.6% illiterate, 19.2%: primary education and 19.2% discontinued at high school. 33.6% farmers have access to electronic media and 22.4% have knapsack sprayers as improved agricultural implements. The economic status is very poor with the overall per capita income of below Rs 25000 (83.2%). The data on various parameters in mulberry cuiltivation & production, silkworm rearing & cocoon production were collected.

The yield gap recorded in the annual leaf productivity is ~13% yield gap (demo plots) & 79 % (farmers) and ~28% yield gap (DP) & 71% (farmers) average cocoon productivity in respect of Research institute. The constraints enlisted as major factors for the observed yield gap include poor socio-economic status, low operational land holding, farmer's perception on silkworm rearing (seed crop), low adoption of technologies, poor extension & training activities. The yield gap from Research Institute to Farmers Plot is huge and it could be reduced through adoption of sericultural technologies; intensive extension & training

activities by the concerned departments. The information generated information would be useful for policy makers to devise future developmental projects.

PPA3560: Studies on high bush mulberry plantation under rainfed conditions of Odisha [April 2014 - March 2019]

R. Sahu [PI upto March 2015], N. Rajeswar Rao [PI; upto May 2016] and S.K.Misro

Objective: To develop a package of practice for High Bush and Tree type mulberry plantation to avoid grazing problems in the state of Odisha

Two mulberry varieties (S1635 & C1730) saplings were rised from cuttings and transplanted in RBD at a spacing of 5' × 5', 6' × 6' and 8' × 8'. The plantation was maintained as tree type following prescribed package of practices for a period of two years (2015-2017). The plantation was pruned twice in a year at the crown height during June & January. The leaf yield (kg/plant) data along with other growth parameters viz., length of longest shoot, total shoots length (cm), wt. of 100 leaves (g), moisture content (%), moisture retention capacity (%) was recorded for two years. S1635 mulberry variety with the spacing of 8' × 8' recorded highest average leaf yield (1943g/plant) followed by C1730 (1765g) at 8' × 8'; S1635 (1452g) & C1730 (1288g) at 6' × 6'; S1635 (1236g) & C1730 (1067g) at 5' × 5' spacing. The average shoot length and total shoot length recorded was highest in S1635 mulberry variety followed by C1730 at 8' × 8'. The foliar diseases and pest incidence recorded was below ETL in all the treatments.

The data generated reveals that 8' × 8' wider spacing tree mulberry plantations are better for Odisha farmers. 25-30% more productivity could be achived with both S1635 & C1730 varieties. ECPs/ToTs programmes need to plan for further popularization.

Ongoing Projects

PPA 3613: Studies on drum kit drip irrigation with Hydrogel on yield and water use efficiency of mulberry [Dec 2017 - Nov 2020]

S.K Misro (PI) & K. Alam (from March 2019)

Objectives

- To study the water use efficiency on different treatments of Hydrogels
- To study the growth and yield performance of mulberry by application of Hydrogels

The data on leaf yield was recorded from six treatments with hydrogel and irrigation in three crops (Aug-Sept 2018, Oct-Nov 2018 & Feb-Mar 2019).

Treatment	Leaf yield (kg/ha/crop)		
	Aug-Sept 2018	Oct-Nov 2018	Feb-Mar 2019
Daily Irrigation with Hydrogel	4130.1	2907.0	5142.0
Daily Irrigation without Hydrogel	4025.5	2867.0	6203.0
Alternate day irrigation with Hydrogel	4412.0	3043.0	5336.0
Alternate day irrigation without Hydrogel	4304.0	2683.0	4386.0
No irrigation with Hydrogel	4683.2	2795.0	3524.0
No irrigation without Hydrogel	4300.5	2516.0	3493.0

AIB 3614: Evaluation and Identification of Suitable bivoltine hybrids for Odisha
[Dec 2017 – Nov 2019]

K.C.Brahma (PI; upto May 2018), S.K Misro (PI; from June 2018) & K. Alam (from March 2019)

Objective: To identify bivoltine hybrids with better productivity traits suitable for Odisha region

Silkworm hybrids from different R&D institutes (CSRTI-Berhampore: SK6 X SK7 & B.Con1 X B.Con4; CSRTI- Mysore: CSR50 X CSR51, CSR16 X CSR17, GEN3 x Gen2, CSR2 X CSR4 & FC2 x FC1; RSRS-Dehradun: Dun6 X Dun22; KSSRDI-Bangalore: KSO1 x SP2; APSSRDI-Hindupur: APS45 x APS12 & HTO5 x HTP5) were evaluated in three crops (Aug-Sept 2018; Oct-Nov 2018; Feb-Mar 2019). The rearing performance was documented for further analysis. The performance of FC1 x FC2 was better followed by HTO5 x HTP5.

Collaborative R&D Projects/Activities

RSRS-Koraput has the following four collaborative projects and two continous activities with the main institute. The unit is involved in the collection of data from experiments/farmers/DoS and the respective information is reported discipline wise.

1. PIB 3576: Evaluation of new mulberry genotypes for improvement in productivity and quality
2. PPS 3600: Soil health card preparation for mulberry growing soils in E & NE India
3. AIB 3617: Identification of region specific bivoltine hybrids suitable for highly fluctuating and seasonally variable climatic conditions of E & NE India
4. AIB3616: On-farm Trial of multivoltine silkworm breeds/hybrids developed for high shell percentage and neatness of silk filament
5. Forewarning of mulberry pest & diseases of Eastern and North Eastern India
6. Survey, surveillance and monitoring of silkworm diseases in seed and commercial crops

Extension Activities

Transfer of Technology Programmes: Three ToT programmes involing 2CRCs & 60 farmers with SK6 x SK7 bivoltine hybrids were conducted in Popularization of package of practices of chawki rearing (upto 33.16 kg/100 dfls) & Popularization of package of practices of late age rearing (upto of 43.20 kg/100 dfls)and Popularization of mounting and harvesting technology (upto of 41.61 kg/100 dfls).

Popularization of improved mulberry varieties: A total of 10 acre with high yielding varieties S1635, C2038 etc. was established in area of Kashipur & Rayagada districts of Odisha.

ECPs: RSRS-Koraput and REC-Dhenkikote organized a total of 29 Extension Communication Programmes (Awareness, Field day, Audio-Visual, Exhibition, Group Discussion, Technology Demonstration, Resham Krishi Mela cum Exhibition) and sensitized 1508 farmers on need-base sericulture technologies.

CPP: A total of 4700 dfls of bivoltine hybrids were distributed to the farmers under a cluster Kashipur and an average cocoon yield recorded was 38.26kg/100 dfls (7.76 MT bivoltine raw silk), whereas no dfls were takenup in the Ghatgaon cluster.

CBT Programmes: Nine officials/personnel from DOS-Odisha were trained under one Trainers Training Programme in sericulture at RSRS-Koraput. A total of 40 farmers were trained through Farmers Training Programme (FTP) on improved technologies in silkworm rearing and mulberry cultivation.

Seed Cocoon Generation: 861900 bivoltine seed cocoons (SK6 x SK7) were generated for NSSO-SSPCs in West Bengal by direct intervention by the unit at the farmer's level.

राजभाषा अनुभाग की उपलब्धियाँ

(वर्ष *2018- 2019*)

इस संस्थान में वर्ष 2018-19 के दौरान राजभाषा अधिनियम की धारा-3 (3) एवं राजभाषा नियम-5 जैसे अनिवार्य प्रावधानों का शत-प्रतिशत अनुपालन कर संघ की राजभाषा नीति का सम्यक अनुपालन सुनिश्चित किया गया है। संस्थान में राभाकास, नाराकस की बैठक तथा हिन्दी कार्यशाला, हिन्दी भाषा प्रशिक्षण, हिन्दी पखवाड़ा/दिवस और विविध हिन्दी प्रतियोगिता का आयोजन एवं प्रोत्साहन योजनाओं का कार्यान्वयन के आलवे हिन्दी पुस्तक/ पुस्तिकाओं का संपादन गया। संस्थान द्वारा आलोच्य अवधि के दौरान विभिन्न कार्यान्वयन बिन्दुओं पर की गई कार्रवाई का ब्यौरा निम्नवत है:

- धारा-3 (3) का अनुपालन: राजभाषा अधिनियम की धारा-3 (3) केअर्न्तगत आने वाले सभी कागजात अनिवार्य रुप से द्विभाषी में जारी किए गए।

- हिन्दी पत्राचार :वर्ष के दौरान 'क', क्षेत्र में क्रमश: 87.50%, तथा 'ग' क्षेत्र में 67.11% पत्र हिन्दी में प्रेषित कर राजभाषा विभाग, भारत सरकार द्वारा निर्धारित लक्ष्य से अधिक पत्राचार किया गया।

- हिन्दी प्रशिक्षण:आलोच्य अवधि के दौरान संस्थान के कुल 03 पदधारी [प्रवीण-02 एवं प्राज्ञ -01] के अंतर्गत उतीर्ण हुए। अब तक संस्थान के कुल 97.54% अधिकारी/कर्मचारी इस योजना के अन्तर्गत प्रशिक्षित हो चुके है।

- राजभाषा कार्यान्वयन समिति की बैठकों का आयोजन:आलोच्य वर्ष 2018-19के अंतर्गत राभाकास की चार बैठकें क्रमश: दिनांक 13.04.2018, 27.09.2018, 31.12.2018 एवं 14.02.2019 को आयोजित की गई।

- हिन्दी कार्यशाला का आयोजन: संस्थान में राजभाषा के विविध पहलुओं पर क्रमशः 25.06.2018, 26.09.2018, 01.12.2018 एवं 02.03.2019 को 04 हिंदी कार्यशालाएं आयोजित कर कुल 78 पदधारीगण [अधिकारी - 28 एवं पदधारी - 50] राजभाषा हिन्दी में प्रशिक्षित किए गए।

- अधीनस्थ कार्यालयों / केन्द्रीय रेशम बोर्ड के अन्य कार्यालयों आंबटित कार्यालयों में हिन्दी कार्यशाला: संस्थान के कुल 07 अधीनस्थ केन्द्रों में भी हिन्दी कार्यशालाओं का आयोजन किया गया।

- राजभाषा प्रोत्साहन योजना का कार्यान्वयन: केन्द्रीय रेशम बोर्ड की उदारीकृत प्रोत्साहन योजना के अंतर्गत हिन्दी में मूल रूप से टिप्पण-आलेखन करने वाले कुल 13 पदधारियों को हिन्दी दिवस/पखवाड़ा, 2018 के अवसर पर पुरस्कृत किया गया।

- हिन्दी पुस्तक / पुस्तिकाओं का प्रकाशन: वर्तमान वर्ष के अंर्तगत संस्थान की वार्षिक वैज्ञानिक एवं प्रशासनिक रिपोर्ट वर्ष 2017-18 का सारांश हिंदी में प्रकाशित करने के अतिरिक्त आलोच्य अवधि के दौरान रेशम कृषि मेला के अवसर पर "कोसा पालन की आदर्श पद्धति, पश्चिम बंगाल में शहतूत कृषि हेतु खर्च और उससे लाभ, सी-2038, बाढ ग्रसित तथा जल-जमाव वाले क्षेत्रों के लिए उन्नत शहतूत प्रजाति, वर्षाश्रित अंचल में शहतूत कृषि हेतु पद्धति, मृदा नमूना संग्रहण एवं शहतूत कृषि के लिए मृदा परीक्षण की प्रयोजनियता, सी-776 नमक वाले मृदा हेतु उन्नत शहतूत प्रजाति, शहतूत पर्ण का मुख्य रोग एवं इसके उपाय, पेब्रिन रोग हेतु परीक्षण पद्धति, सिचिंत अंचल में शहतूत कृषि के लिए प्रयोजनीय पद्धति एवं पहाड़ी अंचल में शहतूत कृषि के लिए प्रयोजनीय पद्धति" शीर्षक से 10 लीफ्लेट बंगला भाषा में प्रकाशित की गई।

- नगर राजभाषा कार्यान्वयन समिति का गठन एवं उसकी बैठकों का आयोजन: बहरमपुर नगर स्थित केन्द्रीय सरकार के कार्यालयों आदि में संघ की राजभाषा नीति के सफल कार्यान्वयन का अतिरिक्त दायित्व का निर्वहन करते हुए समिति की 35वीं बैठक दिनांक 28.05.2018 तथा दिनांक 01.12.2018 को 36वीं बैठक संपन्न की गई।

- राजभाषा नियम 10(4) के अर्न्तगत अधीनस्थ कार्यालयों को अधिसूचित किया जाना: राजभाषा नियम-10(4) के अधीन संस्थान के 06 संबद्ध कार्यालयों को अधिसूचित कराया जा चुका है।

- हिन्दी प्रतियोगिता का आयोजन: विगत वर्ष हिन्दी पखवाड़ा के दौरान 01/09/2018 से 14/09/18 तक कुल 04 हिन्दी प्रतियोगिताएं (शब्दावली,निबन्ध,सुलेख व श्रुतिलेख तथा हिंदी टिप्पण व आलेखन) प्रतियोगिता आयोजित कर सर्वश्रेष्ठ प्रतिभागियों पुरस्कृत किया गया।

- कंप्यूटर पर हिन्दी में कार्य: राजभाषा अधिनियम-1963 की धारा 3(3) का अनुपालन, फार्म/प्रपत्र का द्विभाषीकरण, संबद्ध/अधीनस्थ केन्द्रों की तिमाही रिपार्ट का समेकीकरण एवं अनुभागीय प्रगति रिपोर्ट के तुलनात्मक विवरण आदि के संकलन एवं पत्रिका के प्रकाशन/संपादन का कार्य तथा नगर राजभाषा कार्यान्वयन समिति की गतिविधियों संबंधी कार्य को कंप्यूटर पर सुचारू रूप से किया जा रहा है। राजभाषा कार्यान्वयन के विभिन्न पहलुओं में कंप्यूटर के प्रयोग की शुरूआत से राजभाषा कार्यान्वयन के कार्य में गति आई है।

ADMINISTRATIVE & FINANCIAL REPORT

STAFF PROFILE (2018-19)

Category	*MI*	*RSRS*	*REC*	*Total*
Director	1			1
Scientists				
Scientist-D	8	2	6	16
Scientist-C	1	1	2	4
Scientist-B	19	3		22
Technical				
Deputy Director (Computers)	1			1
Junior Engineer	2			2
Sr. Technical Asst.			1	1
Technical Asst.	56	19	21	96
Sr. Field Asst.			1	1
Field Asst.	1	3	10	14
Technician	8	1		9
Asst. Technician	5	2		7
Multi Tasking Staff	8	19	16	43
Skilled Farm Worker	42		5	47
Time-Scale Farm Worker	48		26	74
Accounts & Administration				
Deputy Director	1			1
Assistant Director	4			4
Superintendent	2	1		3
Asst. Supdt.	10	3	1	14
Stenographer-Grade-I		2		2
Jr. Translator (Hindi)	1			1
Staff Car Driver Grade-I	2	1	1	4
Stenographer-Grade-II	1			1
UDC	5	5		10
Staff Car Driver Grade-II	1	3		4
Cook	1			1
Total	228	65	90	383

Budget 2018-19 (Rs. In lakhs)

Non-Plan	Plan-Gen	Plan-Cap	NE		Total
			Gen	Cap	
3683.56	530.13	579.85	83.27	11.70	4888.51

R & D PERSONNEL

Director
Dr. Kanika Trivedy [Rtd on July 2018]
Ms. Chandna Maji [I/c upto Dec 2019 & Rtd on Jan 2019]
Dr. V. Sivaprasad [from Jan 2019]

CSRTI-BERHAMPORE

Scientist-D
Dr. Subhra Chanda [Rtd on Dec 2018]
Dr. Bimal Chandra Roy [Rtd on Jan 2019]
Mr. N. B. Kar [Rtd on Jan 2019]
Dr. Anil K. Verma
Mr. D. Das [upto May 2018]
Mr. Debashish Chakravarty
Dr. Dipesh Pandit
Mr. G. Mitra [from Sept 2018]
Mr. Gopal Chandra Das
Dr. Lakshmanan Velusamy
Dr. Soumen Chattopadhyay
Dr. Tapati Dutta (Biswas) [from May 2018]
Mr. Zakir Hossain [upto May 2018]

Scientist-C
Dr. Sukhabrata Sarkar

Scientist-B
Dr. Anil Pappachan
Dr. N. Chadrakanth
Dr. R. Mahesh
Dr. Manjunatha, G. R
Ms. Pooja Makwana
Mr. Rahul K
Mr. Shafi Afroz [study leave from 31.01.2018]
Mr. Suresh K
Dr. V. Vijay
Dr. Aparna Kopparapu [from Jan 2019]
Dr. Deepika Kumar Umesh [from Jan 2019]
Dr. Gangadhar Nanda [from Jan 2019 to March 2019]
Ms. Immanuel Chongboi Haokip [from Jan 2019]
Dr. Mihir Rabha [from Jan 2019]
Dr. Parameshwaranaik, J [from Jan 2019]
Ms. Radha, M. B [from Jan 2019]
Dr. Raviraj, V.S [from Jan 2019]
Dr. Thangjam Ranjita Devi [from Jan 2019]
Mr. Yallappa Harijan [from Jan 2019]

REC-Kamnagar
Dr. Tapati Dutta (Biswas) [upto April 2018]

REC-MOTHABARI
Dr. Satadal Chakrabarty, Scientist-D [from July 2018]

REC-BHANDRA
Dr. G. S. Singh, Scientist-D

REC-DHENKIKOTE
Mr Satyabrata Dey, Scientist-C [upto April 2018, Expired]
Dr. Subrat Satapathy, Scientist-C [from April to July 2018]
Dr. N. Balaji Chowdary, Scientist-D [from Aug 2018]

RSRS-KALIMPONG
Dr. Ranjit Kar, Scientist-D [Rtd on Oct 2018]
Mr Zakir Hossain, Scientist-D [from May 2018]
Dr. S. Harish Babu, Scientist-B [from Jan 2019]

RSRS-KORAPUT
Dr. K. C. Brahma, Scientist-D [Rtd on May 2018]
Mr S.K.Misro, Scientist-D
Mr. Khasru Alam, Scientist-B [from Jan 2019]

RSRS-JORHAT
Dr. S. N. Gogoi, Scientist-D [Rtd on Oct 2018]
Dr. U. C. Baruah, Scientist-D [Rtd on July 2018]
Ms Mina Pamegam, Scientist-D [upto July 2018]
Mr P. Kumaresan, Scientist-C [from July 2018]
Mr. Chandan M [from March 2019]

REC-MAMRING (RONGPO)
Mr S.T.Lepcha, Scientist-D

REC-IMPHAL
Dr. Reeta Luikham, Scientist-D [upto Oct 2018]
Dr. L. Somen Singh, Scientist-D [upto July 2018]

REC-DIMAPUR
Dr. A. Borah, Scientist-D [Rtd on May 2018]
Mr Intimokchung, Technical Assistant [from June 2018]

REC-MONGALDAI
Mr B. K. Basumatary, Scientist-D

REC-SHILLONG
Dr. Collin Z. Renthlei, Scientist-D

REC-AIZWAL
Dr. L. Pachuau, Scientist-C

REC-MP RAJ
Mr Anwarul Haque, Technical Assistant [upto Dec 2018]

REC-SILLE
Mr Subedar Pertin, Technical Assistant [upto July 2018]
Mr Lohit Sonowal, Scientist-C [from Aug 2018]

REC-AGARTALA
Dr. G.B.Singh, scientist-D [Rtd on Aug 2018]
Dr. L. Somen Singh, Scientist –D [from Aug 2018 to Oct 2018]
Mr. Haridhan Nama, Technical Assistant [from Oct 2018]

ADMINISTRATIVE PERSONNEL
Mr. Surendra Nath, (DD-A&A; Rtd. on July 2019)
Mr. Mirza Ibrahim Baig (DD-A&A; from Feb 2019)
Mr P.K.Prasad (DD-Computer)
Mr Biswajit Halder (AD-A&A)
Mr R. Krishna Murthy (AD-A&A; upto Sep 2018)
Mr Ram Briksh Choudhary (AD-OL)
Mr Sanatan Tiadi (AD-A&A)
Mr Subhasish Ghosh (AD-A&A; from Sep 2018)

RESEARCH ADVISORY COMMITTEE (RAC)

CHAIRMAN

Dr. Chirantan Chattopadhyay

Vice Chancellor, Uttar Banga Krishi Viswavidyalaya (UBKV), Pundibari, Coochbehar, West Bengal

MEMBERS

Dr. S. Nirmal Kumar Director (Rtd)-CSB #1169, II Main, II Cross, SRIRAMPURA, IIStage Mysore -570 023	Commissioner Director of Textiles 45 G.C. Avenue Kolkata -700013, West Bengal
Prof. Somnath Bhattacharya Bidhan Chanadnra Krishi Viswavidyalaya (BCKV) Mohanpur -741 252	Director of Sericulture Near Research Gate, P.O. Khanapara, Guwahati-781 022, Assam
Prof. D.C. Ghosh Prof. (Rtd) Agronomy Viswa Bharathi University Birbhum -731 235	Director of Handlooms Handicrafts & Sericulture Jawaharlal Nehru Complex, Gorkha Basti Agartala -799006, Tripura
Dr. S. Mukhopadhyay Principal Scientist & Head, GIS&RS ICAR-NBSS&LUP Bidhan Nagar, Koklata -700 091	Director of Textiles & Handloom Sahidnagar Bhubaneswar - 751 007 Odisha
Director (Technical) Central Silk Board Madiwala, BTM Layout, Bangalore - 560 068	Director of Sericulture & Weaving 3rd Sectt. (Nongkrek building), 2nd Phase, 2nd Floor Shillong - 793 001, Meghalaya
Scientist – D Reginal Silk Technological Research Station (CSB) # 76/B, I Floor, Monakamana Road Malda - 732 101	Director (Handloom & Sericulture) Dept. of Industries Vikas Sachivalaya, Patna- 800 015 Bihar
Md. Samsul Haque *Rearers Representative* Korjora Village, Block-Nabagram, Murshidabad - 742 184.	Director of Sericulture Resham Sanchanalaya, Kanij Bhawan, Ring Road Telibandh, Raipur-492006 Chhattisgarh
Md. Ebarat Ali *Reelers Representative* Dakshin Laxmipur Village, Kazigram, Kaliachak Malda - 732 201	Director of Sericulture Directorate of Industries III Floor, Nepal House, Doranda Ranchi - 834 002, Jharkhand
Director Boroland Territorial Council (BTC) Kokrajhar- 783370, BTAD, Assam	Director of Sericulture Aizawl -796001 Mizoram
Director of Sericulture Dept. of Forest & Environment Deorali, Gangtok-737102, Sikkim	Director of Sericulture P.O. Lamphelpat Imphal –795 004, Manipur
Director Directorate of Textiles & Handicrafts Itanagar - 791 111, Anunachal Pradesh	Director of Sericulture Kohima – 797001 Nagaland

MEMBER CONVENOR

Director, CSRTI-Berhampore

Highlights of
Results Framework Document (RFD)
2018-19

Success Indicator	Unit	Target	Achievement
Total on-going Projects	No.	18	26
Projects concluded	No.	8	11
New projects taken up	No.	7	3
Research projects (on-going) at RSRS's	No.	2	1
Technologies/innovations developed/likely to be from concluded projects	No.	2	2
New technologies for field testing	No.	2	2
Equipment/machines newly developed for sericulture mechanization	No.	1	1
Machines /equipment absorbed in the field	No.	1	
Technologies commercialized	No.	1	
Technologies applied for patenting (patents filed)	No.	1	
Farmers database created for m-Kisan portal	No.	1000	1402
Messages up-loaded in m-Kisan portal	No.	80	94
Up-loading of data in Seri-5k portal	No.	2000	7118
Research projects uploaded for E-monitoring	No.	12	17
Digitization of soil health records	No.	7000	8835
Preparation of technology descriptor adoption document	No.	5	4
Seri-model villages identified	No.	15	15
Farmers adopted	No.	1200	1210
Expected raw silk output	MT	40	36.74
Dfls proposed for large scale trial	No.	0.50	0.50
CPP cluster adopted	No.	15	15
Farmers covered	No.	2500	5566
Raw silk output	MT	80	212.48
Popularization of improved mulberry varieties	Acres	80	94.79
Villages covered under Swachha Resham Gram	No.	1	1
Adoption of villages	%	90%	90%
Farmers coverd under 100% adoption of technology	No.	1500	1540
Programmes conducted	No.	210	251
Farmers covered	No.	9500	12444
Post programme follow up	No.	90%	90%
Participation in Radio programmes	No.	12	11
Participation in TV programmes	No.	6	8
Success stories submitted for publication under various aspects	No.	6	7
Papers/ popular articles published like Indian Silk magazine	No.	10	14
Quality Video on all popular technologies developed by Institute	No.	2	2
Beneficiaries trained under structured & need based programmes etc.	No.	400	592
Revenue generation through commercialization of technology	Rs.in lakh	0.40	
Revenue generation through other methods	Rs.in lakh	20	21.308
Effective utilization of cultivable land for assigned mandates	Acres	32	32
Extent of utilization of facilities for the core purpose of assigned mandates	%	90%	90%
Utilization of scientific manpower for research activities	%	90%	90%
Projects taken up for collaborative research	No.	1	
RFD SCORE = 91%			

Capacity Building of Scientific Personnel (2018-19)

Personnel	Topic	Period	Institution
Mr. N. Chandrakanth Scientist-B CSRTI-Berhampore	Teaching & Learning of Molecular Biology & Enzymology through Hands on Expreience	18.09.2018 to 23.09.2018	NIIT Warangal
Dr.Manjunatha G.R Scientist-B CSRTI-Berhampore	Advanced Bioinformatic Tools & its Application in Agriculture	25.09.2018 to 29.09.2018	ICAR-NAARM Hyderabad
Dr. Ghanashyam Singh Scientist-D REC- Bhandra	Farmers Producer Organizations (FPO)	18.02.2019 to 20.02.2019	NABARD & DOS Raipur
Mr. D. Sarkar Technical Assistant CSRTI-Berhampore	Mass Production of Biocontrol Agents	10.03.2019 to 25.03.2019	RSRS (CSRTI-Mys) Salem

CSRTI-BERHAMPORE'S GRATEFUL FAREWELL

Employee	***Designation***	***Retirement/VR# /Expired****
Shri Satyabrata Dey	Scientist-C	09.04.2018*
Shri N.C. Saikia	Tech. Asst.	20.04.2019#
Shri Dharmendra Mishra	Staff car Driver	30.04.2018#
Mrs. L. A. Longchar	Asst. Supdt.	30.04.2018#
Dr. K.C.Brahma	Scientist-D	31.05.2018
Shri Bimal Ch. Mistri	MTS	31.05.2018
Shri Krishna Sankar Roy	Asst. Technician	30.06.2018
Shri Khogeswar Das	MTS	30.06.2018
Dr. Kanika Trivedy	Director	31.07.2018
Shri S.Surendranath	Dy. Director	31.07.2018
Shri Uttam Ch. Boruah	Scientist-D	31.07.2018
Smt. Anita Bhatta	Asst. Supdt.	31.08.2018
Dr. G.B. Singh	Scientist-D	31.08.2018
Shri Sunil Kr. Ghosh	Tech. Asst.	30.09.2018
Shri Santi Ranjan Saha	Tech. Asst.	30.09.2018
Dr. Ranjit Kar	Scientist-D	31.10.2018#
Dr. S. N. Gogoi	Scientist-D	31.10.2018
Smt. Y.L. Bhutia	Asst. Supdt.	31.10.2018
Smt. Narayani Gupta	Asst. Supdt.	31.10.2018
Sri J.N. Mahanta	Tech. Asst.	30.11.2018
Shri Kajal Kr. Bakshi	Technician	17.12.2018*
Dr. Subhra Chandra	Scientist-D	31.12.2018
Shri Tapan Kr. Dutta	Tech. Asst.	31.12.2018
Shri K.C.Das	Tech. Asst.	31.12.2018
Shri Subrata Chakrabarty	Supdt.	31.01.2019
Shri Sankar Chandra Das	MTS	31.01.2019
Smt. Chandana Maji	Scientist-D	31.01.2019
Dr. Bimal Ch. Roy	Scientist-D	31.01.2019
Shri N. B. Kar	Scientist-D	31.01.2019
Smt. Reba RoyChowdhury	Asst. Supdt.	31.01.2019
Shri Kajal Kr. Roy	Tech. Asst.	31.03.2019

PUBLICATIONS

Research Articles

Afroz, S., Asha, T., Manjunatha, G.R, Biswas, T.D. and Pandit, D. (2018). Skill gap analysis in silkworm rearing among farmers and extension workers in Eastern India. ***Indian Journal of Extension Education***, 54(***3***)***:*** 85-90 [NR-5.32].

Afroz, S., Asha, T., Manjunatha, G.R and Trivedy, K. (2018). Constraints faced by sericultural farmers of Murshidabad district with the Advisory Services of SMSs through m-Kissan portal. ***Journal of Community Mobilization and Sustainable Development***, 13(***3***)***:*** 554-560. [NR-5.30].

Chandrakanth, N. and Moorthy, S.M. (2019). Effects of mating temperature on female reproductive output and longevity in silkworm, Bombyx mori. ***IJRESM***, 2(1)***:*** 329-632.

Chandrakanth, N., Lakshmanan, V., Verma, A. K., Rahul, K. and Trivedy, K. (2018). Identification of potential thermo tolerant bivoltine silkworm breeds through phenotypic and molecular approach. ***Global Journal of Bio-science & Biotechnology***, 7(4): 525-530.

Chandrakanth, N., Lakshmanan, V., Verma, A.K., Suresh Kumar, N. (2018). Evaluation of silkworm hybrids tolerant to the high temperature and high humidity conditions of West Bengal***.*** ***IJRESM***, 1 (12): 633-636.

Jyothsna, T.S.S., Rahul, K., Dutta, S., Sasikala, Ch., Venkata Ramana, Ch.V. (2019). Phylogenetic diversity of sulfate-reducing bacteria of sediments of Chilika Lake, India, determined through analysis of the dissimilatory sulfite reductase (dsr AB) gene. ***3 Biotech***, 9:134 (https://doi.org/10.1007/s13205-019-1655-2).

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Pappachan, A., Rahul, K., Chakravarty, D. and Sivaprasad, V. (2019). Phylogenetic analysis of Paramyrothecium roridum causing brown leaf spot of mulberry. ***Int. Journal of Current Microbiology and Applied Sciences***, 8(3): 1393-1399. [NAAS-5.38].

Subhra, C., Manjunatha, G. R., Pappachan, A., Das, D. and Kanika T. (2018). Variation in the occurrence of major sucking pests on mulberry in West Bengal, India. ***Bioinfolet***, 15 (2): 207- 210 [NR-3.75].

Paper Presented in Conferences/Seminars /Symposia etc.

Manjunath, G.R., Afroz, S., Pandit, D. and Maji, C. (2019). Economics of mulberry cocoon production in West Bengal. ***6th Asia-Pacific Congress of Sericulture & Insect Biotechnology Conference (APSERI-2019)***, Mysuru (2-3 March 2019), *p.*33.

Suresh, K., Jhansi Lakshmi, K., Chakravarty, D., Lasker, D., Manjunatha, G. R., Ghosh, M. K., Trivedy, K. and Maji, C. (2019). Evaluation of drought tolerance in mulberry genotypes based on drought tolerance indices and morpho-physiological traits. ***APSERI-2019, Mysuru (2-3 March 2019)***, ***p. 85.***

Sivaprasad, V. (2019). Research prospects and perspectives in mulberry silkworm, *Bombyx mori*. ***APSERI-2019, Mysuru (2-3 March 2019),*** *p.* 62.

Sivaprasad, V., Moorty, M., Paramesh, B. Bindhiya, B., Hukkeri, S.M., Grekov, D. and Tzenov, P. (2019). Evaluation of Bulgarian silkworm genotypes in Indian conditions and development of high silk content silkworm hybrid. ***APSERI-2019, Mysuru (2-3 March 2019),*** *p.* 76.

Sivaprasad, V., Chandrasekhar, K.V., Kulkarni, S.B., Soudamini, P.V., Dayananda, Morrison N. and Shankara (2019). Field performance of improved cross breed, MV1 x S8 (Cauvery Gold) for cocoon productivity and silk quality. ***APSERI-2019, Mysuru (2-3 March 2019),*** *p.* 100.

Sivaprasad, V., Satish, L., Mallikarjuna, G., Moorty, M. and Mary Joseph, A.V. (2019). Pebrine monitoring in silkworm breed maintenance and multiplication units through modified lamp (Loop-mediated isothermal amplication) assay. ***APSERI-2019, Mysuru (2-3 March 2019),*** *p.* 104.

Popular Articles

Datta Biswas, T., Saha, A.K., Bindroo, B.B. and Nirmal Kumar S. (2018). Seed crop production in West Bengal: Scope for improvement***. Indian Silk***, Vol.9 (57 old) No.3-4, pp. 12-13***.***

Sarkar, S., Karmakar, S., Pandit, D., Manjunath, G.R., Afroz, S., Das, D., Dutta Biswas, T. and K. Trivedy (2018). A report on Resham Krishi Mela organized at CSRTI-Berhampore (Jan 2018). ***Indian Silk***: Feb.to April, 2018, p.43.

Sarkar, S., Karmakar, S., Manjunath, G.R., Pandit, D.and Trivedy, K. (2018). A report on visit of Shri Keshari Nath Tripathi, Hob'ble Governor of West Bengal to CSRTI-Berhampore (6th Feb 2018). ***Indian Silk***: Feb. to April, 2018, p.31.

Manuals/Books/Book Chapters

Afroz, S., Manjunatha, G.R., Tapati, D.B., Dipesh Pandit, Bimal, C. R. and Kanika Trivedy (2019). ***Training Manual on Sericulture for Eastern India*** (CSRTI-Berhampore). pp.107

Ramesh, D., Manjunatha, G.R., Mishra, P., Tailor, A. K. and Dhekale B.S. (2018). ***Design of experiment, Essentials of Statistics in Agricultural Sciences*** (Apple Academic Press). pp. 73-142.

Collin Z. Renthlei (2018). Silkworms Rearing Techniques in Meghalaya (DOS-Meghalaya)

Collin Z. Renthlei (2018). Techniques for Mulberry Cultivation and management in Meghalaya (DOS-Meghalaya)

Sequences published in NCBI

Acession Number	Organism Indentified	Source
LR535736	*Bacillus zhangzhouensis*	Mulberry phylloplane (Biocontrol agent)
LR027882	*Paramyrothecium roridum*	Mulberry Brown Leaf Spot

Magazine by CSRTI-Berhampore

News & Views - Half Yearly R&D News Bulletin [English]

Kishan Barta - Quarterly R&D News Bulletin [Bengali]

Pamphlets

Language (State)	Topic	Unit
Assamese (Assam & BTC)	Nuni Khetit Baga Machir Pradurbhab Aru Iyar Pratikar Nuni Gach Narcharir Koushal Nuni Khetitr Pratipalan Nuni Khetit Milibag Aru Iyar Pratikar Chalukiya Pat Palupalan Pat Palur Bemar Aru Niyantran	RSRS-Jorhat REC-Mangaldoi
Bengali (West Bengal & Tripura)	Parinat palupalaner adarsha padhwati Paschimbange tut chaser kharach o labh Bristinirbhar Anchale Tut Chasher Prayojaniya Paddhatisamuha Sechsebit Anchale Tunt Chasher Prayojaniya Paddhatisamuha Parbatya Anchale Tunt Chasher Prayojaniya Paddhatisamuha C-776 Upakuliya Labanakta Anchaler Matir Jany Unnata Tut Prajati C-2028 Banyapraban/Jalplabit Elakar Jany Ekti Unnata Tut Prajati Parinata Polupalaner Adarsha Paddhati Matir Namuna Sangraha Ebang Tunt Chashe Mati Parikshar Prayojaniyata Tunt Patar Pradhan Rog O Tar Pratikar Pebrine Roger Anubikshanik Parikshar Paddhati Resham Pokar Dim Jharai Ba Brushing Paka Pokar Chandrakikaran Ba Mounting Sech Elakay Tut Chashe Utkristaman O Falaner Jany Karaniy Bishay Tut Gache Sada Machir Pradurbhab Ebang Tar Niyantra-Parikalpana Tut Gacher Rog O Pratikarer Upay Ghar Sodhon	CSRTI-Berhampore REC-Mothabari REC-Tripura
Khasi (Meghalaya)	Mulberry cultivation, its management & silkworm rearing Cocoon deflossing technique Muga diseases management & its food plant Plastic mountage Rotary Mountage	REC-Shillong
Oriya (Odisha)	Mulberry Sericulture & Rearing Room 2nd Year Onward Maintenance of Mulberry Garden Success thrips for mulberry bivoltine sericulture production in Odisha	RSRS-Koraput REC-Dhenkikote
Tangkhul (Manipur)	A comprehensive guide to use plastic mountages	REC-Imphal
English	Silkworm Diseases and Pest Management Mulberry cultivation Shoot rearing technologies for late age silkworm rearing in North-East India Method of brushing of silkworm eggs Mounting technology of ripen silkworm Package of practices for mulberry under rainfed condition Package of practices for mulberry under irrigated condition Package of practices for mulberry under Hilly condition Method of brushing of silkworm eggs Mounting technology of ripen silkworm Management of major foliar diseases of mulberry Microscopic examination for detection of Pebrine Soil sampling and its importance in mulberry cultivation	CSRTI-Berhampore & Nested Units

METEOROLOGICAL DATA

IMD Regional Centre @ CSRTI-BERHAMPORE (24°6'N, 88°15'E, 19m >MSL)

Month	Temp. (°C)		R H (%)		Rainy Days	Rain-Fall	Avg. Wind Velocity	Avg. Bright Sunshine	Avg. Evaporation
	Max.	Min.	Max.	Min.	(No.)	(mm)	(kmph)	(Hrs/day)	(mm/day)
April 2018	37.4	19.6	93	38	6	116	4.1	4.2	3.4
May 2018	37.0	20.0	94	47	5	95	4.2	4.6	4.6
June 2018	38.8	23.0	94	60	8	140	4.0	5.8	4.9
July 2018	36.4	23.4	98	65	15	280	4.4	4.4	3.5
Aug 2018	38.0	25.2	94	66	9	170	3.2	4.8	4.1
Sept 2018	36.6	20.2	95	68	7	196	3.0	6.6	5.3
Oct 2018	36.2	20.6	95	61	4	74	2.8	5.2	3.6
Nov 2018	34.0	14.0	97	60			1.6	7.1	3.4
Dec 2018	31.0	7.0	95	52	1	24	3.7	6.9	2.6
Jan 2019	27.2	9.0	88	44	1	10	2.4	3.3	1.7
Feb 2019	32.4	10.2	91	47	4	49	2.4	3.2	2.4
Mar 2019	38.0	13.2	92	47	3	17	2.5	4.8	3.6
Total/Avg	35.2	17.1	93.8	54.5	63	1171			

RSRS-Kalimpong

Month	Temp. (°C)		R H (%)		Rain-Fall	Rainy Days
	Max.	Min.	Max.	Min.	(mm)	(No.)
April 2018	31	13	98	22	6.7	11
May 2018	31	14	100	38	67.6	16
June 2018	33	19	100	48	26.9	13
July 2018	36	21	100	39	76.4	24
Aug 2018	36	21	100	40	146.3	22
Sept 2018	33	19	100	41	86.4	18
Oct 2018	31	21	98	19	2.3	5
Nov 2018	29	11	98	31	0.4	2
Dec 2018	24	5	100	25	1.9	2
Jan 2019	24	7	94	16	0.2	1
Feb 2019	26	7	100	26	7.4	8
Mar 2019	29	7	96	27	7.0	7
Total/Avg	30.3	13.8	98.7	31.0	429.5	129

RSRS-Koraput

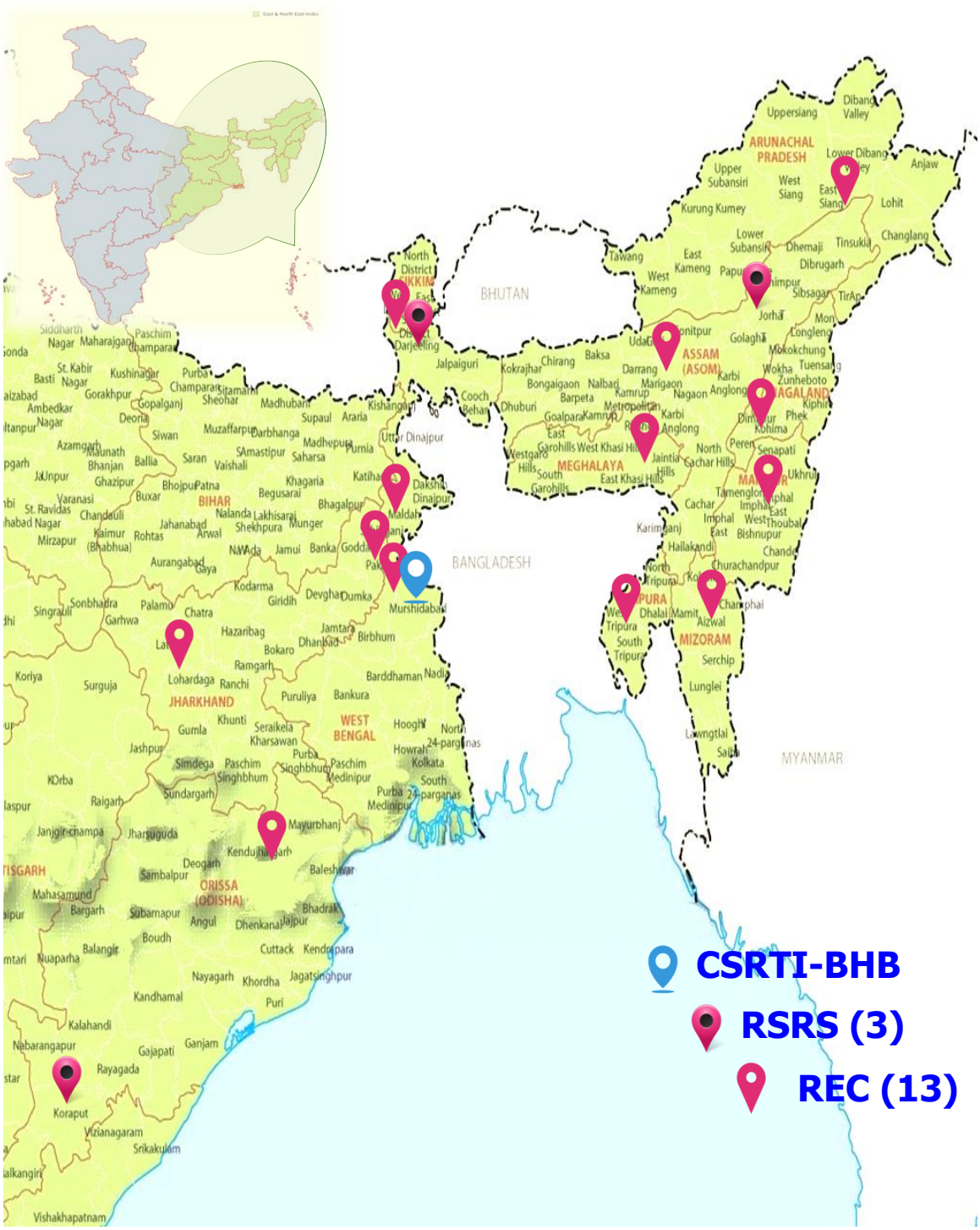
April 2018	20	32	49	69	67.2	5
May 2018	20	35	39	84	62.8	7
June 2018	21	33	58	91	93.9	10
July 2018	18	28	70	100	584.8	28
Aug 2018	21	28	76	100	669.7	27
Sept 2018	20	29	64	100	256.3	17
Oct 2018	16	29	36	100	23.0	3
Nov 2018	12	27	29	91	9.0	1
Dec 2018	11	26	34	100	25.9	3
Jan 2019	11	24	38	90	2.0	2
Feb 2019	13	30	24	90		0
Mar 2019	18	35	27	92	3.8	1
Total/Avg	16.8	29.7	45.3	92.3	1798.4	104

RSRS-JORHAT						***REC-MANGALDOI***					
Month	Temp. (°C)		R H (%)		Rain-Fall	Month	Temp. (°C)		R H (%)		Rain-Fall
	Max.	Min.	Max.	Min.	(mm)		Max.	Min.	Max.	Min.	(mm)
Apr-18	29	18	86	58	114	Apr-18	30	21	91	63	188.5
May-18	32	21	87	52	191.2	May-18	36	19	91	64	294
Jun-18	33	21	86	52	41.6	Jun-18	39	22	92	62	378
Jul-18	35	20	87	72	45	Jul-18	38	25	93	63	400
Aug-18	38	27	86	71	49.1	Aug-18	39	26	92	63	297
Sep-18	33	30	84	69	74.2	Sep-18	37	24	92	68	161.5
Oct-18	33	25	86	72		Oct-18	32	19	92	64	24
Nov-18	28	18	86	69	30	Nov-18	31	13	91	63	90
Dec-18	22	18	71	52	32	Dec-18	26	10	90	61	116.5
Jan-19	22	16	70	59	14	Jan-19	26	9	89	51	0.5
Feb-19	23	17	72	63	30	Feb-19	28	10	90	55	8.5
Mar-19	23	19	81	62	85	Mar-19	28	10	90	51	66.5
Total/Avg	29.3	20.8	81.8	62.6	706.1	Total/Avg	32.5	17.3	91.1	60.7	2025
REC-DIMAPUR						***REC-AIZWAL***					
Apr-18	30.3	26.1	76.0	65.8	10.3	Apr-18	34.0	7.1	98	52	115
May-18	27.8	25.4	80.1	68.1	15.1	May-18	33.5	7.0	98	54	232
Jun-18	29.2	24.3	85.6	68.5	26.52	Jun-18	31.8	10.8	97	84	463
Jul-18	32.2	29.0	86.1	77.1	18.03	Jul-18	30.9	11.7	98	90	224
Aug-18	34.2	25.6	82.8	75.6	379.3	Aug-18	30.4	12.3	98	88	420
Sep-18	33.4	25.1	84.1	75.8	25.3	Sep-18	31.7	14.2	98	85	125
Oct-18	31.7	21.0	83.2	73.1	4.65	Oct-18	32.7	11.2	98	80	89
Nov-18	27.3	20.6	72.5	63.8		Nov-18	32.8	10.0	98	77	2
Dec-18	22.3	13.3	73.4	64.7		Dec-18	25.6	7.0	98	76	
Jan-19	22.7	13.6	73.5	64.1		Jan-19	28.6	11.4	98	90	
Feb-19	22.6	13.4	73.0	67.8		Feb-19	31.0	13.0	96	72	42
Mar-19	26.9	19.3	74.1	65.4	18.1	Mar-19	30.4	13.5	96	62	37
Total/Avg	28.4	21.4	78.7	69.1	497.3	Total/Avg	31.1	10.8	97.6	75.8	1749
REC-AGARTALA						***REC-SHILLONG***					
Apr-18	33	20	96	60	180.5	Apr-18	25.8	11	97	37	166
May-18	32	21	92	70	527	May-18	26.5	12	99	39	184.4
Jun-18	32	24	96	73	411.5	Jun-18	27.3	14.7	100	62	166.7
Jul-18	33	24	92	70	224.5	Jul-18	29.1	17.2	97	53	305
Aug-18	32	25	92	73	73	Aug-18	28.2	15.7	97	58	270.2
Sep-18	34	23	92	58	57.14	Sep-18	25.9	15.3	97	66	476.8
Oct-18	30.5	21.5	92	64	21.38	Oct-18	24.9	12.5	96	72	128.1
Nov-18	28	18	92	53	70.18	Nov-18	22.4	7.2	96	49	26.3
Dec-18	25	11.5	91	56	2.67	Dec-18	20.0	3.9	95	59	10.2
Jan-19	25	12.5	90	46		Jan-19	18.7	4	93	20	
Feb-19	27	15	95	43	45.45	Feb-19	19.3	4.1	91	27	30.3
Mar-19	31	14	91	48		Mar-19	23.4	6.1	92	35	10.3
Total/Avg	30.2	19.1	92.6	59.5	1613	Total/Avg	24.3	10.3	95.8	48.1	1774

Mulberry Acerage (ha) in East & North East India					
States	2015-16	2016-17	2017-18	2018-19	Growth Rate
Arunachal Pradesh	341	100	140	300	9%
Assam & BTC	7765	7898	8594	2783	-64%
Bihar	743	421	557	598	-20%
Chhattisgarh	771	322	261	261	-66%
Jharkhand	372	372	472	502	35%
Manipur	7338	7548	3590	3300	-55%
Meghalaya	3009	3209	3209	3209	7%
Mizoram	3843	4009	4094	4094	7%
Nagaland	743	290	290	394	-47%
Odisha	584	686	464	537	-8%
Sikkim	198	198	185	185	-7%
Tripura	3161	2450	2184	1935	-39%
West Bengal	15500	15990	16480	15400	-1%
India	208947	216810	223927	235001	13%
E & NE Share (%)	21%	20%	18%	14%	

Mulberry Raw Silk Production (MT) in East & North East India					
States	2015-16	2016-17	2017-18	2018-19	Growth Rate
Arunachal Pradesh	3	2	2.3	3.3	11%
Assam & BTC	39	52	59	69	77%
Bihar	19	23	17	7.6	-60%
Chhattisgarh	9	8	8.3	8.9	-1%
Jharkhand	3	1	3	3.1	2%
Manipur	144	161	92.5	137	-5%
Meghalaya	15	28	39	49	229%
Mizoram	55	65	75	83	51%
Nagaland	7	8	12	13	87%
Odisha	3	3	3	2.8	-8%
Sikkim	4	6	0.001	0.4	-91%
Tripura	52	75	87	230	342%
West Bengal	2351	2524	2570	2365	1%
India (mulberry rawsilk)	20478	21273	22066	25344	24%
E & NE Share	13%	14%	13%	12%	
India (Total Raw Silk)	28523	30348	31906	35468	24%
Mulberry Raw Silk Share	72%	70%	69%	71%	

CSRTI-BERHAMPORE
EXTENSION NETWORK



Shri K. Hanumantharayappa (Chairman-CSB)
@ RKM-Berhampore-West Bengal

Shri R R Okhandiar (Member Secretary-CSB)
@ CSRTI-Berhampore

Shri R R Okhandiar @ SMV-Barbakpur (Nadia)

PGDS Convocation @ CSRTI-Berhampore

केंद्रीय रेशम उत्पादन अनुसंधान एवं प्रशिक्षण संस्थान
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