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प्रस्तावक
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निदेशक, केंरेउअप्रसं-बहरमपुर

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प्रस्तावना

केरेउअवप्रसं, बहरमपुर शहतूती रेशम के क्षेत्र में अनुसंधानात्मक एवं विकासात्मक सुविधाओं से परिपूर्ण, केंद्रीय रेशम बोर्ड के अधीन एक अग्रणी संस्थान है। यह संस्थान, पूर्वी तथा उत्तर-पूर्वी भारत के शहतूती रेशम कृषकों के उपयोगार्थ उन्नत रेशमकीट नस्लें, अधि-उपज वाली शहतूत प्रजातियों के विकास के साथ ही रेशमकीट संबंधी अत्याधुनिक जानकारी तथा संचार प्रौद्योगिकी, संरक्षण एवं उत्पादन में वृद्धि तथा इसके प्रचार-प्रसार हेतु सतत सक्रिय भूमिका अदा करते आ रहा है।

केरेउअवप्रसं, बहरमपुर के लिए विगत वर्ष अर्थात् 2019-20 पुनः एक बार सर्वोत्कृष्ट साबित हुआ। संस्थान द्वारा, इस दौरान हितधारकों को रेशम कृषि से जुड़े प्रौद्योगिकी तथा वैज्ञानिक उत्कृष्टता को सहयोगियों और उत्तर तथा उत्तर-पूर्वी भारत के रेशम निदेशालयों के समन्वय एवं सहयोग से मुहैया कराया गया। इसके अतिरिक्त, विगत वर्ष हितधारकों के लाभार्थ अनुसंधान एवं विकास कार्यक्रमों का अधिक सुसंगत व प्रभावी क्रियान्वयन का भी साक्षी रहा है। वर्तमान समय में, केरेउअवप्रसं, बहरमपुर द्वारा रेशम अनुसंधान के कतिपय रुझानों पर अपनी बेहतर स्थिति का लाभ उठाने के साथ ही शहतूत पर्ण चित्ती तथा एंटीफंगल पेप्टाइड के माध्यम से मूल विगलन रोग के उन्मूलन; पर्यावरण एवं उपयोगकर्ता के अनुकूल प्रभावी निर्मूल नामक एक सामान्य रोगाणुनाशी; शहतूत पारिस्थितिकी- तंत्र में मृदा जैविक स्वास्थ्य हेतु एक आदर्श, तीव्र एवं सरल मूल्यांकन पद्धति; आशाजनक अधि-उपज व सूखा सहिष्णु शहतूत जीनप्ररुप; पौधरोपण प्रणाली; 12Y x BFC1, एक उन्नत संकर; क्षेत्र विशिष्ट द्विप्रज डबल संकरों (BHP & WB)का नव-आरंभ; रेशमकीट में उच्च आर्द्रता के लिए निर्णायक आणविक मार्कर; AICEM-IV चरण प्रारंभिक प्रक्षेपण; मृदा स्वास्थ्य कार्ड कार्यक्रम; सुवर्णा प्रोटोटाईप [आदिप्ररुप]; पीड़क प्रबंधन आदि हेतु जैवनियंत्रण एजेंटो जैसे अभियानों का संचालन उत्पादकता एवं गुणवत्ता में उन्नयन हेतु ठोस वैज्ञानिक आधार पर किया जा रहा है। हम, अपना ध्यान निस्तारी के उन्नयन, उच्च तापमान एवं उच्च आर्द्रता सहिष्णु रेशमकीट नस्लों, रोग प्रतिरोध, उत्परिवर्तन प्रजनन, पर्ण गुणवत्ता में सुधार, एप्टामर प्रौद्योगिकी, उपोत्पाद का उपयोग, उपयुक्त मशीनीकरण, अपशिष्ट भू-खंड का विकास एवं आईएफएस पर केंद्रित कर इन क्षेत्रों में सुयोग व संभवानाओं की पहचान कर अपने कार्य को और भी व्यापक बनाने हेतु सतत प्रयासरत हैं।

हमने, पिछले कुछेक वर्षों के दौरान अपने मिशन को सफल बनाने हेतु वैज्ञानिक सौष्ठव के साथ ही रचनात्मक प्रक्रियाओं का भी उपयोग किया है। समय के साथ यह सुस्पष्ट हो गया है कि प्रौद्योगिकी हस्तांतरण के लिए बारम्बार एक ही प्रक्रिया को अपनाये जाने से सकारात्मक परिणाम प्राप्त नहीं होते हैं। साथ ही, सफल प्रौद्योगिकी को अपनाने के लिए अपनी तरह के नवाचार की आवश्यकता होती है। अब, रेशम अनुसंधान के विस्तार में विश्वविद्यालयों @ कल्याणी, मोहनपुर, उत्तर बंगाल, रायगंज, किशनगंज एवं मैनेज-हैदराबाद की साझेदारी व सहयोग तथा उनकी विशेषज्ञता मददगार साबित हो रहा है। हम रेशम कृषि से जुड़े लोगों को लाभान्वित करने के लिए संपूर्ण क्षेत्र में आईसीएआर-केवीके के साथ पहुंच से परे [आउटरीच] कार्यक्रम की शुरुआत करने का भी प्रयास कर रहे हैं। हमने, इस वर्ष हितधारकों को परिणाम-उन्मुखी टीओटी कार्यक्रमों के माध्यम से महत्वपूर्ण इनपुट प्रदान करने की प्रयास की। साथ ही, संस्थान के सहकर्मियों द्वारा नवीनतम तकनीकी इनपुट एवं क्षमता निर्माण कार्यक्रमों को अभिनव तौर पर डिजाइन कर इसे हितधारकों तक प्रभावी रुप से पहुंचाने के अतिरिक्त इसे प्रभावी ढंग से क्रियान्वित भी किया गया। माननीय प्रधानमंत्री द्वारा उनके 'मन की बात' कार्यक्रम के दौरान बिहार में कोसा हस्तशिल्प प्रशिक्षण कार्यक्रम को एक प्रेरणादायी कार्य के तौर पर उल्लेखित किया। इसमें कोई संदेह नहीं है कि अगले वर्ष भी इस क्षेत्र में और अधिक उपज के साथ नवीनता व प्रवीणता आएगी, क्योंकि हम कृषकों की आजीविका को बेहतर बनाने के लिए सतत तौर पर बेहतर गुणवत्ता के साथ अधिक रेशम उत्पादन करने की दिशा में सर्वदा क्रियाशील व सक्रिय है।

केरेउअवप्रसं, बहरमपुर के बहु-विषयक दल का ठोस व समर्पित प्रयास क्षेत्र में बड़ी संख्या में हितधारकों को प्रभावी प्रौद्योगिकियां मुहैया कराने व समर्थन के लिए अनवरत जारी रहेगा।

[डॉ. वी. शिवप्रसाद]
निदेशक

FOREWORD

CSRTI @ Berhampore under the aegis of Central Silk Board is the leading sericulture R&D facility which develops and deploys improved silkworm breeds, high yielding mulberry varieties, cutting edge information and communication technology for cultivation, protection, production for mulberry sericulture farmers in Eastern & North Eastern India.

CSRTI-Berhampore again had an excellent twelve months delivering sericulture technology and scientific excellence to the stakeholders with the coordination & cooperation of the collaborators, the DOSs of Eastern & North Eastern India. The past year has seen more coherent implementation of R&D programmes for the benefit of stakeholders with growing impact. Today CSRTI-BHP is well positioned to capitalize on a number of trends in sericulture research including Novel process to suppress mulberry leaf spot and root rot through antifungal peptide; NIRMOOL, an eco- and user-friendly effective general disinfectant; A novel, rapid and simple assessment method for soil biological health in mulberry ecosystem; Promising high yielding & drought tolerant mulberry genotypes; Tree plantation systems; 12Y x BFC1, an improved crossbreed; Novel introduction of region-specific bivoltine double hybrids (BHP & WB); Breakthrough molecular markers for high humidity in silkworms; Early launch of AICEM-IV phase; Soil Health Card programme; Suvarna prototype; Biocontrol agents for pest management etc. driven by strong scientific basis to improve the productivity and quality. We are trying to broaden our work to identify opportunities focusing on Nistari improvement, High temperature & high humidity tolerant silkworm breeds, Disease resistance, Mutation breeding, Leaf quality improvement, Aptamer technology, By-product utilization, Appropriate mechanization, Waste land development & IFS.

Over the years, we've pursued that mission with scientific excellence and sometimes in creative ways. Time has come to realize that in technology transfer, the beaten path(s) doesn't always lead to results, and successful technology adoption requires its own kind of innovation. Expertise is now helping expand research by partnering with the Universities @ Kalyani, Mohanpur, North Bengal, Raiganj, Kishanganj & MANAGE-Hyderabad. We are also looking forward to establish outreach programmes with ICAR-KVKs across the region to benefit the sericulture fraternity. This year we tried to provide critical inputs to the stakeholders through result-oriented ToT programmes. Latest technological inputs and capacity building programmes were innovatively designed and executed effectively by my colleagues to reach stakeholders effectively. Cocoon Handicraft's training programme in Bihar found a mention in Prime Minister's Mann-Ki-Baat programme as an inspiration. No doubt that the next year will yield even more innovation and ingenuity as we venture to produce more silk with improved quality in a sustainable manner to enliven farmer's livelihoods.

The concerted and dedicated efforts of multi-disciplinary team @ CSRTI-Berhampore would continue to deliver and support large number of stakeholders in the region with impacting technologies.

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 77वाँ 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।

दृष्टि

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

मिशन

- प्रमुख (थ्रास्ट) 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

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।

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 9 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 आयोजित किए जाते हैं। केरेउअवप्रसं, बहरमपुर स्नातकोत्तर 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 77th 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.

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

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.

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), 9 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-government 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.

अनुसंधानात्मक एवं विकासात्मक उपलब्धियां

केन्द्रीय रेशम उत्पादन अनुसंधान एवं प्रशिक्षण संस्थान, बहरमपुर अपने तीन अधीनस्थ क्षेत्रीय रेशम उत्पादन अनुसंधान केन्द्रों [क्षेरेउअके] तथा नौ अनुसंधान विस्तार केन्द्रों [अविके] 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। मुख्य उपलब्धियाँ निम्नानुसार हैः

शहतूत फसल सुधार तथा संरक्षण

- पांच आशाजनक सूखा सहिष्णु एवं अधि-उपज शहतूत जीनप्ररुपों (PYD-1, PYD-4, PYD-7, PYD-8 & PYD-21) की पहचान वर्षाश्रित अवस्था हेतु सूखा सहिष्णु (C-1730) की अपेक्षा >15% तथा रुलिंग चेक प्रजाति (C-2038) की तुलना में >6% पर्ण उपज सुधार समेत की गई।
- PRE-2 का विकास, माइरोथेशियम रोरिडम (पर्ण चित्ती; एमएलएस) एवं फुसैरियम सोलानी (शुष्क मूल विगलग; एफआरआर) के कारण होने वाले फंगल रोगों को अप्रत्यक्ष तौर पर समाप्त करने के लिए किया गया।
- ओडिशा में, एकदिन के अंतराल पर हाइड्रोजेल का अनुप्रयोग कर ड्रम किट टेप सिंचाई मितव्ययी (BCR of 1:1.37) होने के साथ ही साथ पर्ण उपज (4.78 मीट/फसल) में भी प्रभावी पाया गया।
- अधि-उपज शहतूत जीनप्ररुपों (PPY-8, PPY-10, PPY-24, PPY-7, PPY-20 & PPY-6) की पहचान चेक प्रजाति (C-2038) की अपेक्षा 10-35% सुधार सहित बेहतर गुणवत्ता व निम्न पीडीआई समेत की गई।
- अधि-उपज शहतूत जीनप्ररुपों (C-01 & C-11) की पहचान सिंचित (>30%) तथा वर्षाश्रित (>20%) अवस्था के अधीन S1635 की अपेक्षा सुधार समेत की गई।
- शहतूत पारिस्थितिकी - तंत्र में मृदा जैविक स्वास्थ्य हेतु एक आदर्श, तीव्र एवं सरल मूल्यांकन प्रणाली की पहचान की गई।

रेशमकीट फसल सुधार व संरक्षण

- पूर्वी तथा उत्तर-पूर्वी राज्यों (औसत उपज: ~52किग्रा के साथ N x SK6.7 की अपेक्षा ~10% सुधार) में 12Y x BCon1.4 (12Y x BFC1) की पहचान आशाजनक बहु x द्वि संकर के तौर पर ओएफफटी के माध्यम से की गई।
- SK6 x SK7 & Bcon1 x Bcon4 (औसत उपज: ~65किग्रा) की अपेक्षा उन्नत कवच के साथ द्विप्रज डबल संकर (BHP3.2 x BHP8.9)विकसित की गई।
- ओडिशा में, FC1 x FC2 की पहचान सर्वोत्कृष्ट द्विप्रज संकर के तौर पर ओएसटी के माध्यम से की गई।
- शहतूत के माध्यम से रोडोपस्यूडोमोनस एसपीपी अशन कराकर स्टैफिलोकोकस एसपी द्वारा फ्लैचरी के विरुद्ध उत्तरजीविता में 16% सुधार दर्ज की गई।
- निर्मूल नामक एक सामान्य रोगाणुनाशी का विकास रेशम कीटपालन गृह एवं उपकरणों को विसंक्रमित करने हेतु की गई।

- ताप-सहिष्णु द्विप्रज संकरों (WB7.5 x WB1.3 & KA19.WB5 x WB1.3) की पहचान प्रतिकूल मौसमों में और आगे के मूल्यांकन के लिए किया गया।
- रेशमकीट में आर्द्रता सहिष्णुता के लिए आण्विक मार्कर्स (pyx1 व pyx2) का विकास किया गया।
- सुवर्णा के प्रोटोटाईप [आदिप्ररुप] (संशोधित चरखा) का डिजाइन उन्नत दक्षता हेतु किया गया।

प्रौद्योगिकी हस्तांतरण

- कृषकों में मृदा स्वास्थ्य कार्ड (18076) का संवितरण किया गया।
- जैव-नियंत्रण एजेंटों, स्किम्नस बीटल्स (चूर्णी मत्कुण) एवं क्राइसोपरला (थ्रिप्स) मास प्रगुणन का संस्थापन कृषकों को आपूर्ति करने हेतु की गई।
- पूर्वी तथा उत्तर-पूर्वी भारत में क्लस्टर संवर्धन कार्यक्रम (13 क्लस्टर) के द्वारा 102.87 मैट्रिक टन द्विप्रज कच्चे रेशम (16.23 लाख़ रोमुच; औसत उपज: 49.37 किग्रा/100 रोमुच) का उत्पादन किया गया।
- पूर्वी तथा उत्तर-पूर्वी भारत में क्लस्टर संवर्धन कार्यक्रम (8 क्लस्टर) के द्वारा 92.65 मैट्रिक टन आईसीबी कच्चे रेशम का (17.18 लाख़ रोमुच; औसत उपज: 44.00 किग्रा/100 रोमुच) उत्पादन किया गया।
- 14845 हितधारकों को अभिनव रेशम प्रौद्योगिकियों पर 266 ईसीपी के माध्यम से प्रशिक्षित किया गया।
- कुल 5753 कृषकों को एम-किसान पोर्टल के माध्यम से विभिन्न भाषाओं (बंगला, हिंदी, ओड़िया, नेपाली) में 71 वैज्ञानिक परामर्श/संदेश संप्रेषित की गई।

दक्षता निर्माण व प्रशिक्षण

- केरेउअवप्रसं, बहरमपुर के 63% पीजीडीएस छात्र पब्लिक सेक्टर में कार्यरत हैं तथा उनमें से अधिकांश रेशम कृषि के क्षेत्र में बतौर विस्तार अधिकारी के रुप में सेवारत हैं।
- 37 छात्रों को पीजीडीएस (2018-19) की डिग्री प्रदान की गई तथा 2019-20 के लिए 40 छात्रों का नामांकन किया गया।
- शहतूत रेशम कृषि प्रौद्योगिकी पर 354 कृषकों (FST) 139 कार्मिकगण (TOP) प्रशिक्षित किए गए।
- रेशम कृषि प्रौद्योगिकियों पर 600 कृषकों को 6 रेशम संसाधन केन्द्रों के माध्यम से प्रशिक्षित किया गया।
- 95 महिलाएं (प्रधानमंत्री ने 23 फरवरी, 2020 को अपने 'मन की बात' कार्यक्रम में इसे एक प्रेरणात्मक गतिविधि के तौर पर उल्लेखित किया) को रेशम कोसा हस्तशिल्प (माला, बैज, ग्रीटिंग कार्ड, राखी आदि) पर प्रशिक्षित की गई।
- दीमापुर में मैनेज 25 हैदराबाद के सहयोग से - रेशम निदेशालय के पदधारियों के लिए रेशम कृषि में उद्यमिता विकास कार्यक्रम (EDP) का आयोजन किया गया।
- 1766 कृषकों एवं छात्रों के लिए अभिनव रेशम कृषि प्रौद्योगिकी कार्यक्रम का आयोजन किया गया।

HIGHLIGHTS OF R & D ACTIVITIES

Central Sericultural Research & Training Institute, Berhampore along with three Regional Sericultural Research Stations (RSRSs) and nine Research Extension Centers (RECs) are 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 are as follows:

MULBERRY CROP IMPROVEMENT & PROTECTION

- Identified five promsing drought tolerant and high yielding mulberry genotypes (PYD-1, PYD-4, PYD-7, PYD-8 & PYD-21) with >15% leaf yield improvement over drought tolerant (C-1730) and >6% over ruling check (C-2038) varieties for rainfed conditions

- Development of PRE-2 mediated suppression (41-55%) of fungal diseases caused by *Myrothecium roridum* (leaf spot; MLS) and *Fusarium solani* (dry root rot; FRR)

- Application of hydrogel with alternate day drum kit tape irrigation was economical (BCR of 1:1.37) with an effective leaf yield (4.78 MT/crop) in Odisha

- Identified high yielding mulberry genotypes (PPY-8, PPY-10, PPY-24, PPY-7, PPY-20 & PPY-6) with 10-35% improvement over check variety (C-2038) with better quality and lower PDIs

- Identified high yielding mulberry genotypes (C-01 & C-11) with an improvement over S1635 under irrigated (>30%) and rainfed (>20%) conditions

- Identified a novel, rapid and simple assessment method for soil biological health in mulberry ecosystem

SILKWORM CROP IMPROVEMENT & PROTECTION

- Identified 12Y x BCon1.4 (12Y x BFC1) as a promising multi x bi hybrid through OFT in E & NE states (avg. yield: ~52kg with ~10% improvement over N x SK6.7)

- Developed a bivoltine double hybrid (BHP3.2 x BHP8.9) with an improved shell (10-12%) over SK6 x SK7 & Bcon1 x Bcon4 (avg. yield: ~65kg).

- FC1 x FC2 was identified as best bivoltine hybrid (21% shell ratio) in Odisha through OST

- *Rhodopseudomonas* spp. feed supplementation through mulberry improved survival by 16% against flacherie by *Staphylococcus* sp.

- Developed a general disinfectant, NIRMOOL for disinfection of rearing house & appliances

- Identified thermo-tolerant bivoltine hybrids (WB7.5 x WB1.3 & KA19.WB5 x WB1.3) for further evaluation in adverse seasons
- Developed molecular markers (pyx1 & pyx2) for humidity tolerance in silkworm
- Prototype of Suvarna (modified charka) was designed for improved efficiency

TECHNOLOGY TRANSFER

- Soil Health Cards (18076) were distributed to the farmers
- Esatblished biocontrol agents, *Scymnus* beetles (mealybugs) and *Chrysoperla* (thrips) mass multiplication for supply to the farmers
- Produced a quantity of 102.87MT bivoltine raw silk through Cluster Promotion Programme (13 clusters in Eastern & NE India; 16.23 lakh dfls; avg. yield: 49.37 kg/100 dfls)
- Produced a quantity of 92.65 MT ICB raw silk through Cluster Promotion Programme (8 clusters in Eastern & NE India; 17.18 lakh dfls; avg. yield: 44.00 kg/100 dfls)
- Sensitized 14845 stakeholders with recent sericulture technologies through 266 ECPs
- Communicated 71 scientific advisories/messages in different languages (Bengali, Hindi, Oriya, Nepali, Oriya) to 5753 farmers through m-Kisan

CAPACITY BUILDING & TRAINING

- 63% PGDS graduates (2013-2017) from CSRTI-Berhampore were employed in public sector and most being serving as extension officers in sericulture
- 37 students awarded PGDS (2018-19) and 40 students enrolled for 2019-20
- Trained 354 farmers (FST) and 139 personnel (TOP) on mulberry sericulture technologies
- Trained 600 farmers on sericulture technologies through 6 Seri Resource Centres (SRCs)
- Imparted training in silk cocoon handicrafts (garlands, badges, greeting cards, rakhis etc.) to 95 women (Prime Minister's *Mann Ki Baath* 23rd Feb 2020 *as* an inspirational activity)
- Organized Entrepreneurship Development Programme (EDP) in Sericulture in collaboration with MANAGE-Hyderabad for 25 DOS-Nagaland officials at Dimapur
- Organized exposure of recent sericulture technologies for 1766 farmers & students

MULBERRY BREEDING & GENETICS

Concluded Research Project

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

Suresh, K. (PI; April 2016 - Dec 2019), M. K. Ghosh (Jan 2014 - Mar 2016), P. K. Ghosh (Jan 2014 - Jun 2017), D. Chakravarty (Jul 2017 - Dec 2019), S. K. Dutta (Jan 2014 - Apr 2017), Anil Pappachan (Jul 2017 - Dec 2019), M.V. Santhakumar (Jan - Dec 2014), K. Jhansilakshmi (Jan 2014 - Jun 2018), G. Thanavendan (Jul 2018 - Dec 2019), Maloy Lasker (JRF; Sep 2017 - Dec 2019)

Objective: Development of drought tolerant mulberry variety

Mulberry genetic improvement for drought tolerance with higher leaf yield through conventional hybridization and selection based on morphological and physiological traits is a general plant breeding technique. The current work relates to the identification of drought tolerant genotypes for further evaluation. The drought tolerant parents were selected from CSGRC-Hosur R&D efforts (PIG-3432: Physiological characterization of selected mulberry genetic resources with reference to water and nitrogen use efficiency). High yielding genotypes from the germplasm were utilized as male parents. The selected parents were hybridized in strategic combinations (10 crosses; 36837 seeds) and the resultant hybrid seedlings were exposed to natural drought conditions in the nursery at CSRTI-BHP. Around 10-20% seed germination was recorded and the seedlings survival ranged from 80-90%. Normal healthy seedlings (2190), respective parental genotypes and C-2038 (check variety) were established in Progeny Row Trial (PRT).

Strategic Crosses Utilized for PRT

Female Parents	Male Parents	Seeds (Nos)	Seedlings (Nos)	Selection	
				Nos	%
MI-0437 (Baragarh-3)	ME-0125 (Thailand lobed)	1951	265	193	72.83
	MI-0256 (UP-23)	6374	551	340	61.71
	MI-0670 (Madhopur-4)	4838	485	325	67.01
MI-0685 (Khakad-2)	MI-0314 (UP-27)	411	352	213	60.51
	MI-0308 (V-1)	4840	160	131	81.88
MI-0828 (Hosur C8)	ME-0125 (Thailand lobed)	3839	367	277	75.48
MI-0827(Jalalgarah 3)	MI-0012 (S-13)	476	159	147	92.45
MI-0763 (Saranath-2)		5168	763	471	61.73
MI-0762 (Chirayinkizh)	ME-0065 (S-1)	5726	50	42	84.00
MI-0477 (ERRC-32)	ME-0016 (Lazuraso)	3214	57	51	89.47

PRT populations were assessed for visual leaf characteristics and yield traits under rainfed conditions for one year. High phenotypic variability was observed for most of the traits; however, seedlings with desirable characteristics *viz*., smooth, greenish, large-unlobed leaves were very few. Thirty such progeny were shortlisted for PYT with higher mean leaf yield/plant (>433g/crop); fresh leaf weight (>3g), leaf area (>150cm^2), chlorophyll index (>10), leaf moisture (>70%), specific leaf area (<300cm^2/g), inter-nodal length (<5cm), longest shoot length (>150cm) and primary shoots/plant (>8) utilizing multiple trait evaluation index and the top-ranked progenies recorded significantly higher annual leaf yield (1.3-2.6kg) as compared to check variety, C-2038 (1.09kg).

The shortlisted progenies along with three checks, C1730 (drought toletrant), S1635 (popular) & C2038 (ruling check) were established in ARBD under PYT for drought tolerance evaluation. Mean leaf yield/plant ranged from 278g to 568g under irrigated (WW) and from 256g to 505g under moisture-stress (WS) conditions. Leaf yield significantly and positively correlated with leaf weight, leaf area, leaf moisture, relative water content, total soluble protein, primary shoots, total shoots length and negatively correlated to specific leaf area. Mean yield and relative yield performance were the selection criteria for identifying promising genotypes for drought prone regions. Leaf yield significantly decreased by 4-27% in response to moderate drought stress. Fifteen drought tolerant indices were analysed and MP, GMP, HAM, STI, K_1STI, K_2STI, YI and DI recorded positive and significant correlation with yield. Biplot based on principal component (PC) analysis of DTIs and leaf yield revealed that first two PCs had more than one Eigen values and accounted 99.10% total variance. Based on biplot and DTIs, progenies *viz*., PYD 26, 8, 1, 2, 4, 7, 12, 23 & 29 were identified as high yielding and drought tolerant ones.

Performance of Progenies for Yield & Physio-Biochemical Traits (PYT)

Progeny	LLS	LMC	MRC	LAI	LFH	RWC	TSP	TSS	LPC	NRA	ECW	MEI	Rank
PYD 8	140^{ab}	74.96	75.69^{ab}	3.60^{a}	19.26^{b}	79.02	34.29	49.22^{ab}	282	5.17	346^{ab}	60.45	1
PYD 1	140^{ab}	76.59^{ab}	74.41	2.91^{a}	14.17^{ab}	85.53^{ab}	35.35	46.39^{b}	1167^{ab}	3.67	332^{ab}	55.05	5
PYD 21	125	75.72^{ab}	73.00	2.07	16.93^{ab}	79.62	38.53^{ab}	44.03^{b}	725^{b}	4.19	317	55.42	4
PYD 4	133^{ab}	75.19	75.57^{ab}	3.06^{a}	14.70^{ab}	82.39^{b}	35.04	43.75	1035^{b}	7.22^{b}	322^{b}	54.31	6
PYD 7	140^{ab}	75.28	74.72^{a}	2.91^{a}	13.19^{ab}	77.14	33.35	46.48^{b}	357	4.93	338^{ab}	53.77	9
^{a}C1730	128	75.14	74.32	2.30	19.87	83.50	34.85	46.84	943	7.05^{b}	321	52.61	13
^{b}C2038	129	75.13	74.70	3.90	22.92	80.02	35.25	42.66	496	5.94	319	53.82	8
CD@5%	2	0.25	0.44	0.18	0.89	1.42	1.14	1.14	124	0.41	3		

LLS: longest shoot Length (cm), LMC: Leaf moisture (%), MRC: Moisture retention aft 6hr (%), LAI: Leaf area index, LFH: Leaf fall (%) RWC: Relative water content (%), TSP: Total Soluble protein (mg g^{-1}), TSS: Total Soluble sugars (mg g^{-1}), LPC: Leaf Proline content (µg/g) NRA: Nitrate reductase activity (nmol NO^2 g^{-1} h^{-1}), ECW: Epiculticular wax (µg/cm^2) and MEI: Multiple trait evaluation index

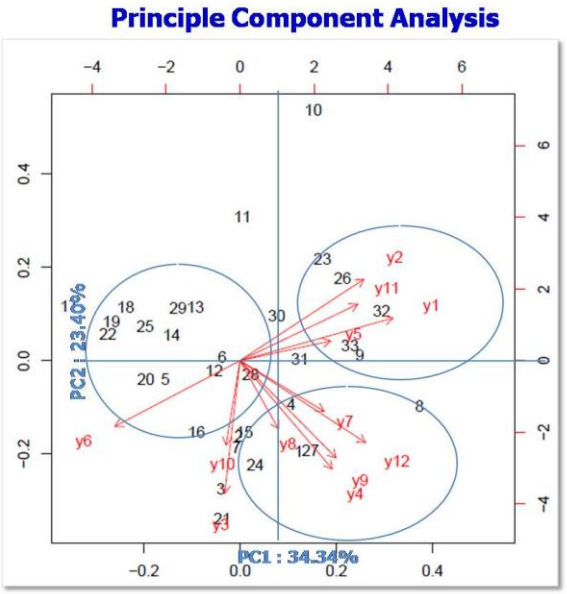
Performance of top progenies for moulting, propagation and Pest-Disease incidence (PYT)

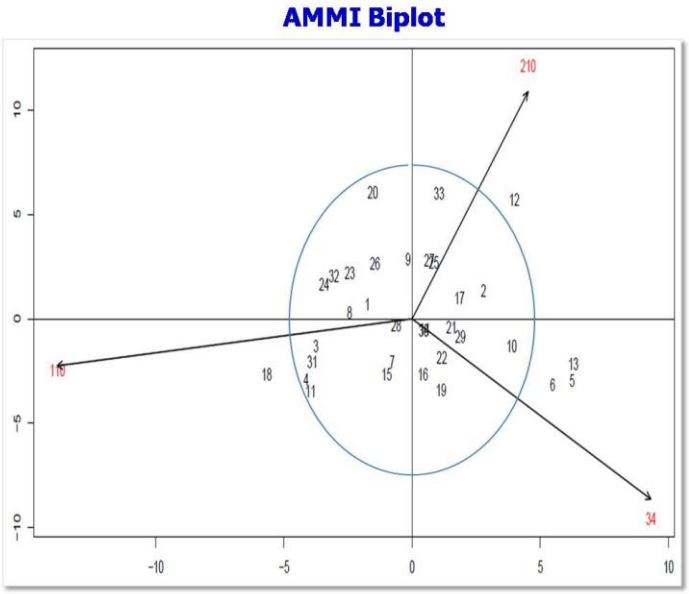
Progeny	FLW	SLW	FMO	SMO	CSP	RLN	RDW	RV	BLS	PLS	MLS	Tukra	MEI	Rank
PYD 8	0.154	1.739^{ab}	91.96	91.34	89^{ab}	31.50^{a}	5.71^{ab}	8.25^{ab}	4.14^{ab}	5.98^{ab}	5.26^{b}	29.54^{b}	50.27	6
PYD 1	0.178^{b}	1.591^{b}	91.94	92.21^{b}	82^{ab}	29.50^{a}	3.54^{ab}	6.25^{b}	4.76^{ab}	8.58^{b}	1.83^{ab}	36.28	48.93	11
PYD 21	0.159	1.664^{ab}	95.17^{b}	94.05^{b}	83^{ab}	19.50	1.55	2.25	5.85^{ab}	11.32	4.89^{b}	37.84	49.05	10
PYD 4	0.173^{b}	1.748^{ab}	93.01	91.04	86^{ab}	44.50^{a}	11.86^{ab}	20.50^{ab}	4.44^{ab}	12.56	3.47^{b}	26.41^{ab}	55.71	1
PYD 7	0.164	1.471	94.99^{b}	91.68	81^{ab}	41.00^{a}	9.01^{ab}	16.25^{ab}	5.85^{ab}	4.88^{ab}	4.26^{b}	26.78^{ab}	52.56	3
^{a}C1730	0.184^{b}	1.600^{b}	96.18*	92.12	80	27.50	2.32	4.60	8.00	7.94	3.52	30.05	52.36	4
^{b}C2038	0.165	1.537	92.95	91.17	78	43.50	2.17	3.75	8.30	11.18	6.75	35.05	49.87	7
CD@5%	0.008	0.030	2.03	2.03	1	2.30	0.96	1.73	0.78	1.35	0.43	2.66		

FLW: First larval weight (g), SLW: Second larval weight (g), FMO: First larval moultout (%), SMO: Second larval moultout (%), CSP: Cuttings survival percent (%), RLN: Primary root length (cm), RDW: Root dry weight (g), RV: Root volume (cm^3), BLS: Bacterial leaf spot, PLS: Pseudocerospora leaf spot, MLS: Myrothecium leaf spot, Tukra: Mealy bug infestation

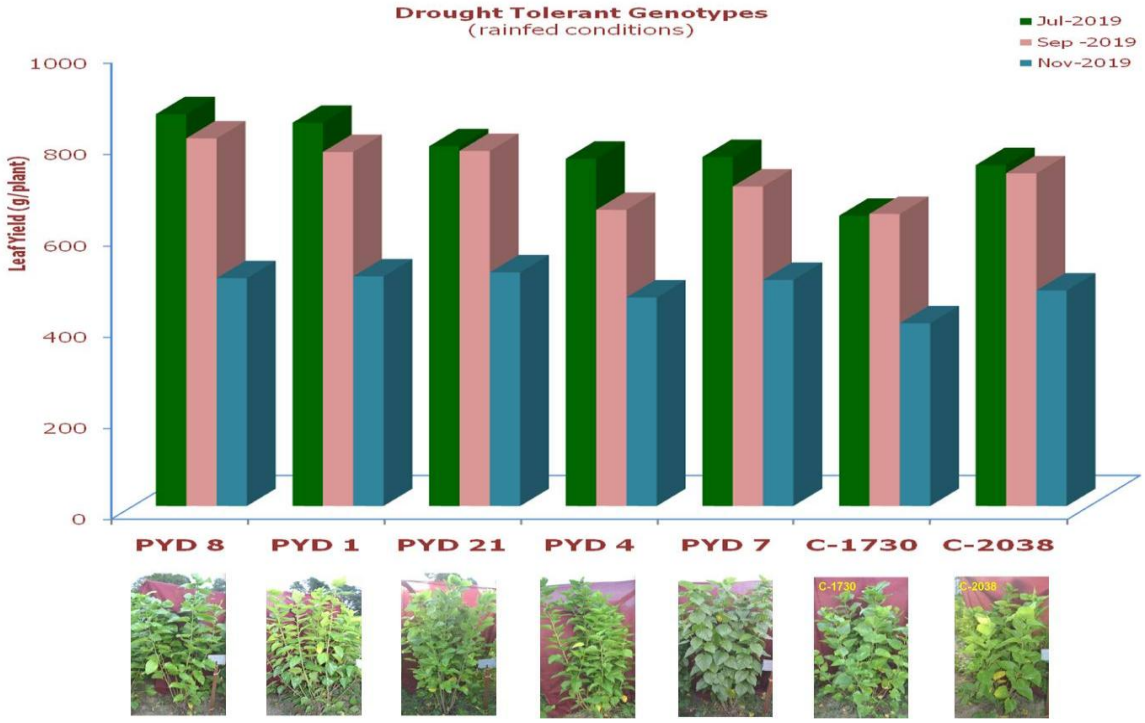
These progenies were further evaluated for leaf yield traits and physio-biochemical parameters under rainfed conditions. Based on MEI for yield traits, progenies *viz*., PYD 8, 1, 21, 4 and 7 were identified as promising genotypes exhibiting better yield potential than the check varieties, C2038 and C1730 under rainfed conditions. The physiological and biochemical indices reveal that superior progenies are medium rankers as compared to C2038 indicating better quality and adaptability under rainfed conditions. It was also observed that promising genotypes were exhibiting superior propagation features and moderate tolerance to pest and diseases based on natural incidence as compared to C2038. Silkworm moulting assay reveals higher moulting ratio (>90%) and larval growth; PYD 26 and 30 were exceptions.

Principle component analysis reveals that first two PCs with more than one Eigen value explain ~58% variability. From biplot, PYD 8, 4, 27, 1, 3, 21, 24, 2, 7 and 5 were identified as high yielding genotypes under rainfed conditions. Further, AMMI analysis of variance for leaf yield shows significant genotype and environmental effects with non-significant G × E interactions. PYD 1, 7, 8, 21, 28, 30, and 14 were close to the origins and are stable performers; might perform well across different seasons. Based on overall leaf yield and quality, five progenies viz., PYD 1, 4, 7, 8, 9, and 21 were identified for drought tolerance with high stable yields under rainfed conditions with >15% over drought tolerant variety, C-1730 and >6% improvement over ruling check variety C-2038.





Traits (y1: Fresh Leaf weight; y2 : Leaf area; y3: Specific leaf area; y4: Leaf moisture y5: Moisture retention after 6h; y6: Leaves/mt. shoot; y7: longest shoot Length; y8: No of primary shoots; y9: Total shoots length; y10: Leaf to shoot ratio; y11: Leaf fall & y12: Leaf yield/plant); 1-30: PYT Genotypes; Checks (31: C1730; 32: C2038; 33: S1635); Season/Crops (110: July; 210: September; 34: November)



Inference: Five promsing drought tolerant and high yielding genetic resources (PYD 1, 4, 7, 8 and 21) were indentified with >15% over drought tolerant variety, C-1730 and >6% improvement in leaf productivity over the ruling check variety C-2038 under rainfed conditions.

Future work plan: Evaluation of newly developed drought tolerant and high yielding genetic resources for leaf and silk productivity in different drought prone agro-ecologies under FYT.

On-going Projects

PIB 3576: Evaluation of new mulberry genotypes for improvement in productivity and leaf quality

[June 2016 - July 2020]

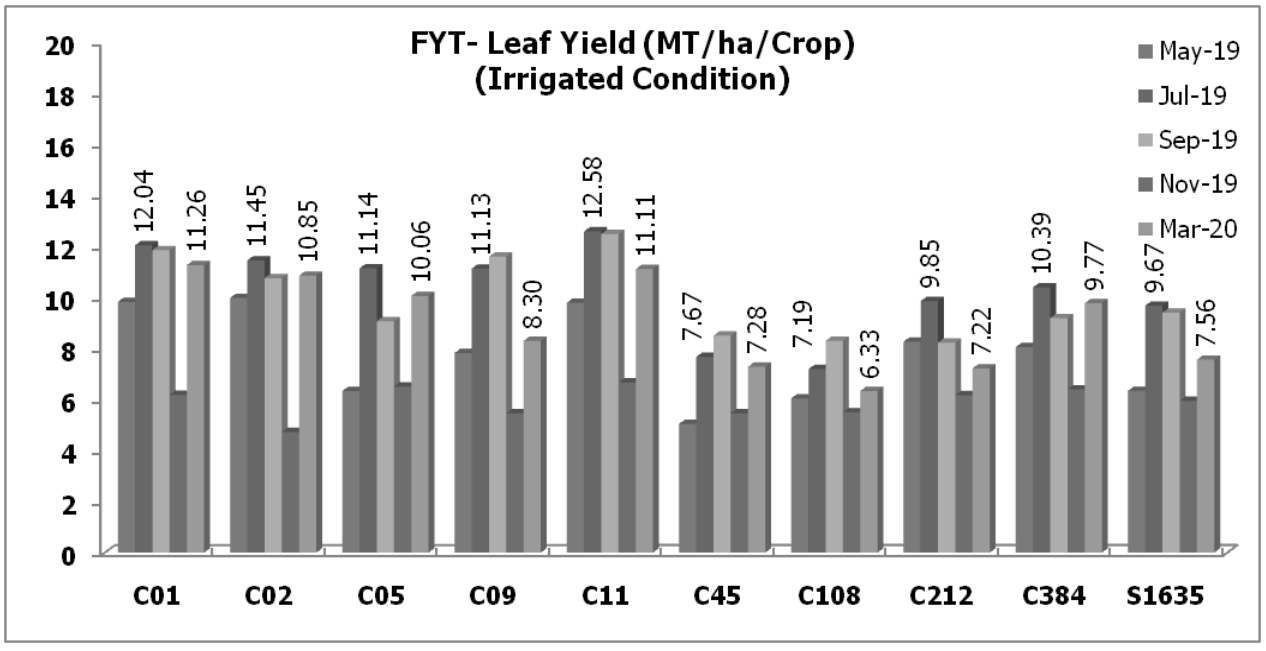
Suresh, K. (PI), Anil Pappachan (from July 2018), Deepika K. U. (from March 2019), G. S. Singh, K.C. Brahma (June 2016 - May 2018); SK. Misro (June 2018 - June 2019); K. Alam (from July 2019); SN. Gogoi (June 2016 - Nov 2018) & P. Kumaresan (from Dec 2018)

Objective: To evaluate high yielding mulberry genotypes with early sprouting during winter

Nine new promising genotypes (PIB3422 & PIB 3424: PYT) and popular variety, S1635 as check were evaluated at four test centers in Eastern & North-Eastern India for leaf yield and leaf quality in different seasons as FYT cum MLT.

Irrigated Conditions (CSRTI-Berhampore)

Mean leaf yield/plot/crop varied from 11.77 to 18.57 kg under irrigated conditions. C-01, C-02, C-05, C-11 and C-384 recorded significantly higher leaf yields over S1635. All the new genotypes were early sprouters as compared to S1635 during winter season, except C2 genotype. The seasonal performance reveals that mean leaf yields during winter crop was comparable to July crop among the new genotypes: C-01, C-02, C-05, C-11, C-384 (9.8-10.3t/ha) revealed exhibiting low temperature stress tolerance. Based on five-season data, annual leaf yield varied from 36.41 to 57.21 kg/ha and C-11 C-01, C384 and C-02 recorded >20% higher yield over S1635. The morphological and biochemical traits recorded significantly higher values in most of the test genotypes as compared to S1635.



Performance of Genotypes under Irrigated Condition (5 crops)

Genotype	DHS (N/W)		ULA (cm^2)	LMC (%)	LLS (cm)	TSL (cm)	TSP (mg/g)	TSS (mg/g)	LYP (kg/crop)	ALY (t/ha)	Gain (%)
C-01	9*	35*	181	77.01	132*	900*	36.63*	28.37	18.04*	56.35*	36
C-02	11	40	164	74.58	127	759	34.31*	30.39	16.85*	51.48*	24
C-05	10	35*	200	74.41	148*	926*	26.03	31.48	15.20*	47.86*	15
C-09	10	33*	199	75.37	123	885*	36.23*	32.61	15.63*	45.58*	10
C-11	10	26*	171	77.03	116	896*	25.97	28.47	18.57*	57.21*	38
C-45	11	25*	125	75.55	130*	986*	43.60*	26.81	11.98	36.41	-12
C-108	10	30*	128	73.45	119	898*	23.17	26.92	11.77	38.06	-8
C-212	10	27*	177	75.08	114	823	33.49*	31.75	14.01	46.35*	12
C-384	11	28*	169	76.84	120	867*	34.97*	32.61	15.45*	50.57*	22
S-1635	9	40	201	76.62	116	813	31.26	32.87	13.73	41.49	
CD@5 %	1	5	41	2.09	12	51	0.86	0.54	0.90	1.81	

DHS: Days to 100% sprouting in N: Normal; W: winter; ULA: Unit Leaf area; LMC: Leaf moisture; LLS: Length of longest shoot ; TSL: Total shoots length; TSP: Total Soluble protein; TSS: Total Soluble sugars; LYP: Leaf yield per plot; ALY: Annual leaf yield

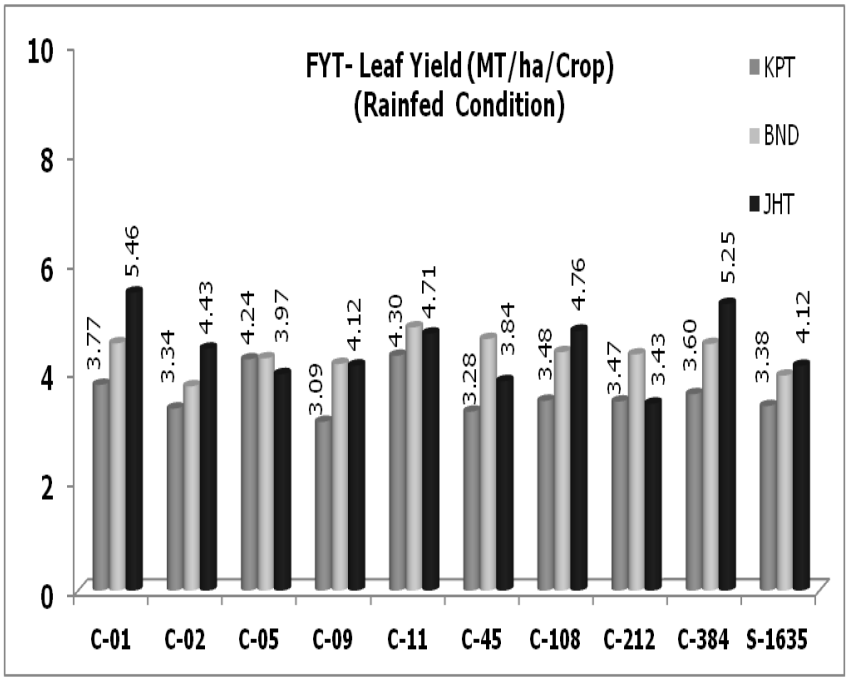
Silkworm bioassay studies were conducted with bivoltine hybrid (SK6 × SK7) during Feb - Mar 2020. C-11, C-384, C-212 and C-01 were top rankers for cocoon parameters based on multiple trait evaluation indices. Mean PDIs were documented for Bacterial leaf spot (3.84-8.87%), *Myrothecium* leaf spot (1.85-6.10%), *Pseudocercospora* leaf spot (2.38-6.4%) and powdery mildew (9.08-12.58%). Whitefly infestation (9-15/leaf) was recorded during September/November crop, which was minimal and comparable to check, S1635.

Rearing Performance under Irrigated Conditions (SK6 × SK7; Feb - Mar 2020)

Genotype	Larval Wt. (g)	Cocoon Wt. (g)	Shell Wt. (g)	SR (%)	ERR (No)	ERR (g)	LCR	MEI	Rank
C-01	34.83	1.405*	0.212*	15.29	8402	14.37*	18.69*	48.89	6
C-02	33.83	1.298	0.214*	16.46*	8853*	13.31	20.44*	48.43	7
C-05	32.70	1.285	0.199	15.47	8644*	13.72*	24.45	47.18	9
C-09	37.33*	1.265	0.220*	17.38*	8364	14.03*	20.22*	51.93	4
C-11	37.00*	1.412*	0.249*	17.64*	8617*	13.80*	18.45*	56.27	1
C-45	35.17	1.361*	0.195	14.32	8233	14.30*	23.85	48.04	8
C-108	32.60	1.393*	0.231*	16.61*	8642*	13.39	19.85*	49.23	5
C-212	34.13	1.424*	0.228*	16.04*	8907*	14.67*	18.83*	53.98	3
C-384	34.97	1.533*	0.251*	16.36*	7973	13.40*	24.38	54.51	2
S-1635*	34.67	1.297	0.191	14.75	8248	12.72	21.75	41.70	10
CD@5%	1.32	0.052	0.015	1.09	235	0.68	0.68		

Rainfed Conditions (RSRS-Koraput; RSRS-Jorhat; REC-Bhandra)

Nine test genotypes were evaluated for leaf productivty and quality under rainfed conditions in different seasons. Leaf yield/crop varied from 3.74 to 4.61t/ha; C-01, C-05, C-11, C-108 and C-384 were significantly superior to check, S-1635. Annual leaf yield varied from 11.22 to 13.84t ha^{-1}; C-01 and C-11 recorded >20% over S1635 under rainfed conditions. Morphological and leaf traits recorded significantly higher values in most of the test genotypes as compared to S1635.



Performance of Genotypes under Rainfed Condition (2 crops)

Genotype	DHS	LMC (%)	LMS (No)	LLS (cm)	TSL (cm)	LFH (%)	LYP (kg/crop)	ALY (t/ha)	Gain (%)
C-01	8*	75.72*	24*	151*	830*	13.09*	18.21*	13.77*	20
C-02	10	75.63*	22	148	739	13.28*	15.16	11.52	1
C-05	9*	75.55*	22	150	777*	13.14*	16.49*	12.47*	9
C-09	9*	74.90	23	134	684	16.13	15.05	11.37	-1
C-11	8*	76.39*	24*	145	780*	14.31*	18.31*	13.84*	21
C-45	10	76.24*	22	153*	714	14.53*	15.52	11.73	3
C-108	10	73.78	23	145	764	12.70*	16.69*	12.61*	10
C-212	11	76.03*	20	143	744	13.44*	14.85	11.22	-2
C-384	11	76.10*	22	149	773	14.63*	17.69*	13.37*	17
S-1635*	10	75.25	22	136	711	19.33	15.14	11.44	
CD@5%	1	0.21	1	15	64	3.41	1.02	0.81	

Silkworm bioassay studies were conducted with bivoltine hybrid (SK6 × SK7) at Korput and Bhandra and better cocoon characteristics were recorded in comparission to S1635 and C-11, C-108, C-384, C-02 and C-01 were top rankers. Powdery mildew (4.83-10.67%) was noticed at Bhandra during November 2019.

New genotypes, C-01 & C-11 recorded significantly higher leaf yields over S1635 under irrigated (>30%) and rainfed (>20%) conditions with better evaluation indices.

Rearing Performance under Rainfed Conditions (SK6 × SK7; Oct-Nov 2019)

Genotype	Cocoon Wt. (g)	Shell Wt. (g)	SR (%)	ERR (No)	ERR (g)	MEI	Rank
C-01	1.481	0.244	17.38*	8772*	14.88*	44.81	6
C-02	1.403	0.255*	17.95*	8755*	15.05*	46.36	4
C-05	1.435	0.238	16.45	8108	14.50	36.36	9
C-09	1.415	0.239	17.17*	8329	15.52*	42.05	7
C-11	1.534*	0.262*	17.63*	9175*	15.98*	54.55	1
C-45	1.624*	0.261*	16.07	8504	14.63*	45.26	5
C-108	1.509	0.270*	17.44*	8568	15.17*	49.13	2
C-212	1.534*	0.242	15.95	7981	14.70*	38.01	8
C-384	1.600*	0.261*	16.82*	8449	15.31*	48.37	3
S-1635*	1.480	0.235	16.09	8394	14.08	36.17	10
CD@5%	0.046	0.010	0.56	180	0.44		

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)

Objectives

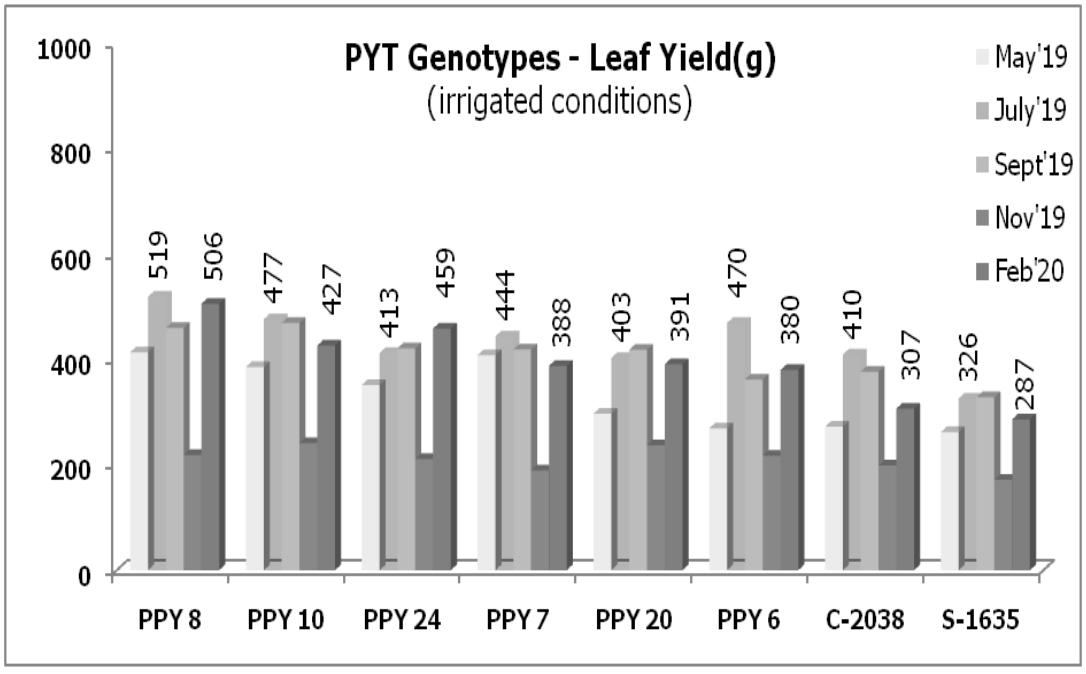
- Evaluation of improved lines for foliage biomass and associated agronomic traits under PYT
- Qualitative assessment through biochemical, propagation and silkworm moulting test

Twenty four test genotypes and two checks (C-2038 & S-1635) were evaluated for leaf yield and yield component traits for five seasons under irrigated conditions at CSRTI-BHP. Pooled mean leaf yield varied from 228 to 424 g/plant/crop as compared to check variety, C-2038 (313g). Annual leaf yield varied from 1.14 to 2.12 kg/plant and six test genotypes *viz*., PPY- 8, 10, 24, 7, 20 and 6

recorded >10% higher yield over C-2038. Morphological and leaf traits recorded significantly higher values in most of the test genotypes as compared to C-2038.

Leaf and Yield Traits under Irrigated Condition (5 crops)

Genotype	DHS (N/W)	FLW (g)	LMC (%)	MRC (%)	LLS (cm)	TSL (cm)	TSP (mg/g)	TSS (mg/g)	ALY (t/ha)	Gain (%over C2038)	Gain (%over S1635)
PPY 8	11/40	3.148	78.15	83.38^{b}	123	664	31.54^{b}	29.95	2.12^{ab}	35	54
PPY 10	9^{a}/22^{a}	4.226^{b}	78.74^{a}	83.90^{b}	119	685	29.97^{b}	36.76^{ab}	2.01^{ab}	28	46
PPY 24	10^{a}/34	2.980	76.86	84.62^{ab}	131^{ab}	725	34.00^{ab}	36.17^{ab}	1.86^{ab}	19	35
PPY 7	9^{a}/39	3.668	77.61	83.41^{b}	123	692	35.63^{ab}	31.00	1.85^{ab}	18	34
PPY 20	11/38	3.480	77.74	83.78^{b}	126^{b}	644	37.43^{ab}	33.72^{ab}	1.75^{ab}	12	27
PPY 6	11/30^{a}	3.797^{b}	79.58^{ab}	84.07^{ab}	121	689	36.83^{ab}	35.55^{ab}	1.69^{ab}	9	24
C-2038*	12/40	4.156	77.14	82.89	117	612	31.83	32.84	1.56		
S-1635	9/31	3.158	78.06	82.16	114	648	28.40	32.91	1.38		
CD@5 %	1/10	0.599	1.03	1.10	11	86	0.61	0.48			



Silkworm moulting studies were conducted with bivoltine hybrid (SK6 × SK7) during March 2020. High moulting ratio (>80%) and larval growth (>1.60 g/50larvae), which is at par with C2038 was recorded, except PPY 9 & 21. Mean PDIs were documented for bacterial leaf spot (2.46-8.36%), *Myrothecium* leaf spot (4.55-8.67%), *Pseudocercospora* leaf spot (3.21-5.81%) and powdery mildew (3.80-9.06%). Mealybug infestation causing tukra (0-13.67%) was recorded during May 2019, which was below the check variety, S1635. PPY- 8, 10, 24, 7, 20 and 6 recorded

significantly higher leaf yield in comparision to check variety, C2038 to a tune of 10-35% along with better quality and lower PDIs.

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)

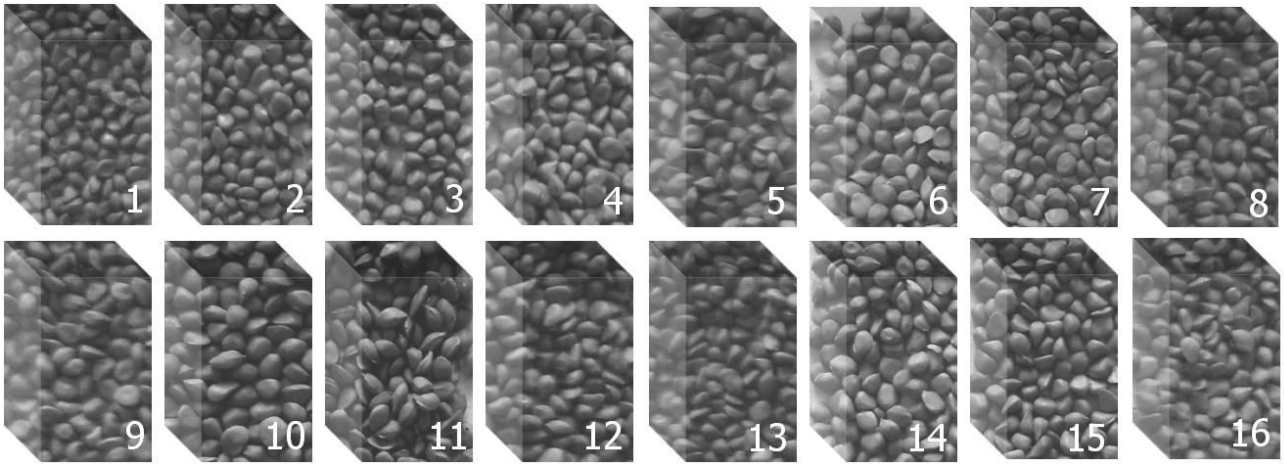
Objectives

- To establish polyclonal seed orchard for creating enormous genetic variability
- To identify promising mulberry seedlings for further utilization

Seed orchard with 29 superior divergent parents was established (5'x5'; males centred-within the famale genotypes; clonal plantation) to develop HY mulberry variety through polycross mating. Natural, open-pollinated and mature fruits were harvested (Feb-Mar 2020). PCH seeds were extracted by water soaking method and processed following standard procedures. Maximum seeds were generated in Kajli OP followed by Kajli, Berhampore-A, Bogura-4, C-2038 and T-13. Around 3.24 lakh PCH seeds were generated and would be utilized for generating PCH seedlings for further evaluation.

Polycross Hybrid (PCH) Seeds Harvest

#	Genotype	Parentage/ Acc.No.	Fruit Wt. (g)	Seeds/ Fruit (No)	100 See Wt. (g)	Total Seed Wt. (g)	Total Seeds (No)
1	Kosen	ME-0066	0.892	37*	0.154	4.36	2829
2	China White	ME-0042	1.494*	44*	0.158*	8.71	5511
3	C-2038	CF1(10) × C-763	1.468*	24	0.174*	48.87	28087
4	C-2045	MHP × CF1(13)	1.468*	41*	0.230*	12.50	5434
5	C-2036	MHP × CF1(23)	1.800*	43*	0.204*	31.87	15624
6	C-2060	KOP × V1	1.576*	26	0.176*	5.28	3000
7	S-30	MI-0046	1.310*	45*	0.182*	3.54	1947
8	Kajli OP	OPH of Kajli	1.904*	42*	0.140	128.50	82690
9	Phillipines	ME-0011	0.828	29	0.192*	21.36	11127
10	CSRS-1	MI-0084	2.062*	35*	0.154	2.99	1940
11	Berhampore-A	MI-0054	2.216*	46*	0.132	47.67	36116
12	Sujanpur-5	MI-0017	0.988	43*	0.156	2.26	1446
13	Matigera Black	MI-0300	0.800	38*	0.134	21.25	15857
14	Bogura-4	ME-0097	0.718	28	0.182*	56.40	31074
15	T-13	Elite clone	0.610	30	0.121	32.85	27146
16	Kajli	MI-0068	0.836	31	0.147	80.58	54817
		CD@5%	0.182	3	0.010	12.02	7888



Pilot Study: Development of mulberry crop schedule for optimal silk productivity in West Bengal

[October 2019 – September 2020]

Suresh, K (PI) and Deepika U.K

Objective: To identify season-wise crop schedule in mulberry sericulture for West Bengal

Proposed Mulberry Silkworm Crop Schedule for West Bengal						
Silkworm Crop	Mulberry Crop	Date of Pruning	Date of Brushing	Days to Chawki	Crop Period	Silkworm Hybrids
Falguni	Dec-Feb	1st Dec	19th Feb* (30th Jan)	80 (60)	105 (87)	Bi × Bi
Baishakhi	Mar-May	15th Mar (25th Feb)	20th Apr* (30th Mar)	36 (35)	61 (66)	M × Bi
Shravani	May-Jul	15th May (25th Apr)	20th Jun	36 (55)	61 (80)	M × Bi
Ashwina	Jul-Sept	14th Jul (15th Jul)	25th Aug	42 (43)	70 (68)	M× Bi
Agrahayani	Sept-Nov	22nd Sep (19th Sep)	31st Oct	40 (42)	70 (72)	Bi × Bi
Existing dates or days are in the parantheses						

New mulberry crop schedule for West Bengal is evaluated at CSRTI-BHP with the existing plantation (S-1635; 5-year old) with an objective to determine optimal mulberry and silk productivity. S-1635 plantation was pruned as planned for assessing leaf, cocoon and Silk productivity under irrigated conditions for November and February (2019-2020) crops. During November 2019, leaf and cocoon yield of both schedules were at par with each other. However, mulberry leaf yield doubled in Feb-Mar 2020 and higher nutrition, larval growth and cocoon parameters were recorded in new schedule.

New Mulberry Silkworm Crop Schdule - Performance

Crop	Schedule	Pruning Date	LYP (g)	LLS (cm)	TSL (cm)	TSP (mg/g)	TSS (mg/g)	Larval Wt. (g)	Cocoon Wt. (g)	Shell Wt.(g)	SR (%)	ERR (kg)
Nov 2019	New	3.12.19	270	98	753*	19.88	34.11	39.21*	1.787*	0.272	15.22	15.13
	Existing	1.12.19	264	95	729	25.63	29.40	38.37	1.765	0.269	15.27	14.98
Feb 2020	New	19.2.20*	518*	104*	1012*	36.20*	34.17*	38.00*	1.323	0.212	16.07	14.42*
	Existing	30.1.20	246	64	659	31.09	31.73	34.80	1.598	0.252	15.86	11.90

Collaborative Projects

PRP 08002 MI: Identification of candidate genes based powdery mildew resistance for utilization in disease resistance breeding in mulberry (with SBRL-Bangalore)

[May 2019 – May 2022]

Suresh K., Ramesha, A. (PI), Dubey, H., and Vijayan, K

Objectives:

- To identify powdery mildew susceptibility genes Mildew Resistance Locus O from mulberry
- To screen PM resistant mulberry genotypes for an association of non-functional mutation in the candidate *MLO* gene with disease resistance
- Validation of CAPS marker for chalcone synthase gene involved in PM resistance in diverse germplasm accessions/segregating progenies

Powdery mildew disease resistant mapping populations of Kajli OP × V-1 and S-1 × Vietnam-2 mainatined at CSRTI-BHP were evaluated for natural incidence of powdery mildew during November 2019 crop. Wider PDIs were recorded in the mapping populations as compared to parental genotypes (KOP: 5.15; V1: 20.14; S1: 17.16; Vietnam 2: 1.25). Leaf samples from segregating progenies and parents were supplied to SBRL-Bangalore for genomic DNA isolation. The identification of candidate genes (MLO) in mulberry is under progress.

Powdery Mildew Incidence (PDI) in Mapping Poulations (Nov 2019)

F1	N=	PDI Range	PDI Class	n	R/S	Top Progenies
Kajli OP × V-1	150	0.98 – 23.50	0-5	25	104 (R)	A6, C33, A13, A17, A15
			5-10	79		
			10-15	23	46 (S)	A24, B27, B16, A32, B19
			>15	23		
S -1 × Vietnam-2	120	0.64 – 35.63	0-5	50	90 (R)	SV-119, 120, 41, 17, 88
			5-10	40		
			10-15	20	30 (S)	SV-39, 54, 37, 47, 58
			>15	10		

PIE 02002 SI: Evaluation of performance of mulberry genotype C-9 under red and laterite soils

[July 2019 - June 2023]

D. Chakravarty, Suresh K., G. S. Singh, K. Alam and Soumen Singh

Objective: To assess the performance of C-9 under red & lateritic soils of Eastern and North-Eastern India

Test genotype (C-9) along with two check varieties (S-1 & C-2038) were established in RBD with five replications at three test centers during July 2019. The plantations are being maintained with recommended cultural practices for further experimentation.

Continuous/Other Activities

Maintenance of mulberry germplasm

D. Chakravarty, Suresh, K., Yallappa, H and Deepika, K.U

Mulberry genetic resources consisting of germplasm accessions, elite clones/ breeding lines and tetraploids were maintained in the clonal repository or field gene bank. Around 354 mulberry GRs of twelve species were maintained as high trunk plantaion for utilization in different breeding programmes. The plants were pruned during June & September following recommended cultural practices for maintenance of healthy plantation.

Mulberry Genetic Resources @ CSRTI-Berhampore

GRs	Total	Indigenous	Exotic
M. indica Lin.	88	83	5
M. alba Lin.	71	32	39
M. latifolia Poir.	31	3	28
M. bombycis	14		14
M. multicaulis	2		2
Wild species	13	6	7
Elite clones	101		
Tetraploids	34		
Total	354	124	95

AICEM-IV: All India Co-ordinated Experimental Trial for Mulberry varieties

[April 2019 – March 2025]

V. Sivaprasad, D. Chakravarty, Soumen Chattopadhyay, Yallappa, H., GS Singh, K. Alam, Y. Debraj, P. Kumaresan, Subhashish Ghosh, Biswabasu Bagchi, Ram Mina, Suresh, K., Mahesh, R., Deepika, KU., Anil Pappachan, Immanuael, CH (upto Dec 2019), Vijay, V., Aparna, K. and Manjunatha G.R.

Objective: To identify and authorize suitable mulberry varieties for commercial use in different agro-climatic mulberry cultivation zones of India.

Test Center	CBP-01 (C-1360)	CMY-01 (AGB-8)	CPP-01 (PPR-1)	C-2038	S-1635
RSRS-Koraput (Odisha)	550	550	566	610	550
REC-Bhandra (Jharkhand)	550	550	550	550	550
DoS-Bilaspur (Chattisgarh)	665	700	756	840	750
CSRTI-Berhamopre (West Bengal)	550	550	550	550	550
DOT(Seri)-Boswa (West Bengal)	550	550	550	550	550
P3-Ambarifalakata (West Bengal)	550	550	550	550	550
RSRS-Jorhat (Assam)	550	550	550	550	550
RSRS-Imphal (Manipur)	550	550	550	550	550

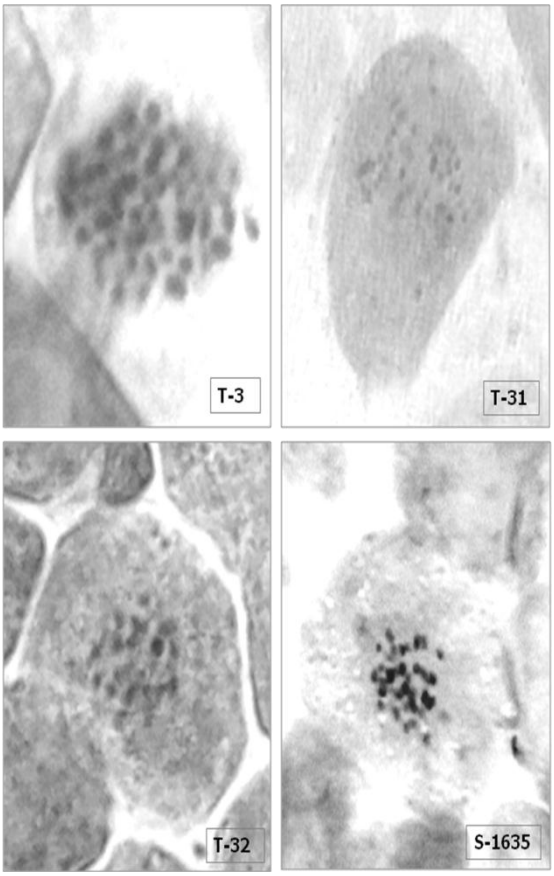
Candidate mulberry varieties approved by MVAC along with two check varieties under AICEM-IV were established in the East Zone by the coordination of CSRTI-Berhampore. Test genotypes cuttings were procured from the progenitor institutes and saplings were multiplied at CSRTI-BHP and supplied to eight test centers. The five genotypes were transplanted in RBD with six replications as per AICEM guidelines. The plantations are being maintained with recommended inter-cultural practices.

Characterization of tetraploids for leaf yield & quality

Pura Jailyang, D. Chakravarty and Suresh, K

Objective: To characterize tetraploids for leaf yield & quality parameters

Mulberry exhibits different ploidy level and triploid forms are generally superior to others in feeding value and tolerance to abiotic stresses. Triploids are obtained by crossing tetraploids (induced by colchicines) with diploids. Thirty colchicine treated mulberry genotypes were studied for mitotic chromosomal count of root tips to confirm the tetraploid nature and also characterized for anatomical, physio-biochemical and yield traits during July and September 2019 crops. S1635, popular variety was used as check variety (triploid). Among thirty genotypes, three genetic resources *viz*., T3, T31 & T32 were identified as true tetraploids with somatic chromosome number being 2n=4X=56. The stomatal frequency was negatively correlated with ploidy level and significantly lower stomata count in three tetraploids as compared to triploid. Tetraploids were also observed to be significantly superior to S1635 for higher palisade to spongy parenchyma ratio, total soluble protein, primary shoots and leaf yield. These superior mulberry tetraploids could be utilized for development of triploids in mulberry in future breeding programmes.



Characteristics of Tetraploids (2 crops)

GR	CSGRC Acc. NO	2n =	SF	PSR	LT	LMC	MRC	CCI	TSS	TSP	LLS	NPS	LYP
T-3	MI-0182	4x=56	430*	1.25*	158.3	74.45	79.32	12.39	36.76	35.77*	58	22	0.87*
T-31	MI-0217	4x=56	407*	1.41*	143.8	70.20	70.60	22.80*	35.93	36.94*	97*	17	0.62*
T-32	MI-0221	4x=56	502*	1.48*	141.3	78.76*	75.19	17.24	32.34	32.64	129*	31	1.31
S1635	MI-0173	3x=42	685	0.82	160.9	73.13	76.63	15.09	36.09	30.38	74	30	0.31
		CD @ 5%	34	0.42	10.91	3.55	3.63	3.25	2.29	3.56	12	3.51	0.13

SF: Stomatal frequency (No/mm^2); PSR: Palisade to spongy parenchyma ratio; LT: Leaf thickness (µg); LMC: Leaf moisture content (%); MRC: Moisture retention capacity (%); CCI: Chlorophyll content index; TSS: Total soluble sugar(mg/g); TSP: Total soluble protein(mg/g); LLS: Length of longest shoot (cm); NPS: No. of primary shoots/plant; LYP: Leaf yield/plant (kg)

Comparative physiological & biochemical profile for mulberry varieties

Padmini, B., Yallappa H., and Deepika K.U

Objective: To compare physio-biochemical characteristics among different mulberry varieties

Mulberry is cultivated in diverse environments and different genotypes/varieties have been authorized (cultivated) over a period of time. Profiling of physiological and biochemical markers associated with quality and stress is useful for developing future programmes in East and North-Eastern India. The varieties were assessed under irrigated conditions at CSRTI-BHP. Lower TBARS content reveals the lower lipid peroxidation activity indicating higher level of stress tolerance and genotype, S-1 recorded the maximum followed by C-2028, Tr-10 and Kajli. Higher secondary metabolites (TPC, TTFC and TTC; antioxidants) were recorded in C-2028 and C-2060 indicating higher stress tolerance. TSS, TSP, CCI and NRA are leaf quality parameters which were at par with S-1 in most of the genotypes. C-2060, Tr-23 and Bombai local recorded maximum length of longest shoot over S-1. Leaf yield/plant varied from 370g (Kajli) to 1301g (C-2060) and all the genotypes recorded significantly higher leaf yield over S-1, except Kajli and Bombai local. C-2060 (Gen-1) recorded 12% higher yield over C-2038, the ruling mulberry variety in the zone. Multiple Trait Evaluation Index (MEI) values indicates that genotypes C-2028, C-2060 and C-1730 are superior in physio-biochemically and might exhibit better tolerance to various stresses.

Physiological & Biochemical Profiling of Authorized/Candidate Mulberry Varieties

Genotype	TBARS (nm/g)	TFC (mg/g)	TTC (mg/g)	TPC (mg/g)	ECW (µg/cm^2)	NRA (nm/g/h)	CCI	TSP (mg/g)	TSS (mg/g)	LLS (cm)	LYP (g)	MEI
Kajli	746.53	6.48	3.77*	17.63	293.66	5.88*	19.57	20.40	23.80	83.09	370	42.25
Bombai	935.14*	7.04*	3.11	19.32*	254.25	1.58	17.57	28.23	27.32	150.16*	437	45.39
S-1635	1268.00*	6.56	3.16	18.57*	284.32	5.88*	20.07	31.23	24.92	141.61	1022*	51.81
C-2038	899.84*	7.60*	3.08	20.93*	269.29	5.25*	18.56	32.11	21.83	133.52	1158*	48.72
Tr-10	718.73	6.64	3.06	11.27	249.37	4.12*	16.43	34.57*	23.47	145.41	682*	43.09
BC_2-59	947.24*	7.92*	4.08*	19.03*	278.46	5.12*	16.54	35.41*	22.64	134.45	723*	48.95
Tr-23	969.46*	5.28	4.41*	23.52*	282.34	4.56*	20.54	28.79	25.81	153.22*	821*	50.74
C-1730	1028.02*	6.56	4.92*	16.19	276.32	8.16*	23.93	40.99*	29.65	137.62	760*	56.09
C-2028	677.91	9.12*	5.99*	27.87*	296.39	5.88*	19.14	36.44*	25.64	142.01	874*	56.32
C-2017	923.20*	8.08*	2.77	23.59*	305.49*	5.37*	17.84	27.10	23.79	144.32	832*	50.33
C-2016	890.15*	6.87	3.67*	13.20	317.32*	8.82*	19.01	34.92*	23.20	132.42	864*	51.06
C-2060	930.85*	9.60*	5.43*	22.50*	305.36*	6.79*	14.62	35.10*	23.20	150.83*	1301*	56.56
*S-1**	524.00	6.88	3.52	18.15	296.4	3.23	26.34	28.39	27.13	145.6	549	48.71
CD@ 5%	292.8	0.09	0.01	0.15	0.51	0.02	2.47	4.33	2.84	9.91	0.93	

TBARS: Thiobarbituric acid reacting substances; TFC: Total flavanoid content; TTC: Total tannin content; TPC: Total phenol content; ECW: Epicuticular wax content; NRA: Nitrate reductase activity; CCI: Chlorophyll content index; TSP: Total soluble protein; TSS: Total soluble sugar; LLS: Length of longest shoot; LYP: Leaf yield per plant

BIOTECHNOLOGY

Concluded Project

PRE3589: Assessment of designed antimicrobial peptides for mulberry protection against brown leaf spot and root rot: a biotechnological approach

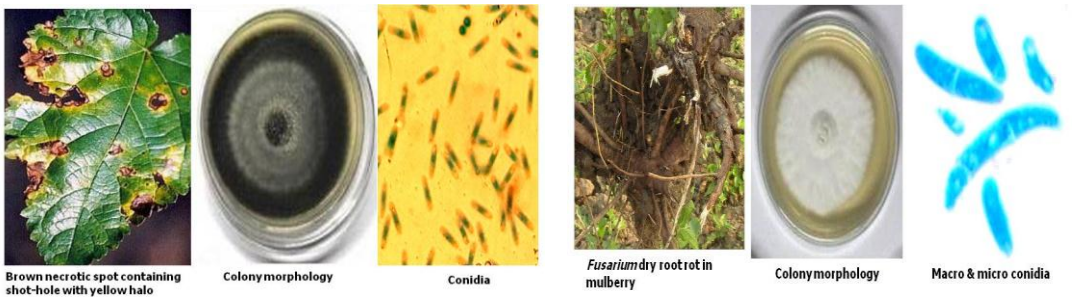
[Oct 2016 –Sept 2019]

S Chattopadhyay (PI), Rita Banerjee (Oct 2016-June 2017), Pooja Makwana and Anil Pappachan (Jan 2019-Sept 2019)

Objectives:

- Assessment of disease protection potential of synthetic antimicrobial peptides (AMPs) against *Myrothecium* leaf spot (MLS) and *Fusarium* root rot (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

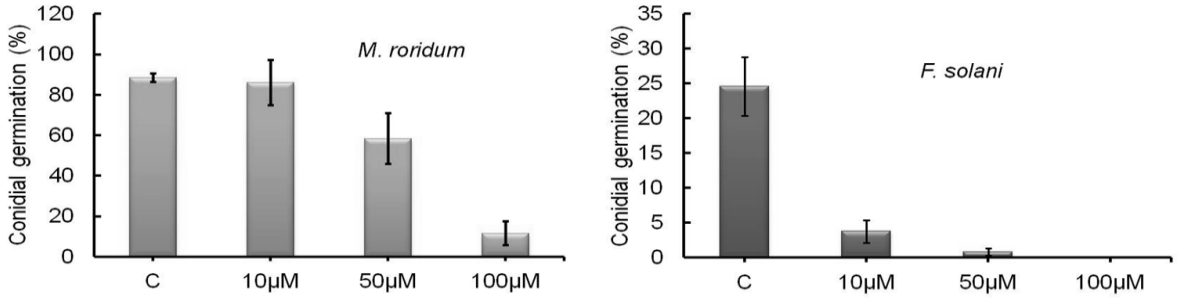
Myrothecium leaf spot (MLS) symptomatic leaves were collected from the infected mulberry cultivar S-1635 in the field of the Institute; whereas, *Fusarium* root rot (FRR) infected root samples were collected from the farmers' fields of Murshidabad, Birbhum and Nadia (West Bengal). The causative pathogens were isolated form the infected tissues and cultured on 2% PDA amended with 0.3g/L streptomycin sulfate following standard protocols. Single-spore cultures derived from the isolated sources were multiplied by sub-culturing at 10 and 15days of intervals for MLS and FRR pathogens, respectively. The *Myrothecium roridum* and *Fusarium solani* cultures were maintained at CSRTI-BHP. Koch postulates were established for both the pathogens.



Eight designed antimicrobial peptides (AMPs; PRE-1 to 8; amino acid sequences available in public domain) were synthesized by outsourcing. These AMPs were assessed against MLS and FRR pathogens *in vitro.* Fungal growth inhibition assay was performed in microtiter plates following broth dilution method. Fungal growth was determined at specific time intervals (0-72h) by measuring A_{450} (patent information).

Considering the significantly higher mycelial growth suppression ability of PRE-2 against *M. roridum* and *F. solani* at lower doses (10µM onwards), subsequent experiments were undertaken to confirm the unique potential of PRE-2. Different concentrations of PRE-2 were evaluated to assess

suppression of conidial germination and mycelial growth of *M. roridum* and *F. solani in vitro*. Freshly prepared conidial suspensions ($2x10^5$ conidia/ml) were incubated with specified doses of PRE-2. Conidial germination was observed by light microscopy (600X) at 24h interval for 7 days. PRE-2 inhibited *F. solani* conidial germination significantly, >50% @ 10µM on first day; >90% @ 50µM & 100µM. *M. roridum* conidial germination was inhibited up to 24h at 50µM by >30% and >80% at 100µM.

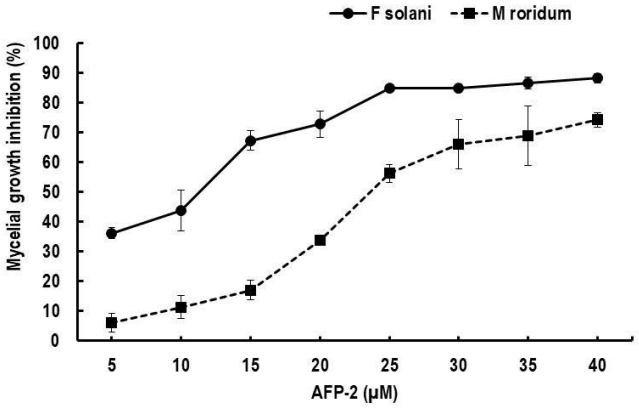


The mycelial growth suppression assay was performed in microtiter plates. Inocula ($2x10^5$ spores/ml) were incubated for 1-72h in PD broth containing different concentrations of PRE-2 (10µM-175µM). Appropriate controls (water + PD broth+ conidial suspension) and blanks (water + PD broth) were maintained. Fungal growth was determined at specific time intervals by measuring A_{450}. Highly significant mycelial growth inhibition by PRE-2: 72-96% after 18-48h at 50µM; 100% after 72h was observed.

Mycelial Growth Inhibition by PRE-2

Pathogen	Mycelial growth inhibition (%)					
	50µM			100µM		
	18h	24h	48h	18h	24h	48h
M. roridum	71.5 ± 4.6	91.5 ± 6.6	96.6 ± 2.2	85.2 ± 3.1	95.4 ± 1.1	96.9 ± 1.1
F. solani	73.6 ± 1.5	90.1 ± 2.4	97.3 ± 1.0	79.9 ± 4.5	92.1 ± 2.3	98.2 ± 0.7

MIC_{50} of PRE-2 was measured by modified broth microdilution method, with the assay conditions as described earlier ($2x10^5$ spores/ml in PD broth containing 5-40µM PRE-2 concentrations). The mycelial growth inhibition was monitored at specific time intervals (0, 1, 18, 24, 42, 48, 66 and 72h) with a microplate reader at 450nm. The MIC_{50} of PRE-2 was defined as the lowest concentration exhibiting 50% of inhibition of mycelial growth against the peptide-free controls (PD broth & water). The MIC_{50} of PRE-2 was 13.6µM for *F. solani* and 23.1µM for *M. roridum* after 24h incubation.



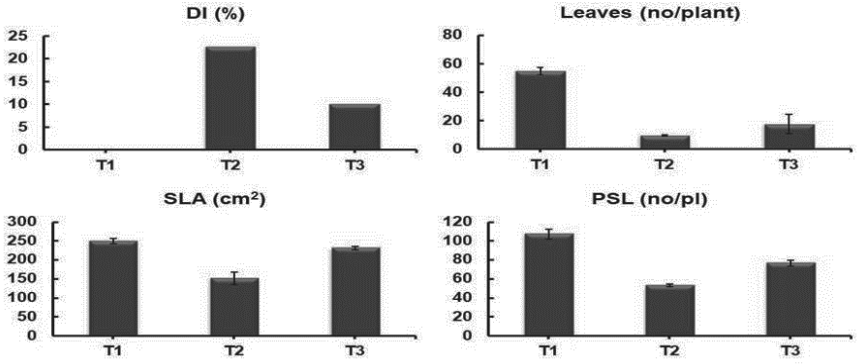
Assessment of MLS and FRR suppression by PRE-2 *ex vivo* was carried out in potted 30 days old S-1635 saplings in the glasshouse. *M. roridum* conidial suspension ($1x10^6$ conidia/ml; 5ml/plant) was inoculated onto the leaves and maintained in the greenhouse for 8-10 days with irrigation at 4 days interval. With the onset of characteristic leaf spot symptoms (10days), aqueous PRE-2 (50µM & 75µM) was sprayed to run-off; control plants were sprayed with distilled water. DSI was recorded upto 20 days (0-5 scale). Application of PRE-2 showed significant control of MLS disease severity *ex vivo* and MLS suppression was 1.4 fold (50µM) and 1.8-folds (75µM) and no disease symptoms were recorded post-PRE2 treatment.

Suppression of MLS disease by PRE-2 *ex vivo*

Treatment	Disease severity index (DSI)		Inhibition (%)	
	10d	20d	10d	20d
PRE-2 (50µM)	6.8 ± 0.6	9.9 ± 0.5	36	31
PRE-2 (75µM)	5.2 ± 0.7	8.4 ± 0.9	44	41
Control	9.3 ± 0.7	14.3 ± 0.9		

Data are mean of two individual experiments (n=3)

Suppression of FRR Disease Incidence by AFP-2 *ex vivo*



T_1: non-inoculated control; T_2: *F. solani* inoculated control without AFP-2
T_3: *F. solani* inoculated with AFP-2; DI: disease incidence;
SLA: Single leaf area; PSL: Primary shoot length

For FRR suppression study, about 30 days old S-1635 saplings grown in earthen pots in glasshouse were soaked in the conidial suspension ($1x10^6$/ml) overnight and transferred into the pots and kept in the glasshouse without any irrigation regime for 48h. The plants were maintained for 70 days. After the appearance of root rot infection symptoms (30 DAI), the saplings were sprayed with PRE-2 (100µM). *Fusarium* root rot (FRR) incidence along with the above ground morphological parameters was measured 70 days after treatment with PRE-2. PRE-2 treated and water treated plants were examined visually for the reduction of root rot symptoms (DI: 55%). The restoration was 48% leaves per plant, 67% leaf area and 34% primary shoot length in PRE-2 treated plants.

To determine the cytotoxicity of PRE-2 to silkworm hemocytes *in vitro*, bivoltine silkworm foundation cross (BCon1x BCon4) was reared following standard rearing methods. The silkworm haemolymph was collected by pricking prolegs of fifth instar 3rd day larvae (10 nos) on ice. The hemocytes were separated by centrifugation at 5000rpm for 10min at 4ºC. The hemocytes (20000 cells) were loaded on to 96-well flat bottom microtiter plate and mixed with different concentrations of PRE-2 (50-175µM) in quadruplets (200 µl/well). The plates were incubated for 4h at 27°C and lactate dehydrogenase release was determined by LDH assay (Pierce, Thermo Inc. India). PRE-2 cytotoxicity to silkworm hemocytes was negligible (0.68% at 50µM and 3.6% at 100µM); while, it was only 9.4% even at 175µM after 4h post-treatment (patent information).

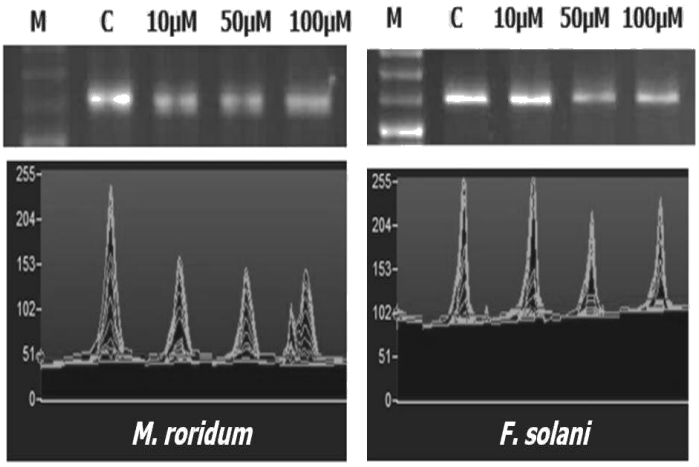
Silkworm hybrid [MCon4 x (BCon1.BCon4)] were brushed following standard method to determine the toxicity of *PRE*-2 to silkworms. 50-day old S-1635 plants were sprayed with PRE-2 (50µM & 100µM @ 20ml/plant) and leaves were utilized after 8 days post-treatment. Observations were recorded on survival (%) and larval weight (g) at the initiation of second and third instars. Non-significant differences were observed on silkworm larval weight and survival of young age silkworms in PRE-2 treated batches. Larval body mass was unaltered by PRE-2 in comparison to water-treated leaves. PRE-2 was non-toxic to silkworms at effective concentrations.

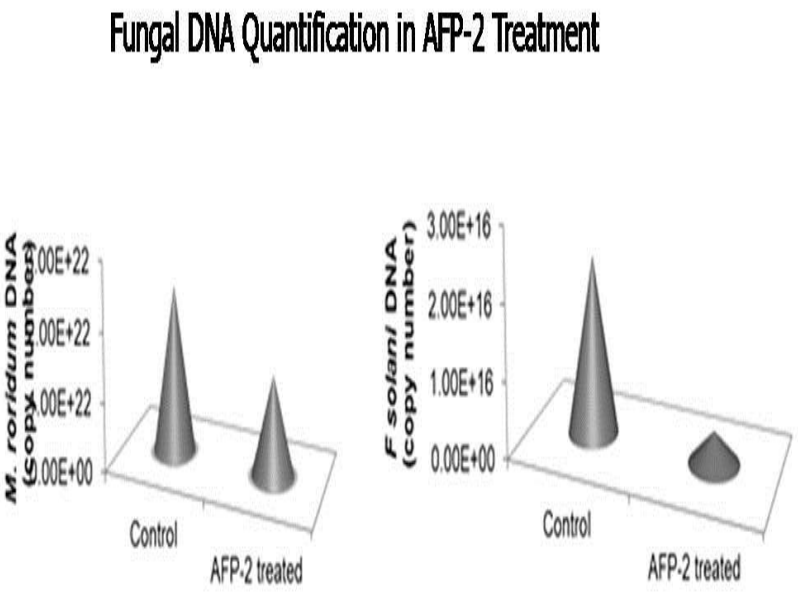
PRE-2 Effect on Young Age Silkworm Rearing

Treatments	Hatching (%)	Survival (%)		10 Larvae Wt. (g)
		2nd Instar	3rd Instar	
50µM PRE-2	93.7 ± 0.75	93.5 ± 1.11	90.5 ± 1.17	7.04 ± 0.66
100µM PRE-2	94.0 ± 0.81	93.9 ± 1.20	91.6 ± 1.08	7.26 ± 0.63
Control	94.4 ± 0.96	94.6 ± 0.70	91.5 ± 0.96	7.36 ± 0.62

Data are mean ± SE (n = 5)

The MLS and FRR suppression ability of PRE-2 was confirmed by determining the amplification of pathogens DNA *in vitro* and *ex vivo*. *M. roridum* and *F. solani* conidia ($1x10^5$ spores/ ml) were exposed to PRE-2 (10, 50 and 100µM) *in vitro* and allowed to grow for 24h in PD broth. Genomic DNA was subjected to PCR amplification by fungal ITS primers (ITS-1&4). In *F. solani*, PRE-2 at 10µM, 50µM and 100 µM concentrations reduced 1.1-fold, 1.2-fold and 1.2-fold DNA amplifications after 24h, respectively; 1.3 to 1.5-folds reduction of *M. roridum* at 10-100µM. Lower DNA amplification in peptide treated samples indicate that PRE-2 inhibited the multiplication of *F. solani* and *M. roridum*.





In the *ex vivo* experiment, after the development of disease symptoms (MLS: 15 DAI; FRR: 30 DAI) in potted plants, PRE-2 (100 µM; 10ml/plant) were sprayed and maintained further in greenhouse (MLS: 15 days; FRR: 30 days). Pathogen DNA from leaf and root of PRE-2 treated and control plants was isolated & quantified by qPCR. Absolute fungal DNA quantity was determined by Cq values to external standards. Lower DNA content in PRE-2 treated plants, 1.7-folds (*M. roridum*) and 5.5-folds (*F. solani*) indicates inhibition of multiplication of pathogenic fungi.

Inference:

- PRE-2 exhibited maximum conidial germination and mycelia growth suppression abilities against *M. roridum* (MIC_{50}: 23.1µM) and *F. solani (*MIC_{50}:14.6µM)
- 75µM PRE-2 suppressed MLS disease severity by 41%
- 100µM PRE-2 suppressed FRR by 55% symptoms and restored 48% leaves and 67% leaf area
- PRE-2 application inhibited fungal multiplication (qPCR; MLS: 1.7-folds; FRR: 5.5-folds)

Ongoing project

AIC02004CN: Molecular characterization and assessment of the efficacy of low molecular weight peptides isolated from mulberry leaf against flacherie disease of silkworm *[in collaboration with UNB, Siliguri]*

[May 2019 - May 2022]

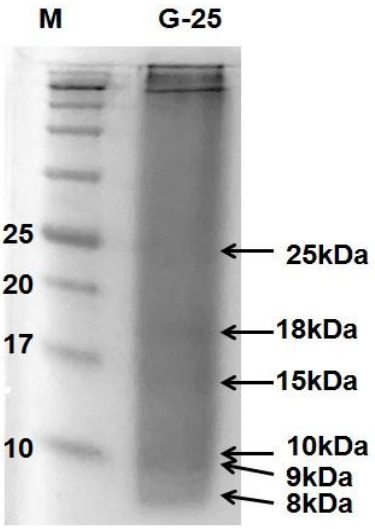
Pooja Makwana (PI), Palash Mandal (PI; UNB), Soumen Chattopadhyay, K Rahul, Suravi Ghosh (JRF; from Nov 2019)

Objectives:

- Purification and characterization of potential peptide(s) by HPLC-MS based approach
- Assessment of protection potential of low mol. wt. peptide fractions against flacherie
- Validation of disease suppression ability and silkworm quality parameters by the synthesized specific peptide against flacherie

Low molecular weight antimicrobial peptides (LMWPs) of 3-to 10kDa mass (<50 amino acids) are produced by plants which are mainly cationic in nature and rich in cysteine or glycine

residues. Many of these peptides are natural antibiotics and/or acts as primary defense barrier against pathogenic microorganisms. The study aims to identify bioactive peptides from mulberry leaves with antimicrobial and antioxidative properties against flacherie disease in silkworms.



A group of LMWPs (0.5-10KDa) from S-1635 mulberry leaves were enriched at UNB-Siliguri. Semi-purification of LMWPs was achieved by powdering in liquid Nitrogen and incubated in extraction buffer (pH 7.2; 1:5 v/v) for 3h at 4ºC. The mixture was centrifuged at 14000 rpm for 20 min at 4ºC and the supernatant was collected. Proteins were precipitated from the supernatant solution by 40% ammonium sulphate (40%) and centrifuged (14000rpm/20min/4ºC). The precipitated protein was dissolved in sterile deionised water. Desalted proteins (Sephadex G-25) were subjected to 15% SDS-PAGE and six peptides (25kDa to <10kDa) were resolved. Further, the desalted protein was subjected to ion-exchange chromatography (Dowex) and elute was filtered through Millipore Ultra-filtration system with Amicon filters (10; 3; 0.5 kDa). These fractions (10-5kDa; 5-3kDa; <3kDa) were stored at -20ºC for further experimentation. Protein quantity in these farctions was determined (µg/µL; 5-10kDa: 7.91; 3-5kDa: 6.32; <3kDa: 7.1). The semi-purified peptide fractions are being processed further. Standard cultures of *Bacillus* sp. and *Staphylococcus* sp. which causes bacterial flacherie in silkworm are being maintained for *in vitro* evaluations.

Continuous/Other Activities

A novel, rapid and simple assessment method for soil biological health in mulberry ecosystem

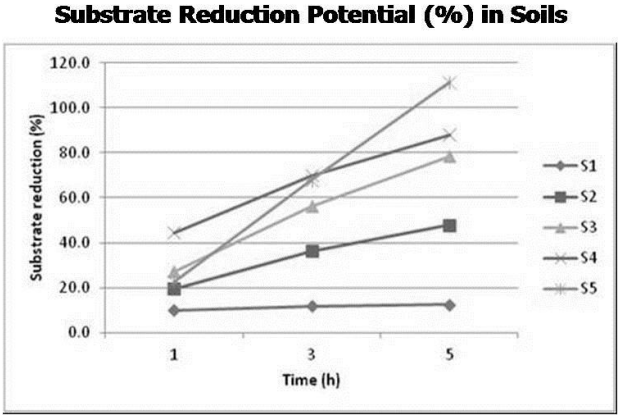
Aparna Kopparapu and Pooja Makwana

Objective: To device a rapid method for assessing soil microbial activity

Soil health is dependent on physical, chemical and biological properties of soil, the latter including the microbiota of the soil and influence plant productivity and health (USDA, 2018). General soil tests including Soil Health Card (SHC) programme are carried out to determine the levels of available macro- and micro-nutrients and recommend fertilizer/nutrient suppliments to improve crop productivity. These soil health assessment tests are incomplete as they do not include any test to assess the soil microbial load or activity. The current study aims to develop a simple and rapid method for assessing soil microbial activity to overcome the constraints associated with the existing practices. The assays are being designed based on the ability of soil microorganisms to reduce certain compounds. Rhizospheric soils were collected from different experimental mulberry plots at CSRTI-BHP (Kajli, V-1, S-1, S-1635, Vietnam-2, C-2038). The concentration of the substrate (designated as D_{ox}) was standardized. The concentration of reduced product (D_{red}) formed is directly proportional to the microbial activity of soils. The colour change brought about by

the reduction of substrate was measured spectrophotometrically at two wavelengths (WL1 & WL2). The substrate reduction potential was calculated from A_{WL1} & A_{WL2}. Soil samples collected from mulberry fields (12 farmers; Nadia district, West Bengal) also were utilized to standardize various components.

The quantity of soil required and other additives for minimizing errors as well as for accelerating the microbial activity have been standardized. The optimum incubation period for the assay was standardized to 4h based on the substrate reduction rate in different soils. The soils with highest microbial activity showed complete reduction of substrate at 5h. The novel method of measuring the soil microbial activity results could be well-correlated with the existing methods of soil microbial activity *i.e.*, dehydrogenase activity with a correlation coefficient of 0.7. The novel method developed allows visual interpretation of colour changes and takes 5h for minimizing the errors as soils from different areas/conditions vary widely. This visual assesemnt kit facilitates easy soil health assessment, which could be utilized by small soil testing laboratories and farmer's themselves.



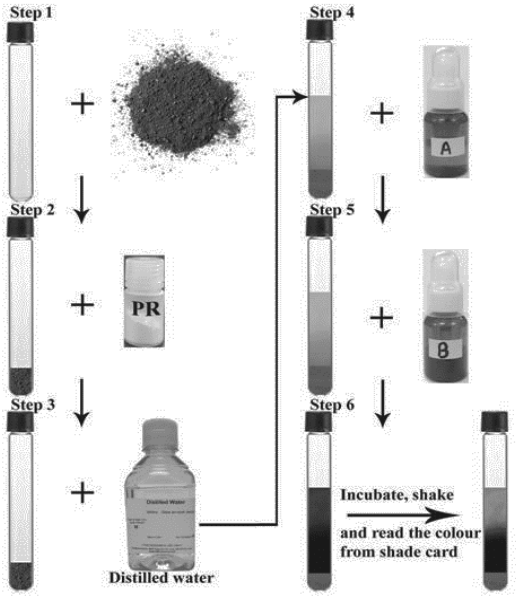
Soils can be categorized into one of the four groups based on soil microbial activity (kit's results) and to recommend required fertilizer/ manure/ nutrient supppliments accordingly. The kit would be useful to maximize and sustain the mulberry productivity besides improving mulberry leaf quality by mere monitoring of soil microbial activity assessment.

Soil Microbial Activity Assay

Assay Inference for Microbial Activity = Soil Health		Visual Colour*	Hex Colour Code*
Initial Sample			#
Very Low	0-25%		#
Low	26-50%		#
Medium	51-75%		#
High	75-100%		#

*** Patented Information**

Novel Soil Health Assessment Kit
(representative expression)



The advantages of the novel assay is that it is a simple method for assessment of soil microbial activity, which does not require any skill and facilitates for determining the general microbial activity of soils as an indicator for routine soil health monitoring; less expensive and does not require any sophisticated laboratory facilities; quicker than the existing methods (turbidometry, CO2 flush measurement, dehydrogenase activity, culturing of microbes); good correlation to the current reference method, dehydrogenase activity and alleviates the drawback of extensive extraction of the coloured product formed and is less influenced by the clay content of the soil, quite unlike the dehydrogenase assay.

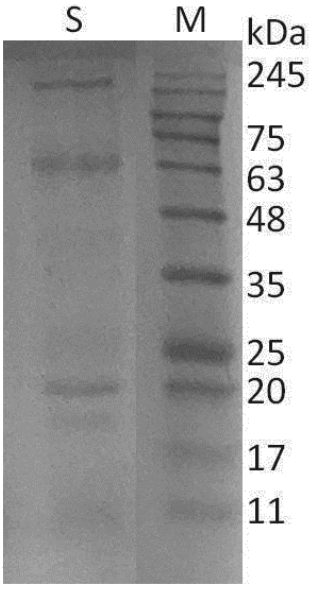
A simple and rapid test kit (to be appropriately named later) has been developed for accurate measurement of soil microbial activity in mulberry ecosystem. The kit developed needs to be validated further with a greater number of samples. The novel assay kit for soil health in terms of soil microbial activity is being applied for the patent and the kit could form as a less expensive and easy to operate assay for soil helath determination with minimum facilities and skill.

Standardization of Sericin extraction method from Nistari cocoons

Pooja Makwana

Objective: To standardize protocol for extraction of sericin polypeptides from Nistari cocoons

Silkworm *Bombyx mori*, produces silk consisting of two major proteins, fibroin and sericin. The two fibroin filaments are enveloped by consecutive layers of sericin protein to form a silk fibre. Sericin is endowed with several valuable properties such as antimicrobial activity, antioxidant activity, moisturizing and UV resistance that avenue its application in biomedical, cosmetics and food industry. The structural, biological and molecular properties of sericin polypeptides largely influence the utilization for various biomaterial purposes.



Nistari silkworm hybrids are predominantly reared in the Eastern India and reportedly associated with resistance to several abiotic/biotic stresses. Nistari silk yarn is quite popular in the region as Malda silk or Murshidabad silk. However, sericin is washed-off in the degumming process during silk reeling and large quantities of sericin are lost due to alkaline hybrdolysis. The current study aims to isolate native sericin polypeptides in an active form for biomaterial purposes from Nistari cocoons. The protocol was standardized by dissolving sericin portion in sterile water followed by precipitation and resolution on 10% SDS-PAGE. The gels were stained with Coomassie Brilliant Blue R-250 and destained using standard procedures. A total of 13 polypeptides were observed (8-200kDa), which corresponds to the sericin proteins reported from other strains of mulberry silkworm. The aim of the present study was for low molecular weight peptides and they were excised from gel and stored in 25mM aqueous solution of ammonium bicarbonate. These polypeptides are being analyzed/ characterized through LC-MS/MS by outsourcing for sequencing.

AGRONOMY & SOIL SCIENCE

Concluded Research Projects

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

V. Sivaprasad (PI; Jan-Oct 2019); C. Majee (PI; Aug-Dec 2018); K. Trivedi (PI; Nov 2016-July 2018); D. Chakravarty (Jan 2018-Oct 2019); M. Chaudhuri (Nov 2016-Dec 2017); V. Vijay; R. Mahesh; A. Pappachan; K. Suresh (Jan 2018-Oct 2019); L.S. Singh; R. Luikham (Nov 2016-July 2018); S. Chakraborty (July 2018-Oct 2019); G.B. Singh (Nov 2016-Aug 2018); L. Pachuau; B.N. Choudhury; P. Kumaresan (July 2018-Oct 2019); S.N. Gogoi (Nov 2016-Aug 2018); M. Pamehgam (Nov 2016-May 2018); U.C. Boruah (Nov 2016-July 2018); C.Z. Renthlei; B.K. Basumatary; S.K. Mishra (Nov 2016-June 2019); K. Alam (July 2019-Oct 2019); Z. Hossain (Nov 2018-Oct 2019); R. Kar (Nov 2016-Oct 2018); G. Singh; S.T. Lepcha; S. Dey (Nov 2016-May 2018); A. Borah (Nov 2016-May 2018); Sayantan Manna (SRF; Dec 2016-Oct 2019); Arunima Banerjee (SRF; June 2017-Oct 2019); Pebam B. Singh (JRF; Jan 2017-Oct 2019); Kanika Karan (JRF; Dec 2016-July 2017); Sibanjan Ghosh (JRF; July 2017-July 2018)

Objective: To analyse 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 soil health card (SHC) to the sericulture farmers (18000) in Eastern and North Eastern India.

States	Farmers			
	2017-18	2018-19	2019-20	Total
West Bengal (WB)	5068	9347	828	15243
Orissa (OR)		101		101
Chhattisgarh (CG)				
Jharkhand (JH)		48		48
Bihar (BR)				
Assam (AS)	100	113	182	395
Meghalaya (MG)		176	85	261
Arunachal Pradesh (AR)				
Tripura (TR)		1134		1134
Manipur (MN)	472	671	94	1237
Mizoram (MZ)		206	94	300
Nagaland (NL)				
Total	5640	11796	1283	18719

Representative soil samples of 18,719 sericulture farmer fields (607 villages; 75 blocks; 31 districts; 8 E & NE states) were collected following standard procedures. In brief, 2.5 hectare grid scale system was adopted in case of irigated mulberry farms, wherein 0-30cm deep representative surface soil samples from four corners and centre were collected for each $\leq$2.5 hectare land containing *n* number(s) farmers. Collected samples were mixed and reduced to 500g by quartering for obtaining composite sample. Five representative samples were collected and composite sample was prepared for each farmers plot in the hilly terrains/sparse growing areas. Composite samples with all the details were transported to

soil testing laboratory at CSRTI-Berhampore or RSRS- Imphal for further processing. The air dried, powdered and sieved samples were analysed following standard procedures prescribed (Mridaparikshak), a quantitative soil test minilab kit (Nagarjuna Agro Chemicals Pvt. Ltd., Wardha, India). The kit results could be comparable to methods of organic carbon (OC) by Walkley and Black; available nitrogen (N) by Subbaiah & Asija; available phosphorous (P) by Olsen & Bray; available potassium (K) by neutral ammonium acetate; available iron (Fe) & zinc (Zn) by DTPA extraction; available boron (B) by hot water soluble methods. Classification of soil nutrient status was conducted in accordance with the Soil Health Card Portal. SHC(s) with personalized soil test based recommended dose of nutrient(s) were distributed to the respective farmers and the data were uploaded in SHC portal, *https://soilhealth.dac.gov.in*. Soil fertility status with regard to available OC, N, P, K & S were assessed by calculating nutrient index (NI) value for each nutrient as described by Motsara *et al*. (1982). Descriptive statistical analysis was performed and state-wise data were documented.

Physico-Chemical Properties & Nutrient Status in Mulberry Growing Soils in E & NE India

Particulars	AS	JH	MN	MG	MZ	OR	TR	WB	Over All
Soil : Farmer	395:395	48:48	882:1237	205:261	87:300	101:101	266:1134	1194:15243	3178:18719
pH	3.01-8.26 (5.46±0.97)	4.08-7.90 (5.24±0.97)	4.26-7.57 (5.76±0.64)	3.60-7.47 (4.87±0.53)	4.47-7.49 (5.42±0.70)	3.26-6.16 (4.46±0.59)	3.50-6.85 (4.68±0.66)	3.07-8.63 (5.76±1.36)	3.01-8.63 (5.52±1.09)
EC (dS/m)	0.01-2.00 (0.28±0.29)	0.01-0.59 (0.12±0.14)	0.00-1.72 (0.06±0.14)	0.00-0.50 (0.08±0.11)	0.00-1.90 (0.21±0.26)	0.01-0.46 (0.21±0.19)	0.01-1.00 (0.29±0.28)	0.01-3.30 (0.37±0.31)	0.00-3.30 (0.24±0.28)
OC (%)	0.04-2.53 (0.69±0.40)	0.04-1.99 (1.04±0.60)	0.31-1.92 (1.21±0.27)	0.26-1.99 (1.38±0.35)	0.58-1.76 (1.35±0.25)	0.17-2.24 (0.95±0.39)	0.02-2.30 (0.73±0.42)	0.02-2.28 (0.83±0.39)	0.02-2.53 (0.97±0.43)
N (kg/ha)	46.7-748 (296±104)	128-543 (339±129)	154-529 (377±57.0)	176-614 (425±82.0)	243-495 (408±52.2)	163-595 (331±88.2)	119-691 (300±106)	28.0-686 (326±103)	28.0-747 (343±97.9)
P_2O_5 (kg/ha)	0.89-291 (75.8±70.5)	13.4-230 (71.1±46.5)	0.89-311 (66.6±64.9)	0.89-318 (69.7±64.6)	0.89-76.9 (21.5±18.8)	1.79-224 (48.3±55.6)	1.79-213 (42.7±41.0)	0.89-947 (106±87.4)	0.89-947 (78.9±75.8)
K_2O (kg/ha)	5.16-577 (172±127)	27.9-490 (254±112)	1.39-532 (179±129)	1.29-489 (164±125)	104-503 (313±91.1)	16.7-409 (141±91.8)	5.16-507 (157±100)	1.29-908 (161±128)	1.29-908 (172±126)
S (mg/kg)	1.00-76.3 (18.2±13.4)	2.00-124 (31.3±27.9)	1.00-102.0 (14.2±14.6)	1.00-61.0 (11.2±11.3)	1.00-37.0 (8.07±9.10)	5.00-68.0 (22.1±13.0)	1.00-72.8 (16.3±15.1)	1.00-128 (10.2±12.8)	1.00-128 (13.5±14.3)
Zn (mg/kg)	0.18-15.5 (2.83±2.90)	0.31-7.76 (2.42±1.70)	0.18-6.84 (1.64±1.42)	0.18-8.14 (2.43±2.17)	0.18-6.28 (2.57±1.81)	1.11-16.7 (5.86±3.02)	0.18-9.06 (2.93±1.65)	0.18-24.3 (4.68±3.57)	0.18-24.3 (3.26±3.02)
B (mg/kg)	0.09-9.29 (1.83±1.60)	0.12-6.99 (2.24±1.25)	0.09-3.95 (0.69±0.70)	0.09-37.7 (2.70±7.27)	0.09-8.00 (2.53±2.96)	0.09-5.70 (1.73±1.64)	0.09-9.01 (1.99±1.81)	0.09-26.0 (2.36±2.94)	0.09-37.7 (1.80±2.87)
Fe (mg/kg)	3.13-48.6 (26.2±7.71)	7.39-35.2 (24.0±7.82)	6.38-39.6 (31.6±3.54)	0.56-39.3) (24.4±9.10)	15.2-48.7 (31.1±3.72)	0.55-43.1 (22.3±7.97)	6.60-36.6 (28.7±5.14)	0.89-42.3 (25.0±9.32)	0.55-48.7 (27.3±7.97)
Mn (mg/kg)	0.45-70.9 (8.53±7.96)	3.60-49.4 (23.1±13.3)	2.25-59.3 (24.9±11.9)	0.90-40.4 (13.2±6.58)	9.89-47.6 (31.3±8.73)	0.45-58.2 (24.7±16.7)	0.45-45.8 (11.4±7.31)	0.45-87.2 (18.6±18.4)	0.45-87.2 (18.8±15.2)
Cu (mg/kg)	0.09-41.5 (10.0±9.85)	0.09-26.9 (7.31±7.46)	0.09-19.9 (2.39±2.65)	0.09-12.0 (1.90±2.32)	1.77-9.07 (3.67±1.13)	0.09-93.0 (3.95±9.23)	0.18-33.9 (8.76±7.83)	0.09-38.0 (6.56±6.76)	0.09-93.0 (5.56±6.91)

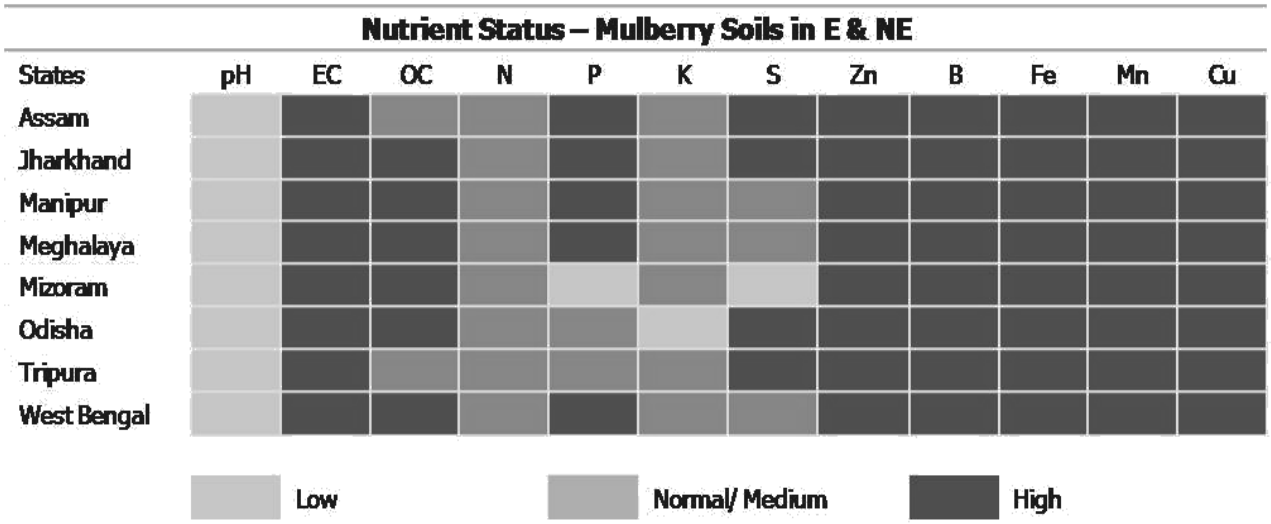
Fertility Status of Mulberry Growing Soils (%)

State	pH						EC		OC		
	Acidic (<4.5)	Mod. Acidic (4.5-5.5)	Slightly Acidic (5.6-6.5)	Neutral (6.6-7.5)	Slightly Alkaline (7.6-8.5)	Alkaline (>8.5)	Not-Saline (<2)	Slightly Saline (2-4)	Low (<0.5)	Medium (0.5-0.75)	High (> 0.75)
AS	15.4	33.7	35.7	14.2	1.01	Nil	99.8	0.25	33.9	27.6	38.5
JH	22.9	43.8	20.8	10.4	2.08	Nil	100	Nil	27.1	8.33	64.6
MN	0.79	35.4	51.0	12.7	0.11	Nil	100	Nil	0.79	3.74	95.46
MG	19.5	72.2	6.34	1.95	Nil	Nil	100	Nil	2.44	6.34	91.2
MZ	1.15	66.7	21.8	10.3	Nil	Nil	100	Nil	Nil	1.15	98.9
OR	52.5	44.6	2.97	Nil	Nil	Nil	100	Nil	15.8	10.9	73.3
TR	49.2	38.0	11.3	1.50	Nil	Nil	100	Nil	34.6	20.3	45.1
WB	21.5	28.9	17.1	15.6	16.4	0.50	99.6	0.42	21.7	24.3	54.0

Almost all the soil samples were non-saline as per EC values

Macro & Micro Nutrient Status in Mulberry Growing Soils (%)

Nutrients	Range	AS	JH	MN	MG	MZ	OR	TR	WB	Over All
N	Low (<280)	48.1	37.5	4.65	7.32	1.15	27.7	47	34.3	26
	Medium (280–560)	50.6	62.5	95.4	87.3	98.9	71.3	51.1	64	72.6
	High (>560)	1.27	Nil	Nil	5.37	Nil	0.99	1.88	1.76	1.35
P_2O_5	L (<23)	30.4	10.4	31.5	21	57.5	48.5	38.4	12.7	25.1
	M (23-57)	22	41.7	29.3	35.6	35.6	23.8	38	21.3	26.7
	H (>57)	47.6	47.9	39.2	43.4	6.9	27.7	23.7	66	48.2
K_2O	L (<145)	52.2	18.8	49.1	53.7	5.75	60.4	51.9	53.4	50.4
	M (145-337)	34.7	56.3	35.2	33.7	52.9	36.6	42.9	36.9	37.1
	H (>337)	13.2	25	15.8	12.7	41.4	2.97	5.26	9.72	12.5
S	L (<10)	31.7	16.7	47.3	54.6	66.7	9.9	49.6	67.2	52.4
	M (10-15)	16.7	18.8	16.1	18.5	16.1	28.7	11.7	12.9	15.2
	H (>15)	51.7	64.6	36.6	26.8	17.2	61.4	38.7	19.9	32.5
Zn	Sufficient (>0.6)	83.5	93.75	65.1	75.6	77	100	98.12	94.89	83.9
	Insufficient (<0.6)	16.5	6.25	34.9	24.4	23	Nil	1.88	5.11	16.1
B	Sufficient (>0.5)	76.2	93.75	50	72.7	65.5	65.3	82.3	81.8	71
	Insufficient (<0.5)	23.8	6.25	50	27.3	34.5	34.7	17.7	18.2	29
Fe	Sufficient (>4.5)	98.73	100	100	93.66	100	98.02	100	97.99	98.62
	Insufficient (<4.5)	1.27	Nil	Nil	6.34	Nil	1.98	Nil	2.01	1.38
Mn	Sufficient (>2)	96.96	97.92	75.8	66.8	100	95.05	99.62	98.91	90.15
	Insufficient (<2)	3.04	2.08	24.2	33.2	Nil	4.95	0.38	1.09	9.85
Cu	Sufficient (>0.2)	88.1	100	100	99.02	100	91.09	95.86	88.9	93.64
	Insufficient (<0.2)	11.9	Nil	Nil	0.98	Nil	8.91	4.14	11.1	6.36

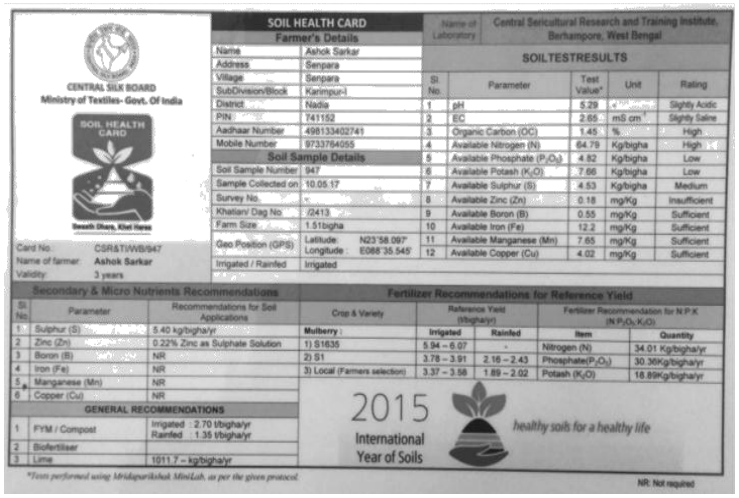


Comprehensive Nutrient Status of Mulberry Growing Soils in E & NE India

States	pH	Nutrient index/Nutrient Status					Micronutrient Deficiency*
		OC	N	P	K	S	
AS	Acidic – Neutral	2.05; M	1.53; L	2.17; M	1.61; L	2.20; M	B > Zn > Mn > Cu > Fe
JH	Acidic – Neutral	2.38; H	1.63; L	2.38; H	2.06; M	2.48; H	Zn = B > Cu
MN	Acidic - Neutral	2.95; H	1.95; M	2.08; M	1.67; M	1.89; M	**B** > **Zn** > Cu
MG	Acidic	2.89; H	1.98; M	2.22; M	1.59; L	1.72; M	**Cu** > B > Zn > Fe > Mn
MZ	Acidic - Neutral	2.99; H	1.99; M	1.49; L	2.36; H	1.51; L	**B** > Zn
OR	Acidic	2.58; H	1.73; M	1.79; M	1.43; L	2.52; H	**B** > Mn > Cu > Fe
TR	Acidic	2.11; M	1.55; L	1.85; M	1.53; L	1.89; M	B > Mn > Zn > Cu
WB	Acidic – Alkaline	2.32; M	1.68; M	2.53; H	1.56; L	1.53; L	B > Mn > Zn > Fe > Cu
Over All	Acidic – Neutral	2.51; H	1.75; M	2.23; M	1.62; L	1.80; M	B > Zn > Cu > Mn > Fe

*Micronutrients found deficient in >33 % of the total samples analyzed are indicated in bold

L: low; M: medium; H: high



SOIL HEALTH CARD

CENTRAL SILK BOARD
Ministry of Textiles- Govt. Of India

Farmer's Details

Name	Ashok Sarkar
Address	Senpara
Village	Senpara
SubDivision/Block	Karimpur-I
District	Nadia
PIN	741152
Aadhaar Number	498133402741
Mobile Number	9733764055
Soil Sample Details	
Soil Sample Number	947
Sample Collected on	10.05.17
Survey No.	-
Khatian/ Dag No.	/2413
Farm Size	1.51bigha
Geo Position (GPS)	Latitude: N23°58.097' Longitude: E088°35.545'
Irrigated / Rainfed	Irrigated

Name of Laboratory: Central Sericultural Research and Training Institute, Berhampore, West Bengal

SOIL TEST RESULTS

Sl No.	Parameter	Test Value*	Unit	Rating
1	pH	5.29	-	Slightly Acidic
2	EC	2.65	mS cm	Slightly Saline
3	Organic Carbon (OC)	1.45	%	High
4	Available Nitrogen (N)	64.79	Kg/bigha	High
5	Available Phosphate (P_2O_5)	4.82	Kg/bigha	Low
6	Available Potash (K_2O)	7.66	Kg/bigha	Low
7	Available Sulphur (S)	4.53	Kg/bigha	Medium
8	Available Zinc (Zn)	0.18	mg/Kg	Insufficient
9	Available Boron (B)	0.55	mg/Kg	Sufficient
10	Available Iron (Fe)	12.2	mg/Kg	Sufficient
11	Available Manganese (Mn)	7.65	mg/Kg	Sufficient
12	Available Copper (Cu)	4.02	mg/Kg	Sufficient

Card No: CSR&TI/WB/947
Name of farmer: Ashok Sarkar
Validity: 3 years

Secondary & Micro Nutrients Recommendations

Sl No.	Parameter	Recommendations for Soil Applications
1	Sulphur (S)	5.40 kg/bigha/yr
2	Zinc (Zn)	0.22% Zinc as Sulphate Solution
3	Boron (B)	NR
4	Iron (Fe)	NR
5	Manganese (Mn)	NR
6	Copper (Cu)	NR

GENERAL RECOMMENDATIONS

1	FYM / Compost	Irrigated : 2.70 t/bigha/yr Rainfed : 1.35 t/bigha/yr
2	Biofertiliser	
3	Lime	1011.7 – kg/bigha/yr

Fertilizer Recommendations for Reference Yield

Crop & Variety	Reference Yield (t/bigha/yr)	
	Irrigated	Rainfed
Mulberry :		
1) S1635	5.94 – 6.07	-
2) S1	3.78 – 3.91	2.16 – 2.43
3) Local (Farmers selection)	3.37 – 3.58	1.89 – 2.02

Fertilizer Recommendation for N:P:K (N:P_2O_5:K_2O)

Item	Quantity
Nitrogen (N)	34.01 Kg/bigha/yr
Phosphate(P_2O_5)	30.36Kg/bigha/yr
Potash (K_2O)	18.89Kg/bigha/yr

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*Tests performed using Mridaparikshak MiniLab, as per the given protocol.
NR: Not required

Nutrient Status in Problematic Soils of E & NE India			
State	Available Nutrient Status		
	Macro	Secondary	Micro#
AS	N & K		
JH	N		
MN			B, Zn
MG	K		Cu
MZ	P	S	B
OR	K		B
TR	N & K		
WB	K	S	
# found in >33 % of the total samples			

Inference: Mulberry growing fields in the Eastern and North Eastern states of India are acidic (81.7%), non-saline (99.8%), high in OC% (NI=2.51), low in available potassium (NI=1.62), medium in available N (NI=1.75), medium in available P (NI=2.23), medium in available S (NI=1.80) and deficient in micronutrients like B (29%), Zn (16.1%), Cu (9.85%), Mn (6.36%) and Fe (1.38%). Availability of potassium was lowest in Odisha (1.43); nitrogen was lowest in Assam (1.53) & Tripura (1.55); available phosphorous was low only in Mizoram (1.49); sulphur was low in Mizoram (1.51) & West Bengal (1.53). Deficiency of micronutrients, particularly Boron followed by Zinc and Copper was predominant. Soil Health Cards with recommended dose of nutrients to alleviate the limitations imposed by acidity, nutritional status and deficiency of micronutrients were distributed to the respective mulberry growing farmers.

Ongoing Projects

PPA02005SI: Optimization of spacing and nutrient dose for newly developed high yielding mulberry variety, C2038 under irrigated conditions

[Oct 2019 - Sep 2023]

R. Mahesh (PI), Vijay, V and D. Chakravarty (Co-ordinator)

Objective

- To find out the optimum spacing and level of fertilizer for higher leaf productivity and better leaf quality under irrigated condition for the high yielding mulberry variety, C2038

C-2038, high yielding mulberry variety is authorised by Mulberry Variety Authorization Committee for Eastern and North Eastern Regions of India. It is essential to develop a comprehensive package of practices for maximizing the potential of new variety. Field experiment was initiated at CSRTI-BHP with treatments of spacing (S_1: 2'×2'; S_2: 3'×3'; S_3: (5'+3') ×2';

S_4: 6'×6') and fertilizer (F_1: 75%; F_2:100%; F_3:110%; F_4:120%; F_5:130% on RDF) under strip-plot design in three replications. Recommended dose of fertilizer for mulberry is 336:180:112 (N:P:K; kg/ha/yr) from recommended sources in two split doses on 15th day and 30th day after pruning. Six months-old C-2038 saplings were raised as per standard practice in nursery and transplanted in experimental plots for establishment with proper agronomic practices. Initial soil fertility status of experimental plot was documented. Data on growth, yield and quality parameters of mulberry would be collected from 2nd year onwards.

Farm Management

The farm management unit maintains 23.33 acres mulberry plantations for experimental, propagation and silkworm rearing purposes. The unit also produces vermicompost utilizing farm resources (4700kg).

Leaf Supply for Silkworm Rearing

Season	Quantity (kg)	DFLs Reared
Baisakhi	4163	565
Shravani	8965	430
Aswina	11716	690
Agrahayani	13165	600
Chaitra	4054	350
Total	42063	2635

Mulberry Plantations

Variety	Spacing	Type	Acres
S1635	2'×2'	Low Bush	0.29
	3'×3'		0.60
	4'×2'		2.44
	6'×3'		0.42
	(5'+3')×2'		1.74
	(5'+3')×4'		2.06
	5'×5'	High Bush	0.08
	7'×7'		3.20
	8'×8'	Medium Bush	0.38
	10'×4'		1.46
C2038	2'×2'	Low Bush	0.38
	3'×3'		0.15
	5'×5'		0.15
	(5'+3')×2'		0.54
	5'×5'	High Bush	0.37
	6'×6'		0.20
C2028	2'×2'	Low Bush	0.14
	4'×2'		0.21
S1	2'×2'		0.11
	4'×2'		0.29
Vishala	2'×2'		0.12
Gen-1	2'×2'		0.33
Ganga	2'×2'		0.50
C1730	(5'+3')×2'	Low Bush	0.16
$BC_2$59	2'×2'		0.13
TR23	(5'+3')×2'		0.16
V1	5'×5'	High Bush	0.08
Experimental Plots	2'×2'	Low Bush	0.99
	3'×3'		0.70
	(5'+3')×2'		0.28
	5'×5'	High Bush	0.37
Germplasm	2'×2'	Low Bush	0.33
	5'×5'	High Bush	1.43
Mapping Populations (ML × V1; BLS-F1; PMS)	(5'+3')×2'	Low Bush	1.1

MULBERRY PATHOLOGY

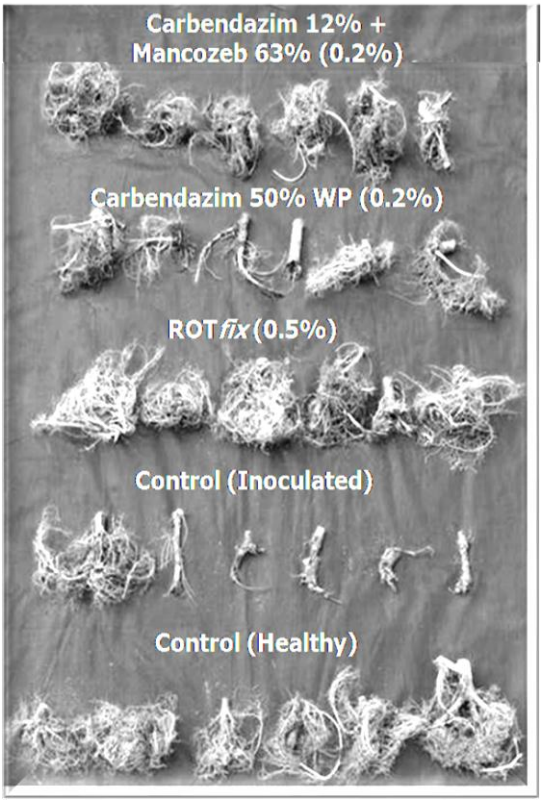
Ongoing Projects:

PRP 02003 SI: Studies on the management of mulberry root rot disease in E & NE India

[May 2019-May 2021]

Anil Pappachan (PI), V. Vijay and G.C. Das

Objective: To validate effective mulberry root rot management practices under field conditions



Fusarium soalni was isolated from the root rot samples from Karjora, Pipulkhola (West Bengal), Sille (Arunachal Pradesh) and Jorhat (Assam); while *Lasiodiplodia theobromae* from Kolasib (Mizoram). Glasshouse studies revealed that application of fungicides and eco-friendly formulation (ROT*fix*) prevented the death of plants due to *Fusarium* dry root rot; where as 44.44 % mortality was observed in untreated controls. Pooled analyses indicate that ROT*fix* increased the length of longest shoot, total shoot Length and biomass. Field trials at farmers' fields of Karjora (10), Alinagar (15), Kachubari (17), Poradanga (1), Bankipur (1) and Mallikpur (10) villages are under progress with the effective treatment.

Effect of Fungicides on Root Rot of Mulberry (Glasshouse Conditions)

Treatment	Survival (%)	Wilting (%)	Rotting (%)	Longest Shoot Length (cm)	Total Shoot Length (cm)	Biomass (g/plant)
Carbendazim 12% + Mancozeb 63% (0.2%)	100.0	17.3	13.3	95.2^{ab}	167.3^{a}	87.5^{b}
Carbendazim (0.2%)	100.0	20.1	16.4	79.6^{bc}	123.5^{b}	73.7^{bc}
ROT*fix* (0.5%)	100.0	16.8	13.5	97.7^{ab}	191.3^{a}	107.8^{a}
Control (Inoculated)	55.6	65.9	60.6	64.4^{c}	108.9^{b}	54.9^{c}
Control (Healthy)	100.0	0.0	0.0	98.2^{a}	196.5^{a}	114.3^{a}
			CD@5%	18.4	32.8	21.0

Continuous/Other Activities:

Forewarning of mulberry diseases of Eastern & North Eastern India

Anil Pappachan (PI), G. R. Manjunatha, I/C of RSRSs & RECs of CSRTI-BHP

Objective: To develop data base for diseases of mulberry in E & NE India

Data on disease incidence was collected at weekly intervals across Eastern and North Eastern India. Prevalence of major 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). The data is recorded for documentation puposes and to consolidate the forewarning system.

PDI Status in Mulberry (2019-2020)

State	Unit	BLS	MLS	PLS	PMLD	BLR
West Bengal	CSRTI-BHP	16.4 (Aug)	15.5 (Aug)	3.9 (Nov)	4.6 (Nov)	
	Murshidabad	16.0 (June)	6.0 (Aug)	3.9 (Oct)		2.0 (Jan)
	Malda	2.4 (Aug)	3.4 (Aug)	1.3 (April)		
	Kalimpong				6.1 (July)	6.3 (Oct)
Odisha	Koraput				5.7 (Oct)	4.8 (May)
Assam	Mangaldoi				1.8 (May)	4.5 (May)
Tripura	Agartala				100.0 (Dec)	
Mizoram	Aizawl			0.4 (July & Aug)		
Nagaland	Dimapur					
Manipur	Imphal			5.6 (June)		
Meghalaya	Shillong	0.7 (Nov)			6.9 (Oct)	3.4 (Nov)

Isolation and molecular identification of mulberry leaf endophytes with antifungal activities against Paramyrothecium roridum causing brown leaf spot

Songja Bey, Anil Pappachan and K. Rahul

Objective: To isolate and identify leaf endophytes from mulberry with antifungal activities against *Paramyrothecium roridum* causing brown leaf spot of mulberry

Sixty endophytes were isolated from the leaves of different germplasm accessions maintained at CSRTI-BHP. Efficacy of endophytes was evaluated against *Paramyrothecium roridum* (Tode) L. Lombard & Crous causing brown leaf spot in mulberry by dual culture. Effective isolates were determined to be *Bacillus spp*. based on morphological characteristics. The bacterial isolates: CG, CA, MF, G_2 and P_2 were the most effective with >80% mycelial growth inhibition. The molecular identification by sequencing of 16S rRNA revealed that CG isolate shared 94.06% nucleotide similarity with *Bacillus subtilis* and 93.62% nucleotide similarity with *B. amyloliquefaciens,* which are well known endophytes.

***in vitro* mycelial growth inhibition by Endophyte's**

Isolate	Growth Inhibition (%)
CG	88.3 (9.4)[a]
CA	87.2 (9.3)[a]
E_1	70.5 (8.3)[bc]
A_3	32.7 (5.6)[d]
MF	88.0 (9.4)[a]
A_2	65.4 (8.0)[c]
G_2	86.5 (9.2)[a]
AA	84.1 (9.1)[ab]
P_2	87.1 (9.3)[a]
CD@5%	0.90

ENTOMOLOGY

Continuous/Other Activities

ToT-PRE 3508-Phase II: Mass multiplication and maintenance of bio-control agent – Scymnus pallidicolli and its popularization at farmers' level

[June 2018 - May 2021]

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

Objectives:

- To conserve and multiply *S. 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 farmers on mass multiplication of *S. pallidicolli*

Around 17000 predators were multiplied with mealy bug cultured on sprouted potatoes and pumpkins and 7500 predators were released in three districts of West Bengal (Malda, Birbhum & Nadia) in 75 farmers' mulberry gardens. Predators were also released in Institute's mulberry gardens. Release of *Scymnus pallidicolli* in farmers' fields resulted in the reduction of pest by 67.74% egg colonies, 51.35% of nymphs and 67.47% of adults.

Field Efficacy of *Scymnus* beetles for mealy bug management (Tukra)

District	Pre release of BCA			Post release of BCA			Reduction in Pest Population (%)		
	Egg Colonies	Nymph	Adult	Egg Colonies	Nymph	Adult	Egg Colonies	Nymph	Adult
Birbhum	10	4	3.2	3.2	2.6	1.5	68	35	53
Nadia	6	2.6	1.6	2	1.2	0.5	67	54	68.7
Malda	8.2	4.6	3.2	2.8	1.5	0.9	66	67	71.8
Avg	8.1	3.7	2.5	2.6	1.8	0.8	67.7	51.4	67.5

75 Officers/Officials/SHGs from West Bengal were trained in mass culture, maintenance and multiplication of Bio-Control Agents (*S. pallidicolli* and *Chrysoperla zastrowi)*.

Survey and Surveillance of Mulberry Pests in the Eastern & North Eastern India

Radha.M.B., Manjunath G.R and I/C of RSRSs & RECs of CSRTI-BHP

Objective: To generate and widen the database on pest incidence and climatic factors

Data on pest incidence was collected from mulberry genotypes cultivated across Eastern and North Eastern regions of India. Data were collected from ten randomly selected plants per 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 the data. From

each twig, number of thrips per leaf (from top 4th, 5th, 6th, 7th leaf) was counted; adult and nymph population of whitefly will be recorded from top, middle and bottom 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. The mealybug infestation recorded in Kalimpong is of root mealybug type.

Seasonal Occurrence of Major Pests in Mulberry Ecosystem (2019-2020)													
Thrips (No/leaf)													
Area	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Range
CSRTI-BHP	18.56	12.47	23.35	0.84		2.03					3.9	1.51	0 - 23.35
Malda	1	2	12	10	8						1.5		0 - 12
Mamring		1.12											0 - 1.12
Koraput	5.56	5.97			2.63	3.80	4.54	2.13					0 - 5.97
Jorhat		3.5											0 - 3.5
Agartala			18.5	5.5									0 - 18.5
Mealybug/Tukra (%)													
CSRTI-BHP	5.2	7.4	8.9	15	2.48	1.63							0 - 15
Malda	1	1	5	4	4								0 - 5
Kalimpong	2.97	4.75	4.72	6.73	6.78	3.27	4.84	4.84		1.69	2.32		0 - 6.78
Mamring													
Koraput	6.39	6.52			2.03	3.29	3.79	4.16					0 - 6.52
Jorhat		5.25	5.6										0 - 5.6
Agartala													
Whitefly (No/leaf)													
CSRTI-BHP					5.5	9.43	21.13	5.33					0 - 21.13
Malda						3	3.43	2.32					0 - 3.43
Koraput	3.74	4.38			0.75	4.23	3.91	5.18					0 - 5.18
Jorhat													
Imphal	0.17	0.49	0.88	1.2		1.19	1.49	0.43	0.53				0 - 1.49
Agartala													

SILKWORM BREEDING & GENETICS

Concluded Projects

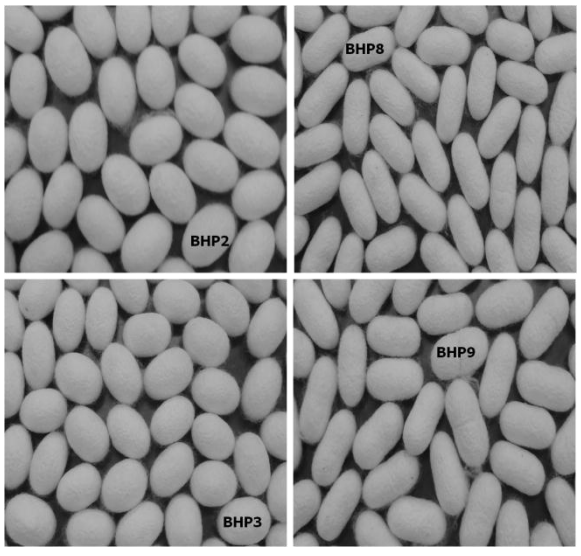
AIB 3617: Identification of region specific bivoltine hybrids suitable for highly fluctuating and seasonally variable climatic conditions of E & NE India (Phase II of AIB 3466)

[April 2017 – March 2020]

V.Lakshmanan (PI), N.Chandrakanth, V.S.Raviraj (from Mar 2019) and NB Kar (Apr 2017-Jan 2019), Gautam Mitra (from Feb 2019) & incharges of REC- Bhandra; RSRS- Jorhat; RSRS- Koraput; RSRS- Kalimpong; REC-Shillong

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

Bivoltine breeds (oval: BHP1, BHP2, BHP3, BHP4 & BHP5; dumbbell: BHP6, BHP7, BHP8, BHP9 & BHP10) developed suitable for climatic conditions of Eastern and North-Eastern India through shuttle breeding approach were subjected for hybrid evaluation in all the seasons (Jaistha, Bhaduri, Agrahayani & Falguni) by rearing 300 larvae @ IV instar in 3-6 cellular batches during 2017-2020. Five breeds *viz*., BHP4, BHP5, BHP6, BHP7 & BHP10 were culled out during different seasons based on inferior overall performance. Directional selection was exercised to improve the shell weight in the BHP lines albeit with lower cocoon weights on par with existing popular bivoltine breeds. The stabilized BHP lines were utilized for conducting evaluation of single and double hybrids in different seasons/locations.



Performance of BHP breeds

Breed	Fec (No)	ERR (No)	ERR Wt (kg)	Cocoon Wt (g)	Shell Wt (g)	Shell (%)
BHP 1	472	7620	10.96	1.379	0.262	19.00
BHP 2	506	9060	13.61	1.456	0.281	19.29
BHP 3	518	8840	12.94	1.436	0.303	21.10
BHP 8	492	9120	11.90	1.274	0.262	20.56
BHP 9	488	8620	12.04	1.330	0.280	21.05
SK6	486	8240	11.56	1.426	0.243	17.04
SK7	472	9010	12.36	1.404	0.236	16.80
BCon 1	502	8640	12.63	1.489	0.249	16.65
BCon 4	466	8060	11.09	1.372	0.250	18.22
CD @ 5%	13	393	0.66	0.051	0.017	1.38

Seasonal Performance of BHP breeds (2017-2020)

Breed	Season	Fec (No)	ERR (No)	ERR Wt (Kg)	Cocoon Wt (g)	Shell Wt (g)	Shell (%)
	Jaistha	492	8917	12.91	1.386	0.243	17.53
	Bhaduri	466	7920	10.64	1.291	0.226	17.50
BHP 1	Agrahayani	458	9092	12.04	1.292	0.246	19.00
	Falguni	547	8560	11.96	1.383	0.254	18.37
	Mean	**491**	**8622**	**11.89**	**1.338**	**0.242**	**18.10**
	Jaistha	486	8450	11.56	1.331	0.240	18.07
	Bhaduri	501	8000	10.61	1.315	0.237	18.02
BHP 2	Agrahayani	498	8710	12.83	1.410	0.251	17.80
	Falguni	522	9360	14.43	1.429	0.270	18.89
	Mean	**502**	**8630**	**12.36**	**1.371**	**0.250**	**18.20**
	Jaistha	479	8333	11.72	1.373	0.245	17.87
	Bhaduri	523	7864	10.21	1.218	0.233	19.12
BHP 3	Agrahayani	506	9217	13.53	1.404	0.270	19.23
	Falguni	516	8740	13.14	1.416	0.281	19.77
	Mean	**506**	**8539**	**12.15**	**1.353**	**0.260**	**19.17**
	Jaistha	495	8200	10.98	1.301	0.248	19.10
	Bhaduri	481	7100	9.55	1.293	0.227	17.57
BHP 8	Agrahayani	476	8700	12.78	1.380	0.253	19.10
	Falguni	454	9240	13.56	1.319	0.256	19.40
	Mean	**477**	**8310**	**11.72**	**1.323**	**0.246**	**18.79**
	Jaistha	485	8225	11.46	1.355	0.254	18.73
	Bhaduri	473	7613	10.48	1.344	0.237	17.60
BHP 9	Agrahayani	484	9258	13.01	1.383	0.260	18.79
	Falguni	492	9760	13.84	1.398	0.266	19.02
	Mean	**484**	**8714**	**12.20**	**1.370**	**0.246**	**18.54**
	Jaistha	485	8425	10.81	1.267	0.208	16.38
	Bhaduri	492	8278	11.11	1.322	0.197	14.93
SK6	Agrahayani	488	7880	10.54	1.313	0.218	16.60
	Falguni	441	8286	10.97	1.308	0.222	16.94
	Mean	**477**	**8217**	**10.86**	**1.303**	**0.213**	**16.34**
	Jaistha	479	9258	11.94	1.278	0.202	15.78
	Bhaduri	514	8167	11.12	1.353	0.214	15.82
SK7	Agrahayani	492	9440	11.75	1.229	0.216	17.57
	Falguni	458	8964	11.86	1.304	0.220	16.87
	Mean	**486**	**8957**	**11.67**	**1.291**	**0.213**	**16.51**
	Jaistha	481	8387	11.21	1.315	0.216	16.40
	Bhaduri	488	7160	10.53	1.308	0.214	15.74
BCon 1	Agrahayani	502	8027	10.46	1.386	0.224	17.25
	Falguni	532	8630	11.54	1.308	0.226	17.25
	Mean	**501**	**8051**	**10.94**	**1.340**	**0.219**	**16.78**
	Jaistha	479	7104	9.31	1.258	0.218	17.31
	Bhaduri	432	6397	9.01	1.215	0.212	17.44
B Con 4	Agrahayani	466	7892	10.81	1.344	0.226	16.81
	Falguni	478	8147	10.64	1.317	0.222	16.85
	Mean	**464**	**7385**	**9.94**	**1.309**	**0.220**	**17.10**

Single hybrids: All possible combinations between BHP oval and dumbbell lines (25 hybrid combinations) were evaluated for two seasons in comparision to popular foundation crosses *viz*., SK6 x SK7 and BCon1 x BCon4. Based on rearing performance, cocoon and fibre characteristics, five hybrid combinations were short-listed employing multiple trait evaluation indices. Further short-listing was conducted based on overall performance across seasons/test centres and two most promising combinations, BHP2 x BHP8 and BHP3 x BHP8 were identified.

Performance of Short-listed Single Hybrids at CSRTI-Berhampore

Hybrid	Fec (No)	ERR (No)	ERR Wt (Kg)	Cocoon Wt (g)	Shell Wt (g)	Shell (%)	Avg. FL (m)	Denier	Reel (%)	Raw Silk (%)	Ren-ditta	Neat-ness	MEI
BHP2 x BHP7	432	8120	13.51	1.634	0.276	16.89	722	2.56	72	11.36	8.80	88	48.91
BHP2 x BHP8	506	9220	15.93	1.733	0.311	17.95	838	2.33	75	12.21	8.19	91	62.34
BHP2 x BHP10	465	8420	13.45	1.604	0.256	15.96	706	2.60	70	10.64	9.39	90	46.71
BHP3 x BHP8	414	8920	14.30	1.591	0.287	18.04	832	2.38	76	12.82	7.80	92	58.41
BHP3 x BHP10	408	7240	11.66	1.619	0.260	16.05	718	2.68	72	11.76	8.50	91	45.81
SK6 x SK7	481	8400	11.76	1.406	0.230	16.35	636	2.32	70	11.10	9.09	88	42.89
BCon1 x BCon4	504	7900	11.08	1.414	0.241	17.04	722	2.68	72	11.72	8.53	84	45.03
CD @ 5%	43	689	1.89	0.126	0.029	0.89	76	0.17	2.42	0.76	0.56	2.88	

Estimates of Heterosis in BHP Hybrids

Hybrid	Survival (No)	ERR Wt (Kg)	Cocoon Wt (g)	Shell Wt (g)	Shell (%)	AVFL (m)	Reel (%)	Raw Silk (%)	Neat-ness
BHP2 x BHP7	1.50	18.82	15.72	10.40	-4.58	3.29	2.86	2.90	-1.12
BHP2 x BHP8	10.55	30.73	19.27	19.62	0.36	15.11	2.74	6.54	1.11
BHP2 x BHP10	-1.86	10.97	14.00	2.81	-9.78	1.00	-2.78	-4.40	1.12
BHP3 x BHP8	2.06	11.28	10.10	9.13	-0.88	10.05	4.11	7.91	1.10
BHP3 x BHP10	-19.38	-8.80	15.73	3.17	-10.86	-1.24	0.00	1.82	1.11
SK6 x SK7 (CI)	8.21	11.05	4.07	5.02	0.89	3.25	-1.41	6.73	1.15
BCon1 x BCon4 (CII)	11.53	12.26	3.67	3.88	0.18	3.74	4.35	7.33	-2.33

Improvement (%) in BHP Hybrids over Existing Hybrids

Hybrid	Survival (No)	ERR Wt (Kg)	Cocoon Wt (g)	Shell Wt (g)	Shell (%)	AVFL (m)	Reel (%)	Raw Silk (%)	Neat-ness
SK6 x SK7 (CI)	8400	11.76	1.406	0.230	16.35	636	70	11.10	88
BCon1 x BCon4 (CII)	7900	11.08	1.414	0.241	17.04	722	72	11.72	84
BHP2 x BHP8	9220	15.930	1.733	0.311	17.95	838	75	12.21	91
IOC (CI)	9.76	35.46	23.26	35.22	9.79	31.76	7.14	10.00	3.41
IOC (CII)	16.71	43.77	22.56	29.05	5.34	16.07	4.17	4.18	8.33
BHP3 x BHP8	8920	14.300	1.591	0.287	18.04	832	76	12.82	92
IOC (CI)	6.19	21.60	13.16	24.78	10.34	30.82	8.57	15.50	4.55
IOC (CII)	12.91	29.06	12.52	19.09	5.87	15.24	5.56	9.39	9.52

Estimates of heterosis reveals that positive heterosis culminated for survival, cocoon weight, shell weight, filament length and raw silk content and was in higher magnitude in BHP2 x BHP8 followed by BHP3 x BHP8. As the expected hybrid vigour was not observed in the BHP hybrids, evaluation of double hybrids was contemplated to achieve sustainable productivity with the farmers across diverse agro-climatic conditions and unfavorable seasons. Double hybrids have unique advantage as they possess inherent plasticity exhibited by four different parental resources.

Double hybrids: Double hybrid evaluation studies were conducted during 2019-20 utilizing the best performing BHP ovals and dumbbell breeds. Twenty each of oval and dumbbell foundation crosses were evaluated along with two popular foundation crosses, SK6 x SK7 and BCon1 x BCon4. Promising foundation crosses, three ovals and five dumbbells were short-listed based on fitness and productivity merits for double hybrid test. Fifteen double hybrids were evaluated in two steps and two most promising combinations, viz., BHP 1.3 X BHP 8.9 and BHP 3.2 x BHP 8.9 were identified based on rearing performance, cocoon and fibre characteristics.

Performance of Selected Foundation Crosses

FC	Fec (No)	ERR (No)	ERR Wt (Kg)	Cocoon Wt (g)	Shell Wt (g)	Shell (%)	MEI
BHP1.BHP3 (O)	502	9217	16.36	1.564	0.310	19.80	56.22
BHP3.BHP2 (O)	522	8467	14.56	1.633	0.305	18.64	54.16
BHP4.BHP3 (O)	498	9250	18.40	1.673	0.315	18.82	53.24
BHP7.BHP9 (D)	508	8200	12.26	1.573	0.291	18.50	52.86
BHP8.BHP7 (D)	492	8740	14.14	1.546	0.288	18.63	56.20
BHP8.BHP9 (D)	455	9480	14.60	1.475	0.296	20.07	57.44
BHP9.BHP6 (D)	526	9120	14.70	1.617	0.306	18.92	54.24
BHP9.BHP7 (D)	456	8900	14.16	1.646	0.311	18.89	53.44
SK6 x SK7 (Control-I; CI)	522	7740	10.72	1.272	0.205	16.12	46.80
BCon1 x BCon4 (Control-II; CII)	508	8540	12.90	1.336	0.235	17.59	49.60

All the four promising hybrids (two single & two double) following comprehensive hybrid evaluation studies were subjected to validation in different seasons (Falguni, Jaistha, Bhaduri & Agrahayani) and popular foundation crosses, SK6 x SK7 and BCon1 x BCon4 were maintained as controls.

Performance of Double Hybrids (CSRTI-Berhampore)

DH	Fec (No)	ERR (No)	ERR Wt (Kg)	Cocoon Wt (g)	Shell Wt g)	Shell (%)	Avg. FL (m)	Denier	Reel (%)	Raw Silk (%)	Ren-ditta	Neat-ness	MEI
BHP1.3 x BHP8.9	553	9240	15.32	1.483	0.281	18.95	810	2.58	72	13.11	7.62	91	61.9
BHP3.2 x BHP8.9	570	9160	15.70	1.506	0.291	19.32	832	2.53	73	13.52	7.39	90	65.4
SK6 x SK7	450	8240	12.86	1.381	0.230	16.65	626	2.42	71	11.56	8.65	90	41.2
BCon1 x BCon4	511	8280	12.44	1.458	0.248	17.01	672	2.68	68	11.62	8.60	86	42.5
CD@5%	19	345	0.65	0.04	0.01	0.39	22	0.04	0.76	0.21	0.14	1.27	

Seasonal Performance of Promising Hybrids (CSRTI-Berhampore)

Particulars		Fec (No)	ERR (No)	ERR Wt (Kg)	Cocoon Wt (g)	Shell Wt (g)	Shell (%)	Avg. FL (m)	Denier	Reel (%)	Raw Silk (%)	Renditta	Neat-ness	MEI
Falguni (FLG)		504	9097	13.68	1.43	0.261	18.15	762	2.51	72	12.73	7.89	89	50.20
Jaistha (JST)		500	8245	11.93	1.41	0.255	18.00	730	2.39	72	12.58	8.00	90	49.61
Bhaduri (BDR)		513	8659	13.50	1.49	0.257	17.23	755	2.48	70	12.00	8.36	89	49.44
Agrahayani (AGN)		507	8759	13.85	1.54	0.278	17.90	788	2.42	74	12.37	8.13	91	50.75
CD @ 5%		**4.03**	**57.12**	**0.09**	**0.01**	**0.002**	**0.13**	**5.38**	**0.02**	**0.50**	**0.09**	**0.06**	**0.57**	
BHP2 x 8		497	9003	13.47	1.46	0.268	18.36	805	2.39	73	12.55	7.97	91	49.28
BHP3 x 8		499	9147	14.22	1.48	0.268	18.12	784	2.57	75	12.77	7.83	92	49.33
BHP 1.3 x 8.9		509	8674	14.02	1.57	0.298	19.03	796	2.47	74	13.05	7.67	92	49.59
BHP 3.2 x 8.9		555	9040	14.46	1.60	0.301	18.82	824	2.44	73	13.57	7.38	92	50.99
SK6 x 7		491	8611	11.92	1.32	0.213	16.12	629	2.31	72	11.08	9.03	87	49.07
BCon1 x 4		484	7666	11.36	1.39	0.230	16.47	714	2.54	68	11.50	8.70	85	48.73
CD @ 5%		**4.93**	**69.95**	**0.11**	**0.01**	**0.002**	**0.16**	**6.59**	**0.02**	**0.61**	**0.12**	**0.07**	**0.70**	
BHP2 x 8	FLG	479	8640	12.74	1.414	0.260	18.38	782	2.42	72	12.32	8.11	92	49.98
	JST	491	9022	13.11	1.434	0.277	19.32	816	2.36	74	13.11	7.62	89	50.39
	BDR	522	9117	13.69	1.497	0.265	17.69	798	2.51	70	12.24	8.16	90	50.07
	AGN	496	9232	14.33	1.495	0.270	18.06	822	2.26	74	12.52	7.98	92	50.50
BHP3 x 8	FLG	454	9110	13.43	1.424	0.270	18.96	802	2.52	74	13.22	7.56	91	50.21
	JST	493	9422	14.31	1.439	0.260	18.07	774	2.61	76	12.98	7.70	94	50.34
	BDR	534	8942	15.3	1.501	0.268	17.83	756	2.48	72	12.56	7.96	90	50.28
	AGN	516	9112	13.84	1.541	0.272	17.63	804	2.66	76	12.32	8.11	94	50.30
BHP 1.3 x 8.9	FLG	522	7885	12.16	1.542	0.286	18.55	764	2.42	72	13.54	7.38	90	50.28
	JST	501	9533	15.46	1.508	0.295	19.56	812	2.51	74	13.66	7.32	94	50.83
	BDR	504	9067	14.74	1.593	0.288	18.10	788	2.56	72	12.32	8.11	92	50.30
	AGN	510	8210	13.71	1.618	0.322	19.9	819	2.38	76	12.69	7.88	90	50.66
BHP 3.2 x 8.9	FLG	556	8766	12.92	1.598	0.298	18.65	788	2.38	74	13.74	7.27	91	50.77
	JST	589	9333	14.86	1.517	0.279	18.39	806	2.55	70	13.44	7.44	89	50.61
	BDR	544	9042	14.65	1.576	0.288	18.27	828	2.48	72	12.96	7.71	92	50.61
	AGN	532	9020	15.4	1.702	0.340	19.97	873	2.33	74	14.12	7.08	94	51.39
SK 6 x 7	FLG	486	7840	10.24	1.234	0.206	16.69	610	2.23	72	11.22	8.91	88	49.02
	JST	471	8940	11.72	1.281	0.210	16.35	622	2.42	72	11.32	8.83	86	49.07
	BDR	498	8142	11.8	1.361	0.215	15.8	636	2.32	70	10.84	9.22	84	48.97
	AGN	508	9520	13.9	1.407	0.220	15.64	648	2.26	72	10.92	9.15	90	49.60
BCon1 x 4	FLG	502	7230	10.1	1.251	0.210	16.78	632	2.38	70	11.42	8.75	86	48.87
	JST	481	8333	12.6	1.426	0.246	17.22	740	2.62	68	11.84	8.44	82	49.20
	BDR	474	7642	10.84	1.395	0.219	15.66	722	2.55	62	11.1	9.00	84	48.58
	AGN	477	7460	11.9	1.502	0.244	16.22	762	2.62	70	11.62	8.60	86	49.17
CD @ 5%		**9.87**	**139.9**	**0.22**	**0.03**	**0.004**	**0.32**	**13.17**	**0.04**	**1.21**	**0.23**	**0.14**	**1.40**	

Two way ANOVA performed over the seasons and the silkworm hybrids indicates that Agrahayani season has been the best season, followed by Falguni and among the silkworm hybrids, BHP3.2 x BHP8.9 has been the best performer followed by BHP1.3 x BHP8.9.

On-Station Trials

Two single hybrids viz., BHP2 x BHP8 and BHP3 x BHP8 and two double hybrids viz., BHP 1.3 x BHP 8.9 and BHP 3.2 x BHP 8.9 were evaluated under OST at six different locations in Eastern and North-Eastern region during spring and autumn seasons in 2019-2020. Five dfls of each combination was brushed enmasse and 250 larvae after III moult were retained in five replications. The overall performance including silk characteristics were recorded in all the crops.

Evaluation of BHP Hybrids – OST (Spring 2019)

Hybrid	Location	Fec (No)	ERR (No)	ERR Wt (Kg)	Cocoon Wt (g)	Shell Wt (g)	Shell (%)	AVFL (m)	Reel (%)	Raw Silk (%)	Rend-itta	Neat-ness
BHP 2 x 8	CSRTI- BHP	512	8454	11.855	1.418	0.262	18.49	788	72	12.44	8.03	90
	RSRS-Koraput	522	7137	10.733	1.580	0.260	16.33	740	70	11.48	8.71	88
	RSRS-Jorhat	536	6900	10.641	1.360	0.260	18.88	706	68	12.36	8.09	90
	RSRS-Kalimpong	542	9240	18.522	2.059	0.364	17.68	822	72	12.21	8.19	89
	REC-Bhandra	498	9040	13.150	1.430	0.237	16.57	692	70	11.86	8.43	92
	REC-Shillong	522	9133	11.690	1.267	0.237	18.60	704	72	12.54	7.97	90
	Mean	**522**	**8317**	**12.770**	**1.519**	**0.270**	**17.76**	**742**	**71**	**12.15**	**8.24**	**89.8**
	CV%	**3.06**	**11.47**	**21.27**	**17.05**	**16.06**	**5.61**	**6.45**	**2.11**	**3.04**	**3.13**	**1.35**
BHP 3 x 8	CSRTI- BHP	478	7733	11.950	1.554	0.273	18.05	766	72	12.88	7.76	90
	RSRS-Koraput	526	7818	11.267	1.550	0.260	16.78	742	74	11.52	8.68	92
	RSRS-Jorhat	542	8011	9.919	1.290	0.220	17.36	652	68	12.11	8.25	89
	RSRS-Kalimpong	512	9050	19.330	2.026	0.377	18.61	852	72	12.98	7.70	88
	REC-Bhandra	488	8660	12.110	1.389	0.242	17.42	686	70	12.36	8.09	90
	REC-Shillong	496	8900	13.170	1.470	0.290	19.68	762	70	13.11	7.62	90
	Mean	**507**	**8488**	**13.159**	**1.545**	**0.278**	**17.97**	**739**	**70.8**	**12.42**	**8.07**	**89.8**
	CV%	**4.78**	**6.23**	**22.91**	**15.10**	**17.97**	**5.29**	**8.62**	**2.71**	**4.51**	**4.60**	**1.35**
BHP 1.3 x 8.9	CSRTI- BHP	522	7885	12.16	1.542	0.286	18.55	764	72	13.54	7.38	90
	RSRS-Koraput	492	7367	10.31	1.545	0.306	19.81	812	70	13.96	7.16	92
	RSRS-Jorhat	570	5744	7.69	1.340	0.240	17.91	706	70	13.14	7.61	88
	RSRS-Kalimpong	498	9300	18.68	2.090	0.380	18.18	836	74	14.06	7.11	92
	REC-Bhandra	532	8860	12.43	1.412	0.252	17.85	716	72	12.86	7.77	90
	REC-Shillong	590	8833	11.92	1.456	0.284	19.51	752	70	14.06	7.11	91
	Mean	**532**	**7993**	**12.20**	**1.564**	**0.291**	**18.63**	**764**	**71.33**	**13.60**	**7.36**	**90.5**
	CV%	**3.24**	**15.01**	**27.18**	**15.71**	**15.57**	**4.09**	**6.16**	**2.09**	**3.44**	**3.49**	**1.53**
BHP 3.2 X 8.9	CSRTI- BHP	556	8766	12.92	1.598	0.298	18.65	788	74	13.74	7.27	92
	RSRS-Koraput	522	8165	13.52	1.612	0.314	19.48	846	70	14.22	7.03	90
	RSRS-Jorhat	586	7122	9.08	1.420	0.264	18.59	740	72	13.66	7.32	92
	RSRS-Kalimpong	535	9184	19.38	2.030	0.384	18.92	906	74	14.38	6.95	91
	REC-Bhandra	562	8920	12.40	1.404	0.266	18.95	762	70	13.62	7.34	90
	REC-Shillong	515	9367	13.14	1.590	0.304	19.12	810	70	14.34	6.97	90
	Mean	**544**	**8552**	**13.50**	**1.611**	**0.306**	**19.02**	**813**	**71.2**	**14.04**	**7.12**	**90.6**
	CV%	**2.17**	**8.85**	**22.56**	**12.81**	**13.04**	**1.57**	**6.78**	**2.53**	**2.32**	**2.34**	**1.00**
SK6 x SK7	CSRTI- BHP	482	7688	10.03	1.342	0.224	16.69	634	72	11.72	8.53	88
	RSRS-Koraput	425	7167	10.11	1.505	0.236	15.68	674	70	11.10	9.00	90
	RSRS-Jorhat	486	7733	11.29	1.320	0.210	15.91	630	68	10.68	9.36	88
	RSRS-Kalimpong	528	9110	17.75	1.718	0.298	17.35	722	74	11.98	8.34	86
	REC-Bhandra	474	8420	10.54	1.224	0.206	16.83	614	68	10.62	9.41	90
	REC-Shillong	526	8800	13.17	1.363	0.230	16.87	628	70	11.24	8.89	90
	Mean	**500**	**8153**	**12.14**	**1.412**	**0.234**	**16.57**	**650**	**70.33**	**11.22**	**8.92**	**88.7**
	CV%	**4.85**	**8.33**	**22.39**	**11.32**	**13.03**	**3.49**	**5.68**	**3.03**	**4.45**	**4.41**	**1.68**
BCon 1 x BCon 4	CSRTI- BHP	502	7392	9.62	1.324	0.232	17.52	630	70	12.26	8.15	88
	RSRS-Koraput	453	6856	10.22	1.654	0.270	16.32	746	72	11.22	8.91	90
	RSRS-Jorhat	522	7200	9.20	1.250	0.210	16.80	614	66	10.86	9.20	88
	RSRS-Kalimpong	540	8670	17.44	1.574	0.309	17.62	782	70	12.34	8.10	88
	REC-Bhandra	546	8200	11.09	1.327	0.211	15.90	608	72	11.62	8.60	90
	REC-Shillong	491	9300	12.28	1.332	0.240	18.02	726	70	12.11	8.25	86
	Mean	**506**	**7936**	**11.64**	**1.440**	**0.245**	**17.04**	**684**	**70**	**11.74**	**8.54**	**88.3**
	CV%	**5.12**	**10.88**	**23.88**	**13.25**	**14.21**	**4.41**	**10.12**	**2.86**	**4.70**	**4.80**	**1.56**

Evaluation of BHP Hybrids – OST (Autumn 2019)

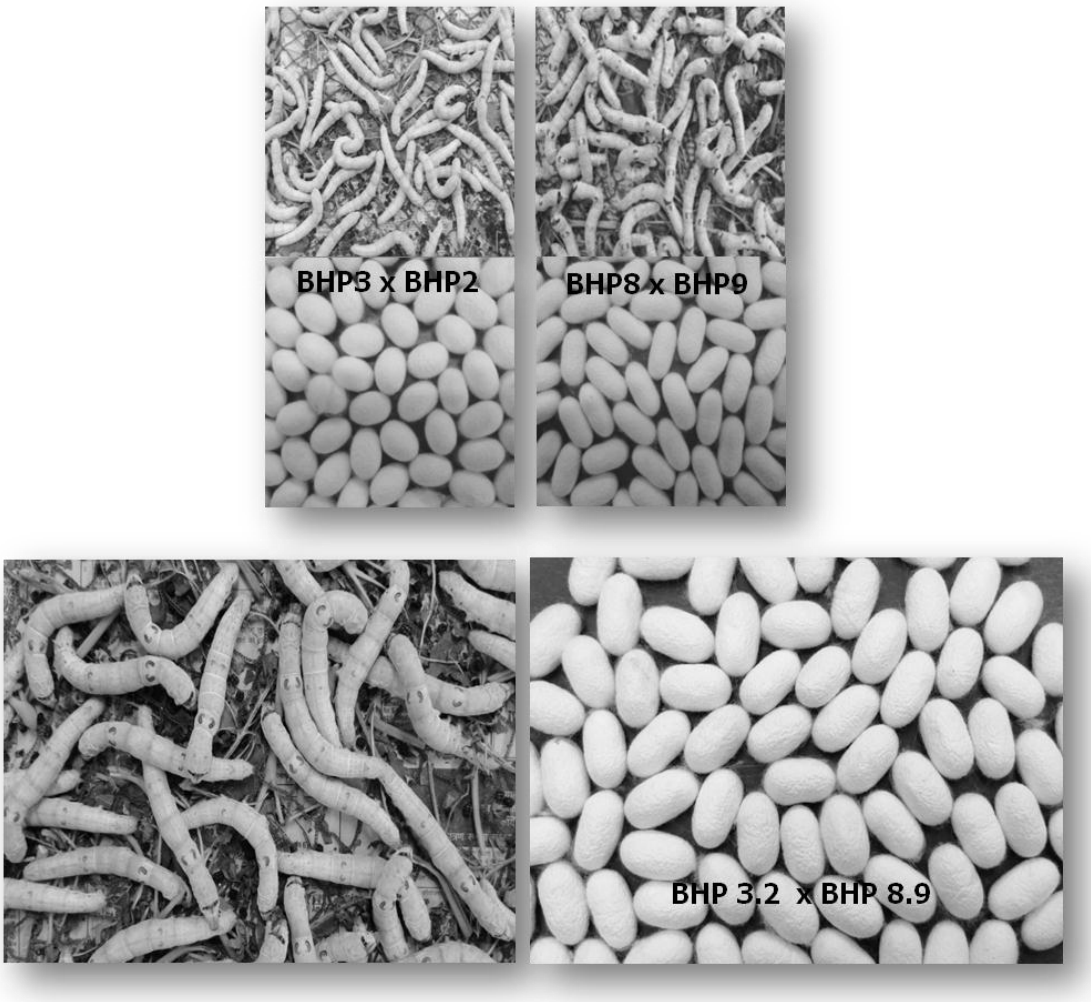
Hybrid	Location	Fec (No)	ERR (No)	ERR Wt (Kg)	Cocoon Wt (g)	Shell Wt (g)	Shell (%)	AVFL (m)	Reel (%)	Raw Silk (%)	Rend-itta	Neat-ness
BHP 2 x 8	CSRTI- BHP	512	8620	13.400	1.518	0.302	19.89	798	78	14.04	7.12	90
	RSRS-Koraput	482	8467	17.000	2.100	0.452	21.52	880	74	14.45	6.92	88
	RSRS-Jorhat	502	7722	12.460	1.462	0.290	19.83	768	72	14.00	7.14	88
	RSRS-Kalimpong	516	8440	16.100	1.885	0.393	20.84	848	70	14.04	7.12	90
	REC-Bhandra	522	9020	12.840	1.397	0.259	18.53	731	74	13.05	7.66	86
	REC-Shillong	508	8386	12.210	1.422	0.280	19.69	808	74	14.00	7.14	88
	Mean	**507**	**8443**	**14.002**	**1.631**	**0.329**	**20.05**	**806**	**73.67**	**13.93**	**7.18**	**88**
	CV%	**2.76**	**4.99**	**14.53**	**17.86**	**23.04**	**5.13**	**6.66**	**3.61**	**3.33**	**3.46**	**1.70**
BHP 3 x 8	CSRTI- BHP	488	8020	12.940	1.544	0.293	18.97	803	78	13.73	7.28	91
	RSRS-Koraput	506	8944	16.667	1.930	0.434	22.48	855	74	14.16	7.06	90
	RSRS-Jorhat	522	7833	11.060	1.360	0.270	19.85	736	70	13.19	7.58	88
	RSRS-Kalimpong	482	7944	13.200	1.613	0.322	19.96	832	72	14.00	7.14	90
	REC-Bhandra	476	8240	11.840	1.382	0.234	16.93	728	77	13.79	7.25	88
	REC-Shillong	484	8053	11.750	1.398	0.272	19.45	784	75	13.36	7.48	90
	Mean	**493**	**8172**	**12.910**	**1.538**	**0.304**	**19.61**	**790**	**74.33**	**13.91**	**7.30**	**90**
	CV%	**3.54**	**4.91**	**15.54**	**14.10**	**22.98**	**9.13**	**6.45**	**4.05**	**2.70**	**2.72**	**1.37**
BHP 1.3 x 8.9	CSRTI- BHP	510	8210	12.70	1.618	0.322	19.90	819	77	12.69	7.88	92
	RSRS-Koraput	486	8922	16.33	1.910	0.432	22.61	890	76	14.66	6.82	90
	RSRS-Jorhat	502	7577	11.94	1.520	0.302	19.86	742	72	13.96	7.16	90
	RSRS-Kalimpong	516	6922	11.86	1.680	0.304	18.09	798	74	13.88	7.20	92
	REC-Bhandra	488	8240	11.74	1.402	0.260	18.54	735	72	13.73	7.28	90
	REC-Shillong	532	8163	12.21	1.472	0.290	19.71	793	74	14.81	6.75	90
	Mean	**506**	**8006**	**12.79**	**1.600**	**0.318**	**19.79**	**796**	**74.17**	**13.92**	**7.18**	**91**
	CV%	**3.46**	**8.42**	**13.79**	**11.33**	**18.64**	**7.96**	**6.97**	**2.04**	**3.09**	**3.09**	**0.89**
BHP 3.2 X 8.9	CSRTI- BHP	532	9020	15.40	1.702	0.340	19.97	873	78	14.12	7.08	90
	RSRS-Koraput	546	8511	16.66	1.900	0.450	23.68	980	76	15.15	6.60	91
	RSRS-Jorhat	528	7000	11.24	1.594	0.312	19.57	786	72	13.77	7.26	91
	RSRS-Kalimpong	552	6500	11.21	1.684	0.331	19.65	865	72	14.04	7.12	90
	REC-Bhandra	568	9210	13.70	1.473	0.282	19.14	794	76	13.51	7.40	90
	REC-Shillong	524	8366	13.13	1.560	0.310	19.87	798	74	14.12	7.08	92
	Mean	**542**	**8101**	**13.55**	**1.652**	**0.338**	**20.37**	**849**	**74.67**	**14.10**	**7.09**	**90.7**
	CV%	**3.10**	**12.47**	**14.82**	**8.81**	**17.37**	**8.20**	**8.64**	**2.42**	**3.82**	**3.82**	**0.83**
SK6 x SK7	CSRTI- BHP	478	8240	10.03	1.340	0.230	17.16	713	77	12.23	8.17	86
	RSRS-Koraput	456	8944	15.75	1.648	0.282	17.10	745	74	12.62	7.92	88
	RSRS-Jorhat	482	7422	10.92	1.314	0.206	15.67	626	72	11.29	8.85	86
	RSRS-Kalimpong	490	7867	14.29	1.615	0.271	16.78	710	70	11.87	8.42	90
	REC-Bhandra	462	8660	12.58	1.438	0.220	15.29	655	72	11.23	8.90	90
	REC-Shillong	502	8530	12.31	1.440	0.240	17.36	683	72	12.51	7.99	88
	Mean	**478**	**8277**	**12.64**	**1.466**	**0.242**	**16.56**	**689**	**72.83**	**11.93**	**8.38**	**88**
	CV%	**3.59**	**6.74**	**16.69**	**9.44**	**12.24**	**5.23**	**6.27**	**3.30**	**5.07**	**5.07**	**2.03**
BCon 1 x BCon 4	CSRTI- BHP	512	7860	11.26	1.385	0.245	17.68	719	74	12.70	7.87	86
	RSRS-Koraput	522	9111	14.83	1.745	0.315	18.07	752	72	12.88	7.76	88
	RSRS-Jorhat	486	7011	9.84	1.350	0.230	17.03	688	74	12.73	7.85	84
	RSRS-Kalimpong	506	6544	12.89	1.903	0.329	17.28	736	70	13.22	7.56	86
	REC-Bhandra	510	7820	11.23	1.424	0.233	16.36	648	70	11.69	8.55	88
	REC-Shillong	522	7858	10.84	1.344	0.246	18.30	681	72	13.38	7.47	90
	Mean	**510**	**7701**	**11.81**	**1.525**	**0.266**	**17.45**	**704**	**72**	**12.75**	**7.84**	**87**
	CV%	**2.61**	**11.42**	**15.03**	**15.64**	**16.45**	**4.09**	**5.49**	**2.48**	**4.86**	**4.86**	**2.41**

Overall performance of BHP Hybrids (OST @ E & NE States)

Hybrid	Season	Fec (No)	ERR (No)	ERR Wt(kg)	Cocoon Wt (g)	Shell Wt (g)	Shell (%)	Avg. FL (m)	Denier	Reel (%)	Raw Silk (%)	Rend-itta	Neat-ness
BHP 2 x 8	Spring	522	8317	12.77	1.519	0.270	17.76	742	2.40	71.00	12.15	8.24	89.8
	Autumn	507	8443	14.00	1.631	0.329	20.05	806	2.37	73.67	13.93	7.18	88
	Mean	515	8380	13.38	1.575	0.300	18.91	774	2.39	72.34	13.04	7.71	88.90
	CV%	3.17	9.10	18.74	17.79	22.63	8.29	7.82	3.10	3.63	7.81	7.86	1.76
BHP 3 x 8	Spring	507	8488	13.15	1.545	0.278	17.97	739	2.48	70.80	12.42	8.07	89.8
	Autumn	493	8172	12.91	1.538	0.304	19.61	790	2.47	74.33	13.91	7.30	90
	Mean	500	8330	13.03	1.542	0.291	18.79	765	2.48	72.57	13.17	7.69	89.90
	CV%	4.28	5.86	20.13	14.65	21.16	8.69	8.22	2.76	4.16	6.08	6.31	1.37
BHP 1.3 x 8.9	Spring	532	7993	12.20	1.564	0.291	18.63	764	2.41	71.33	13.60	7.36	90.5
	Autumn	506	8006	12.79	1.600	0.318	19.79	796	2.45	74.17	13.92	7.18	91
	Mean	519	8000	12.50	1.582	0.305	19.21	780	2.43	72.75	13.76	7.27	90.75
	CV%	6.24	12.47	21.93	13.89	17.73	7.00	6.95	4.45	3.16	4.68	4.73	1.37
BHP 3.2 x 8.9	Spring	544	8552	13.50	1.611	0.306	19.02	813	2.48	71.20	14.04	7.12	90.6
	Autumn	542	8101	13.55	1.652	0.338	20.37	849	2.45	74.67	14.10	7.09	90.7
	Mean	543	8327	13.53	1.632	0.322	19.70	831	2.47	72.94	14.07	7.11	90.65
	CV%	3.95	11.56	19.99	11.25	16.23	6.89	8.19	2.53	3.58	3.21	3.12	0.95
SK6 x SK7 (CI)	Spring	500	8153	12.14	1.412	0.234	16.57	650	2.29	70.33	11.22	8.92	88.7
	Autumn	478	8277	12.64	1.466	0.242	16.56	689	2.38	72.83	11.93	8.38	88
	Mean	489	8215	12.39	1.439	0.238	16.57	670	2.34	71.58	11.58	8.65	88.35
	CV%	5.91	7.67	19.96	10.64	12.75	4.37	6.67	3.63	3.65	5.77	5.76	1.89
BCon 1 x BCon 4 (CII)	Spring	506	7936	11.64	1.440	0.245	17.04	684	2.43	70.00	11.74	8.54	88.3
	Autumn	510	7701	11.81	1.525	0.266	17.45	704	2.55	72.00	12.75	7.84	87
	Mean	508	7819	11.73	1.483	0.256	17.25	694	2.49	71.00	12.25	8.19	87.65
	CV%	4.91	11.25	20.28	13.88	15.90	4.46	8.40	3.89	3.06	6.41	6.55	2.14
CD @ 5%		19	235	0.72	0.070	0.030	1.29	63	0.06	0.79	0.98	0.61	1.34

The double hybrid, BHP 3.2 x BHP 8.9 has shown significantly higher productivity improvement than the existing bivoltine foundation crosses in cocoon yield (9.20% over CI & 15.34% over CII), cocoon weight (13.41% over CI & 10.04% over CII), shell weight (35.29% over CI & 25.78% over CII), shell ratio (18.88 % over CI & 14.20% over CII); average flament length (24.02% over CI & 19.74% over CII) and raw silk (21.50% over CI & 12.32% over CII).

The BHP-DH is the first double hybrid developed at CSRTI-Berhampore with salient features being marked larvae with bluish white body colour, white cocoons with intermediate shape and medium grains, 20-21% shell ratio, 14-16% raw silk, 65-70 kg/100 Dfls yield potential, 7-7.2 renditta, better fitness merits and suitable for E & NE region.



Inference:

- BHP double hybrid performance was more stable than the single hybrid with improvement in major economic traits as compared to the popular foundation crosses.

- The double hybrid, BHP 3.2 x BHP 8.9 would be subjected to OFT from the year, 2020-21 onwards in all the Eastern and North Eastern States.

AIB3616: On-farm Trial of multivoltine silkworm breeds/hybrids developed for high shell percentage and neatness of silk filament

[Sept 2017 - Dec 2019]

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Objectives

- To test the potentiality of 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

Eastern and North Eastern Indian sericulture industry is beseted with the problem of very few bivoltine silkworm hybrids available for commercial exploitation, especially for adverse seasons (high temperature & high humidity) conditions. The bulk of silk produced in India is from multivoltine based hybrids, which are of inferior quality and it is highly pertinent to evaluate more productive multivoltine silkworm hybrids capable of producing quality silk to meet the demand. The data generated on the productivity of newly developed crossbreeds and their suitability to regions/seasons would be useful for undertaking hybrid authorization trials. Three improved crossbreeds viz., 12Y x BCon1.BCon4, 8W x SK6.SK7 & 21Y x BCon1.BCon4 have been developed/ identified in the project AIB-3501.

Laboratory Performance of Improved Crossbreeds (2016-17)

Hybrid	Fec. (No)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)	Pupation Rate (%)	ERR (No)	ERR (Wt. Kg)	Yield/ 100dfls (Kg)	Neat-ness
8W x SK6.SK7	510	1.769	0.349	19.73	92	8189	14.41	57.64	80
12Y x BCon1.BCon4	506	1.720	0.336	19.55	94	9244	15.78	63.12	80
21Y x BCon1.BCon4	495	1.605	0.327	20.38	95	9355	15.79	63.16	75
N x SK6.SK7 (Control)	382	1.366	0.209	15.30	96	9324	12.29	49.16	72

These improved crossbreeds were tested with the farmers for two years (2017-2019) covering all the commercial crops [West Bengal (Murshidabad, Malda & Birbhum): Agrahayani, Falguni, Baishaki, Jaistha & Aswina seasons; Odisha (Koraput), Assam (Jorhat) & Jharkhand (Bhandra): autumn & spring seasons). The popular hybrid, Nistari x SK6.SK7 would be maintained as control. The OFT programme (New crossbreeds: 23400 dfls & Control: 7800 dfls) was undertaken by CSRTI- Berhampore coordination with DOSs. Nested units of CSRTI-BHP were associated with crop monitoring.

Rearing performance in West Bengal

A total of 11 crops were reared in West Bengal, seven crops in favourable (Nov/April) and four (June/Aug) in unfavourable seasons (19800 dfls; 99farmers).

Improved Cross Breeds - OFT: Favourable Seasons in West Bengal

Hybrids	Yield/ 100 dfls (kg)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)	Yield Realization Potential (%)
8W x SK6.SK7	51.30 ±3	1.55 ±0.04	0.27 ±0.01	17.54 ±0.20	94.20
12Y x BCon1.BCon4	60.95 ±1	1.63 ±0.15	0.28 ±0.02	17.35 ±0.21	98.22
21Y x BCon1.BCon4	59.82 ±2	1.52 ±0.13	0.27 ±0.02	17.77 ±0.41	97.88
N x SK6.SK7 (Control)	50.00 ±1	1.43 ±0.07	0.22 ±0.015	15.79 ±0.30	103.74

Mean of 7crops in 3 districts/3farmers/crop/hybrid @ 50dfls each farmer

Improved Cross Breeds - OFT: Unfavourable Seasons in West Bengal

Hybrids	Yield/ 100 dfls (kg)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)	Yield Realization Potential (%)
8W x SK6.SK7	36.44 ±1	1.47 ±0.04	0.24 ±0.014	16.59 ±0.10	64.95
12Y x BCon1.BCon4	43.54 ±2	1.41 ±0.04	0.24 ±0.004	16.94 ±0.10	72.15
21Y x BCon1.BCon4	44.18 ±4	1.43 ±0.02	0.24 ±0.005	17.05 ±0.50	76.28
N x SK6.SK7 (Control)	40.17 ±0.5	1.39 ±0.04	0.21 ±0.006	15.23 ±0.10	81.88

Mean of 4 crops in 3 districts/3 farmers/crop/hybrid @ 50dfls each farmer

Improved Cross Breeds - OFT : District-Wise Performance in West Bengal

Dist.	Hybrids	Yield/ 100 dfls (kg)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)	Yield Realization Potential (%)
Birbhum	8W x SK6.SK7	46.63	1.554	0.282	18.18	80.67
	12Y x BCon1.BCon4	57.37	1.601	0.289	18.05	90.64
	21Y x BCon1.BCon4	55.63	1.488	0.252	17.14	87.89
	Nistari x SK6.SK7 (Control)	46.40	1.458	0.223	15.33	94.19
Murshidabad	8W x SK6.SK7	46.92	1.478	0.247	16.74	81.17
	12Y x BCon1.BCon4	55.53	1.486	0.248	17.23	87.74
	21Y x BCon1.BCon4	57.27	1.422	0.243	17.12	90.49
	Nistari x SK6.SK7 (Control)	47.00	1.352	0.210	15.56	95.41
Malda	8W x SK6.SK7	47.25	1.536	0.269	17.54	81.74
	12Y x BCon1.BCon4	54.22	1.694	0.288	17.03	85.67
	21Y x BCon1.BCon4	55.16	1.608	0.275	17.10	87.15
	Nistari x SK6.SK7 (Control)	46.58	1.485	0.229	15.45	94.56

Mean of 11 crops/3 farmers/crop/hybrid @ 50dfls each farmer

Improved Cross Breeds - OFT : Overall Performance in West Bengal

Hybrids	District	Yield/ 100 dfls (kg)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)	Yield Realization Potential (%)
8W x SK6.SK7	Birbhum	46.63	1.554	0.282	18.18	80.89
	Murshidabad	46.92	1.478	0.247	16.74	81.17
	Malda	47.27	1.536	0.269	17.54	81.78
	Mean	**46.94**	**1.523**	**0.266**	**17.46**	**81.20**
	CD	4.71**	NS	NS	NS	
	CV%	7.48	10.02	13.60	5.06	
12Y x BCon1.BCon4	Birbhum	57.37	1.601	0.289	18.05	90.64
	Murshidabad	55.53	1.486	0.248	17.23	87.74
	Malda	54.22	1.694	0.288	17.03	85.67
	Mean	**55.74**	**1.594**	**0.275**	**17.25**	**88.06**
	CD	4.49**	0.168**	0.044*	NS	
	CV%	6.23	8.68	13.24	6.71	
21Y x BCon1.BCon4	Birbhum	55.63	1.488	0.252	17.14	87.89
	Murshidabad	57.27	1.422	0.243	17.12	90.49
	Malda	54.16	1.608	0.275	17.10	85.57
	Mean	**54.68**	**1.506**	**0.257**	**17.06**	**86.39**
	CD	5.35**	0.161*	NS	NS	
	CV%	7.49	8.67	13.07	6.46	
Nistari x SK6.SK7 (Control)	Birbhum	46.40	1.458	0.223	15.33	94.19
	Murshidabad	47.00	1.352	0.210	15.56	95.41
	Malda	46.58	1.485	0.229	15.45	94.55
	Mean	**46.66**	**1.432**	**0.221**	**15.43**	**94.72**
	CD	2.433**	NS	NS	0.711**	
	CV%	4.01	10.28	9.34	3.62	

Mean of 11 crops in each of 3 districts/3farmers/crop/hybrid @ 50dfls each farmer
* significance @ 1% and ** @ 5% level

Based on overall performance, 12Y x BCon1.BCon4 performed better in West Bengal with an improvement of 19.46% cocoon yield over control; while 8W x SK6.SK7 exhibited better shell content. During unfavourable seasons, 21Y x BCon1.BCon4 performed better, except for cocoon weight and realization potential. During favourable seasons, 12Y x BCon1.BCon4 was observed to be the best performer in respect of cocoon yield, cocoon weight and shell weight.

Rearing performance in Jharkhand

A total of 7 crops were reared in Jharkhand, 5 crops in favourable (Nov/April) and two (June/Aug) in unfavourable seasons (4200 dfls; 21farmers).

Improved Cross Breeds - OFT : Overall Performance in Bhandra, Jharkhand

Hybrids	Season	Yield/ 100 dfls (kg)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)	Yield Realization Potential (%)
8W x SK6.SK7	FAV	46.31	1.230	0.202	16.38	80.12
	UnFAV	50.35	1.331	0.233	17.50	87.10
	Mean	**47.00**	**1.268**	**0.209**	**16.50**	**81.31**
	CV%	**3.45**	**1.19**	**6.41**	**2.20**	
12Y x BCon1.BCon4	FAV	54.28	1.465	0.24	16.38	85.76
	UnFAV	57.91	1.535	0.235	15.31	91.49
	Mean	**56.09**	**1.499**	**0.23**	**15.34**	**86.85**
	CV%	**1.48**	**1.32**	**6.88**	**2.00**	
21Y x BCon1.BCon4	FAV	55.30	1.466	0.240	16.37	87.37
	UnFAV	55.67	1.482	0.224	15.11	87.96
	Mean	**55.56**	**1.520**	**0.24**	**15.78**	**87.78**
	CV%	**0.80**	**1.59**	**4.45**	**0.05**	
Nistari x SK6.SK7 (Control)	FAV	48.38	1.481	0.198	14.13	98.17
	UnFAV	53.14	1.568	0.231	14.73	117.59
	Mean	**50.76**	**1.437**	**0.21**	**14.61**	**103.04**
	CV%	**0.78**	**0.11**	**5.44**	**1.45**	

Mean of 5 (FAV) + 2 (UnFAV) crops/3farmers/crop/hybrid @ 50dfls each farmer

In Jharkhand, 12Y x BCon1.BCon4 performed better based on overall performance with 10.50% yield improvenment over the control; whereas 21Y x BCon1.BCon4 in cocoon weight, shell weight and shell content. During unfavourable seasons, N x SK6.SK7 performed better, whereas new crossbreeds were better in shell ccontent and shell weight. During favourable seasons, 21Y x BCon1.BCon4 was observed to be the best performer.

Rearing performance in Odisha

A total of 7 crops were reared in Odisha, 5 crops in favourable (Nov/April) and two (June/Aug) in unfavourable seasons (4200 dfls; 21farmers).

Improved Cross Breeds - OFT : Overall Performance in Odisha

Hybrids	Season	Yield/ 100 dfls (kg)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)	Yield Realization Potential (%)
8W x SK6.SK7	FAV	50.14	1.739	0.282	16.24	86.74
	UnFAV	60.44	1.577	0.252	16.01	104.56
	Mean	**51.74**	**1.676**	**0.264**	**15.73**	**89.51**
	CV%	**6.76**	**4.58**	**6.31**	**4.16**	
12Y x BCon1.BCon4	FAV	55.01	1.707	0.311	18.22	86.91
	UnFAV	59.16	1.631	0.265	16.25	93.47
	Mean	**57.21**	**1.613**	**0.272**	**16.84**	**90.39**
	CV%	**5.22**	**2.61**	**7.45**	**5.70**	
21Y x BCon1.BCon4	FAV	51.45	1.750	0.312	17.83	81.29
	UnFAV	59.66	1.692	0.269	15.89	94.26
	Mean	**53.82**	**1.712**	**0.281**	**16.43**	**85.03**
	CV%	**4.71**	**4.61**	**5.80**	**7.45**	
Nistari x SK6.SK7 (Control)	FAV	52.07	1.682	0.257	15.31	109.76
	UnFAV	59.95	1.673	0.257	15.39	125.75
	Mean	**55.56**	**1.681**	**0.255**	**15.19**	**112.78**
	CV%	**6.52**	**2.42**	**4.68**	**2.54**	

Mean of 5 (FAV) + 2 (UnFAV) crops/3farmers/crop/hybrid @ 50dfls each farmer

12Y x BCon1.BCon4 performed better in Odisha based on overall performance, cocoon yield and shell conten. During unfavourable seasons, N x SK6.SK7 performed better based on yield and realization potential, whereas new crossbreeds were better in other parameters. During favourable seasons, 12Y x BCon1.BCon4 was observed to be the best performer in respect of cocoon yield and shell content.

Rearing performance in Assam

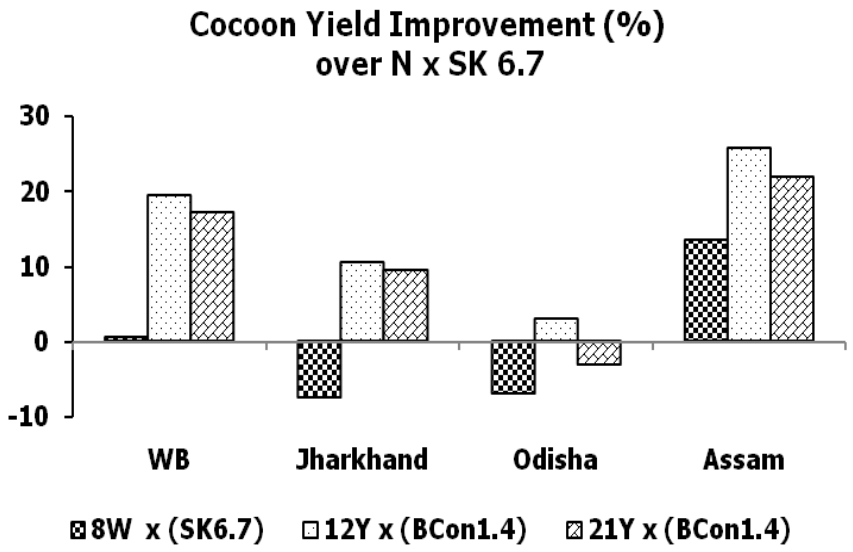
Improved Cross Breeds – OFT
Overall Performance in Assam

Hybrids	Yield/ 100 dfls (kg)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)	Yield Realization Potential (%)
8W x SK6.SK7	47.367	1.479	0.267	17.887	79.80
12Y x BCon1.BCon4	52.520	1.357	0.240	18.106	83.58
21Y x BCon1.BCon4	50.929	1.354	0.235	16.37	80.50
Nistari x SK6.SK7 (Control)	41.746	1.349	0.222	16.164	84.26

A total of 5 crops were reared in favorable seasons only in Assam (3000 dfls; 15farmers). 12Y x BCon1.BCon4 performed better based on cocoon yield and shell content, whereas 8W x SK6.SK7 performed better in cocoon weight and shell weight and N x SK6.SK7 in realization potential. 150dfls of 12Y x BCon1.4 were also reared successfully in REC-Dimapur, Nagaland with an average cocoon yield of 92 kg/100 dfls.

Improved Cross Breeds - OFT : Consolidated Overall Performance

Hybrids	State	Yield/ 100 dfls	Cocoon Wt. (g)	Shell Wt.(g)	Shell (%)	FIL (m)	Reela-bility (%)	Neat-ness	Ren.	Silk Reco. (%)	Realization Potential (%)
8W x SK6.7	WB	45.73	1.51	0.26	17.20	705	74	83	09.64	76	79.11
	JHK	47.28	1.40	0.25	17.60	711	75	79	09.75	77	81.79
	ODS	55.09	1.56	0.26	16.80	618	69	85	10.28	77	95.30
	ASM	46.63	1.40	0.24	17.14	667	73	81	09.98	65	80.67
	Mean	**48.52**	**1.47**	**0.25**	**17.20**	**675**	**73**	**82**	**09.91**	**74**	**83.94**
12Y x BCon1.4	WB	54.32	1.51	0.26	16.85	684	77	80	09.21	74	85.82
	JHK	54.97	1.50	0.25	16.23	667	74	80	09.90	77	86.85
	ODS	57.13	1.55	0.25	16.13	699	71	82	09.27	82	90.26
	ASM	54.90	1.52	0.24	17.62	668	72	80	09.20	66	86.74
	Mean	**55.33**	**1.52**	**0.26**	**16.70**	**687**	**74**	**79**	**09.39**	**75**	**87.42**
21Y x BCon1.4	WB	53.46	1.48	0.26	17.10	673	81	80	08.80	75	84.47
	JHK	55.56	1.50	0.24	15.98	690	76	79	09.50	73	87.78
	ODS	52.76	1.67	0.26	15.80	653	72	83	10.41	82	83.36
	ASM	51.95	1.53	0.25	17.00	620	73	78	09.00	65	82.08
	Mean	**53.19**	**1.54**	**0.25**	**16.50**	**659**	**76**	**80**	**09.43**	**74**	**84.04**
Nistari x SK6.SK7 (Control)	WB	46.27	1.41	0.22	15.70	638	72	78	10.68	76	93.84
	JHK	50.16	1.43	0.21	14.27	641*	71	75	10.86	79	101.82
	ODS	51.47	1.56	0.23	15.23	604	70	78	10.98	75	104.48
	ASM	41.51	1.34	0.22	16.41	576	72	78	10.06	62	84.26
	Mean	**47.23**	**1.43**	**0.22**	**15.40**	**615**	**71**	**77**	**10.64**	**73**	**95.88**
CD @ 5%		**6.01**	**0.115**	**0.08**	**1.20**	**54.06**	**NS**	**3.22**	**0.886**	**NS**	



On the basis of overall performance, 12Y x BCon1.BCon4 performed better (cocoon yield: 55.33kg/100dfls; shell weight: 0.26g; filament length: 687m; renditta: 9.39; silk recovery: 75%) with the highest cocoon yiled realization potential among the test hybrids. The improvement over control (IOC) in respect of cocoon yield/100dfls, shell weight, shell content, filament length and renditta are 17.15, 18.18, 8.44, 11.70 and 12.95%, respectively. Based on overall rearing and reeling performance including yield realization potential during the OFT across different seasons (23400 dfls/2years), 12Y x (BCon1.4) is recommended for authorization trials.

Laboratory Evaluation with Alternative Male Parents (Bivoltine)

New multivoltine breed, 12Y exhibited consistent performance in the field with regard to cocoon yield potential (10-15% improvement) and other economic traits resulting into an extra income to the farmers. Considering the low shell content (15-17%) from BCon1.4, laboratory evaluation was conducted with other bivoltine male parents to identify new multi x Bi combination. A new crossbreed combination, 12Y x BFC1 has revealed that 18-20% shell ratio could be achieved with better yields (56-62 kg/100 dfls).

The OFT data was presented to the Hybrid Authorization Committee (HAC) to evaluate the performance of 12Y x BCon1.4 (12Y x BFC1) in Eastern and North Eastern India and HAC recommended the new crossbreed, 12Y x BFC1 for hybrid authorization trials.

Inference

- Based on overall performance at farmer's field, the improved crossbreed 12Y x BCon1.4 could be reared throughout the year in Eastern and North Eastern India during favourable/unfavourable seasons with highest yield realization potential.

- Laboratory evaluation trials with new bivoltine male parents were to improve shell content in the new crossbreed reveals that the new combination, 12Y x BFC1 could be an alternative to the existing hybrids in the region and subjected to large scale authorization trial.

AIB-3578: Evaluation of exotic bivoltine silkworm breeds to identify promising parental genetic resources *(in collaboration with CSGRC-Hosur; CSRTI-Mysore; CSRTI-Pampore)*

[June 2016 - Sept 2019]

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 (CSGRC)-Hosur conserves 466 silkworm resources including 365 bivoltine (exotic & indigenous) accessions. All the bivoltine exotic accessions were not utilized by the R&D institutions for breeding purposes. With an objective to utilize best performing exotic bivoltine accessions (top ten dumbbell and oval accessions) through pre-breeding approaches in different agro-climatic zones in India.

Evaluation of hybrid performance (foundation cross) with popular parental breeds *i.e.*, CSR2 (oval) and CSR4 (dumbbell) was undertaken at CSRTI-Berhampore (East & North East India). The hybrid dfls were prepared by CSGRC-Hosur and supplied to CSRTI-Berhampore. The popular bivoltine foundation cross in E & NE India, SK6 x SK7 was also reared along with the test hybrids. The evaluations were carried out at CSRTI-Berhampore following standard rearing conditions in the spring (Feb-March) and autumn (Oct- Nov) seasons during 2017-2019. Data was recorded for various rearing and reeling parameters and analyzed using Mano's multi-trait evaluation index. The data was analysed in comparison to the performance of SK6 x SK7 with regad to survival, shell ratio and filament length. The exotic accessions which were found promising could be utilized while undertaking new breeding programmes in the zone.

Top Performing Bivoltine Exotic Accessions

Oval		Dumbbell	
Acc. No	Breed	Acc. No	Breed
BBE-0005	MEIGITSU	BBE-0143	KY-1
BBE-0163	THAICHOAN	BBE-0155	J-DEEP MARKED
BBE-0232	NB1	BBE-0164	SHOGETSU HOSHO
BBE-0329	MIR-4	BBE-0268	J1M
BBE-0013	CHAUNG NAUNG	BBE-0169	SHINKI RAYAKU (M)
BBE-0154	J-MARKED	BBE-0267	14M
BBE-0201	C124	BBE-0177	JPN5 x B25
BBE-0225	JZH (PO)	BBE-0197	A
BBE-0043	BELKOKONA-II	BBE-0050	UKR-2
BBE-0266	J2P	BBE-0035	SANISH-18(M)

Performance of Oval FCs

Crop	Acc. x CSR2 (BBI-0290)	Fec	Hatch (%)	10 Larval Wt (g)	Yield/ 10000 L (kg)	Pupa-tion (%)	SCW (g)	SSW (g)	SR (%)	FL (m)	Mean EI
Autumn	BBE-0005	520	91.65	38.01	8.33	55.06	1.606	0.308	19.24	826	46.87
	BBE-0163	557	98.00	40.32	10.21	61.50	1.671	0.333	19.96	808	53.81
	BBE-0232	460	96.32	42.89	8.84	55.65	1.607	0.328	20.45	897	50.93
	BBE-0329	510	96.52	41.94	5.36	32.06	1.638	0.327	20.12	988	49.10
	BBE-0013	505	97.19	43.59	7.56	47.21	1.537	0.301	19.69	805	47.80
	BBE-0154	484	95.99	43.84	8.82	50.93	1.672	0.366	21.92	868	54.84
	BBE-0201	562	95.48	38.55	9.51	60.16	1.545	0.323	21.04	833	51.78
	BBE-0225	414	86.84	37.32	9.35	61.01	1.466	0.313	21.59	892	45.83
	BBE-0043	539	96.62	35.24	7.72	46.28	1.511	0.283	18.92	794	43.10
	BBE-0266	514	97.36	39.74	7.54	46.98	1.580	0.315	20.03	862	48.59
	SK6 x SK7	492	92.08	41.50	11.90	81.41	1.490	0.281	18.86	797	47.89
Spring	BBE-0005	444	95.79	37.30	6.56	53.46	1.167	0.215	18.58	641	45.58
	BBE-0163	469	95.04	37.86	6.45	49.60	1.298	0.251	19.44	737	49.90
	BBE-0232	475	97.92	36.24	8.41	63.20	1.342	0.269	20.05	746	53.70
	BBE-0329	501	93.71	38.49	3.18	21.93	1.233	0.200	16.31	724	42.39
	BBE-0013	461	96.31	36.53	4.20	28.40	1.290	0.262	20.48	672	47.20
	BBE-0154	453	96.3	36.92	4.33	30.66	1.260	0.241	19.10	729	46.44
	BBE-0201	470	97.13	35.91	7.81	58.60	1.291	0.256	19.79	786	51.51
	BBE-0225	531	94.41	37.14	10.08	76.27	1.320	0.259	19.79	650	53.50
	BBE-0043	507	93.14	37.44	9.02	60.13	1.404	0.260	18.71	699	52.39
	BBE-0266	445	96.72	36.66	8.18	56.53	1.360	0.265	19.69	886	54.07
	SK6 x SK7	435	89.83	41.25	10.05	66.90	1.490	0.260	17.41	866	52.38
Mean	BBE-0005	482	93.72	37.66	7.45	54.27	1.386	0.262	18.91	734	42.47
	BBE-0163	513	96.52	39.09	8.33	55.55	1.484	0.292	19.71	773	52.99
	BBE-0232	468	97.12	39.57	8.63	59.43	1.475	0.299	20.26	822	54.42
	BBE-0329	506	95.12	40.22	4.28	27.00	1.436	0.264	18.22	857	41.79
	BBE-0013	483	96.75	40.06	5.88	37.80	1.414	0.282	20.09	739	45.24
	BBE-0154	468	96.15	40.38	6.58	40.80	1.466	0.304	20.52	799	50.25
	BBE-0201	516	96.30	37.23	8.67	59.38	1.418	0.290	20.42	810	52.06
	BBE-0225	472	90.63	37.23	9.72	68.64	1.393	0.286	20.69	771	48.19
	BBE-0043	523	94.88	36.34	8.37	53.21	1.458	0.272	18.81	747	46.70
	BBE-0266	479	97.04	38.20	7.86	51.76	1.470	0.290	19.86	874	51.53
	SK6 x SK7	463	90.96	41.38	10.98	74.16	1.490	0.271	18.14	832	52.62

Performance of Dumbbell FCs

Crop	Acc. x CSR2 (BBI-0291)	Fec	Hatch (%)	10 Larval Wt (g)	Yield/ 10000 L (kg)	Pupa-tion (%)	SCW (g)	SSW (g)	SR (%)	FL (m)	Mean EI
Autumn	BBE-0143	522	96.93	38.42	7.94	49.17	1.610	0.312	19.46	751	46.56
	BBE-0155	559	96.82	40.76	10.71	66.78	1.565	0.321	20.57	777	52.25
	BBE-0164	549	97.68	40.24	11.43	68.22	1.665	0.336	20.20	801	54.72
	BBE-0268	519	97.45	40.66	8.14	49.80	1.550	0.285	18.47	795	46.17
	BBE-0169	547	97.62	39.66	7.76	47.55	1.570	0.325	20.67	871	49.68
	BBE-0267	552	97.42	40.99	8.90	56.39	1.481	0.306	20.74	881	51.79
	BBE-0177	455	97.75	41.02	8.31	52.72	1.510	0.314	20.86	926	49.06
	BBE-0197	514	96.58	43.07	6.81	39.75	1.641	0.358	21.79	1003	54.20
	BBE-0050	469	96.57	41.60	8.54	51.49	1.656	0.339	20.60	944	53.28
	BBE-0035	534	96.90	40.18	9.72	56.47	1.733	0.336	19.40	813	51.78
	SK6 x SK7	492	92.09	41.50	11.90	81.42	1.491	0.282	18.87	797	47.89
Spring	BBE-0143	486	97.09	36.19	3.20	28.54	1.205	0.214	17.76	622	42.36
	BBE-0155	447	93.32	37.29	7.10	61.40	1.203	0.230	18.87	688	47.25
	BBE-0164	461	96.57	36.08	5.72	44.67	1.305	0.248	19.07	730	47.59
	BBE-0268	458	97.49	34.92	7.80	58.54	1.364	0.260	19.33	889	52.33
	BBE-0169	541	92.33	38.25	8.12	62.07	1.315	0.266	20.39	891	54.77
	BBE-0267	525	97.22	38.63	8.12	61.47	1.360	0.265	19.77	809	54.38
	BBE-0177	516	96.96	36.29	9.44	68.33	1.356	0.269	19.98	783	54.73
	BBE-0197	513	93.68	35.28	5.20	36.33	1.322	0.283	21.60	690	49.63
	BBE-0050	435	94.82	37.71	9.95	80.00	1.260	0.234	18.49	814	52.00
	BBE-0035	437	95.94	35.55	7.52	50.14	1.344	0.240	17.62	649	45.82
	SK6 x SK7	435	89.84	41.25	10.05	66.90	1.490	0.261	17.41	866	52.38
Mean	BBE-0143	504	97.01	37.30	5.57	38.85	1.407	0.262	18.61	687	40.23
	BBE-0155	503	95.07	39.02	8.90	64.09	1.384	0.275	19.72	733	49.33
	BBE-0164	505	97.12	38.15	8.57	56.44	1.485	0.292	19.63	766	52.39
	BBE-0268	488	97.47	37.78	7.97	54.17	1.457	0.272	18.90	842	49.40
	BBE-0169	544	94.98	38.95	7.94	54.81	1.443	0.295	20.53	881	54.86
	BBE-0267	539	97.32	39.81	8.51	58.93	1.420	0.286	20.25	845	55.39
	BBE-0177	485	97.35	38.65	8.87	60.53	1.433	0.291	20.42	855	53.87
	BBE-0197	513	95.13	39.17	6.00	38.04	1.481	0.320	21.69	847	52.88
	BBE-0050	452	95.69	39.65	9.24	65.74	1.458	0.286	19.55	879	53.45
	BBE-0035	485	96.42	37.86	8.62	53.30	1.538	0.288	18.50	731	49.96
	SK6 x SK7	463	90.96	41.38	10.98	74.16	1.490	0.271	18.14	832	52.62

Best Performing Bivoltine Exotic Accessions @ CSGRC-Hosur Eastern & North Eastern India (2017-2019)

Type	Survival (%)		Shell (%)		Filament Length (m)	
	Spring	Autumn	Spring	Autumn	Spring	Autumn
Oval	BBE-225 (76.27)	BBE-201 (60.16)	BBE-232 (20.05) BBE-225 (19.79) BBE-266 (19.69)	BBE-154 (21.92) BBE-201 (21.04)	BBE-266 (886)	BBE-154 (868)
Dumbbell	BBE-177 (68.33)	BBE-155 (66.78) BBE-164 (68.22)	BBE-169 (20.39) BBE-267 (19.77) BBE-177 (19.98)	BBE-155 (20.57) BBE-164 (20.20) BBE-197 (21.79) BBE-50 (20.60)	BBE-169 (891) BBE-267 (809)	BBE-197 (1003) BBE-50 (944)
SK6 x SK7 (Control)	66.90	81.42	17.41	18.86	797	866
Superior Accessions						
Oval	BBE-225		BBE-154, BBE-201		BBE-266	
Dumbbell	BBE-177		BBE-197, BBE-50		BBE-197, BBE-50	

Inference

- No Bivoltine exotic accessions could be recommended based on survival as control hybrids exhibited better performance; while BBE-225 and BBE-177 could be choices for spring season
- Based on shell ratio and filament length, few of the exotic accessions performed well above the control and could serve as alternatives
- The superior bivoltine accessions identified could be utilized in future breeding programmes as per the envisaged objectives/targeted traits

Ongoing Project

AIB 3602: Development of thermotolerant bivoltine hybrids of silkworm through MAS

[November 2016 - April 2021]

N. Chandrakanth, V. Lakshmanan, A. K. Verma, V. S. Raviraj (from March 2019) and Gautam Mitra (from Feb 2019)

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

To develop thermotolerant bivoltine silkworm breeds, temperature tolerant (SK4C & BHR3) and productive (D6M & GEN3) breeds were used as parental stocks and F_1s were reared accordingly at high temperature. Breeding plan involves six generations of backcrossing (BC_6) followed by two generations of sib-mating (BC_6F_2). Marker assisted selection (MAS) was applied in all the generations to select populations with the heterozygous banding pattern for SSR markers (S0803 & S0816) for thermotolerance. During the year, BC_6 populations (BC_6F_2 & BC_6F_3) were evaluated for overall performance especially survival rate and rearing performance at high temperature. The rearing performance of breeds was evaluated by rearing under normal and high temperature conditions (from V instar 3rd day to till spinning at 36°C).

Performance of BC_6F_3 Populations at Normal (25°C) & High Temperature (36°C) (Aug-Sept 2019)

	Breed	Fec. (No.)	Rearing Temp.	ERR (%)	ERR Wt. (kg)	Coc. Wt. (g)	Shell Wt. (g)	Shell Ratio (%)
Dumbbell	WB1	495	25°C	81	13.543	1.494	0.293	19.61
			36°C	65	8.321	1.342	0.236	17.57
	WB3	534	25°C	89	14.321	1.421	0.298	20.97
			36°C	68*	8.550	1.250	0.234	18.72
Oval	WB5	550	25°C	78	12.889	1.399	0.276	19.72
			36°C	65	7.650	1.226	0.233	19.00
	WB7	526	25°C	80	14.101	1.463	0.309	20.42
			36°C	71*	8.100	1.196	0.229	19.88
Control	SK6	482	25°C	92	11.39	1.238	0.225	18.17
			36°C	63	10.28	1.028	0.165	16.06
	SK7	496	25°C	94	12.20	1.298	0.232	17.87
			36°C	61	10.66	1.066	0.178	16.70
	B.Con-1	493	25°C	90	13.59	1.510	0.219	17.11
			36°C	63	10.66	1.066	0.178	16.69
	B.Con-4	518	25°C	92	13.01	1.414	0.223	17.29
			36°C	59	9.89	0.989	0.166	16.79
CD @ 1%		Temp.		0.521	0.069	0.004	0.003	0.117
		Temp. x Breed		1.472	0.195	0.012	0.008	0.330

After completion of breeding plan (@BC_6F_3 generation), WB1 and WB3 (dumbbell) and WB5 and WB7 (oval) breeds were found performing better in terms of pupation rate under high temperature conditions. Four breeding lines (WB2, WB4, WB6 & WB8) were discarded based on overall performance. These thermo-tolerant lines (dumbbell: WB1 & WB3; oval: WB5 & WB7) were maintained further for hybrid evaluation. For improving the survival of silkworm breeds/hybrids in the prevailing high temperature and high humidity conditions in Eastern & North Eastern region, double hybrids were planned for improved sustainability and productivity.

Foundation crosses were made accordingly (dumbbell: WB1 × WB3; oval: WB7 × WB5; KA19 × WB5) and evaluated for rearing performance at 25°C and 36°C. These FCs were utilized to produce thermo-tolerant double hybrids, WB7.5 × WB1.3 & KA19.WB5 × WB1.3 was prepared and rearing was conducted at normal temperature during Falguni (Jan-Feb 2020) and Baisakhi (Mar-April 2020) seasons. SK6 × SK7 and BCon1 × BCon4 were maintained as control hybrids for comparision. The performance of double hybrids would be recorded at normal/high temperatures in other seasons in future.

Performance of thermo-tolerant breed, WB1

Breed/ Gen. (Temp)	Season/year	Fec (No.)	ERR (No.)	ERR Wt. (kg)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)
SK4C	Mar-April 2020 (Parental Stocks)	458	6744	7.93	1.218	0.229	18.80
D6(M)		466	6526	9.33	1.254	0.218	17.35
F_1	May-June 2017	542	9000	13.55	1.506	0.291	19.32
BC_1	Aug-Sept 2017	499	8267	13.59	1.644	0.268	16.30
BC_2	Oct-Nov 2017	511	8400	11.87	1.332	0.246	18.47
BC_3	Mar-April 2018	488	7727	12.36	1.362	0.236	17.33
BC_4	May-June 2018	485	8200	12.90	1.371	0.234	17.07
BC_5	Aug-Sept 2018	489	8237	12.59	1.342	0.248	18.48
BC_6	Feb-Mar 2019	583	8012	10.59	1.211	0.245	20.23
BC_6F_2	June-July 2019	606	7856	12.44	1.294	0.229	17.69
BC_6F_3	Aug-Sept 2019	495	8100	13.54	1.494	0.293	19.61
WB1	**Mar-April 2020**	**517**	**8850**	**12.54**	**1.363**	**0.272**	**19.92**
	CV (%)	8.12	4.21	7.25	8.830	8.900	6.670
SK6	Mar-April 2020 (Controls)	486	8240	11.56	1.426	0.243	17.04
SK7		472	9010	12.36	1.404	0.236	16.80
BCon1		502	8640	12.63	1.489	0.249	16.65
BCon4		466	8060	11.09	1.372	0.250	18.22
	CD @ 1%	10.02	174.15	0.310	0.020	0.006	0.434

Performance of thermo-tolerant breed, WB3

Breed/ Gen. (Temp)	Season/year	Fec (No.)	ERR (No.)	ERR Wt. (kg)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)
SK4C	Mar-April 2020	458	6744	7.93	1.218	0.229	18.80
D6(M)	(Parental Stocks)	466	6526	9.33	1.254	0.218	17.35
F_1	May-June2017	449	9333	14.09	1.510	0.268	17.75
BC_1	Aug-Sept 2017	500	8563	13.01	1.519	0.259	17.05
BC_2	Oct-Nov 2017	485	8400	12.45	1.384	0.265	19.15
BC_3	Mar-April 2018	502	8629	11.09	1.308	0.233	17.81
BC_4	May-June 2018	512	6800	12.80	1.308	0.231	17.66
BC_5	Aug-Sept 2018	502	8431	13.01	1.419	0.266	18.75
BC_6	Feb-Mar 2019	592	8328	11.35	1.416	0.244	17.23
BC_6F_2	June-July 2019	439	8580	14.80	1.438	0.273	18.98
BC_6F_3	Aug-Sept 2019	534	8900	14.32	1.421	0.298	20.97
WB3	**Mar-April 2020**	**486**	**6554**	**8.55**	**1.184**	**0.252**	**21.24**
	CV (%)	8.48	7.68	9.22	4.96	7.66	6.32
SK6	Mar-April 2020 (Controls)	486	8240	11.56	1.426	0.243	17.04
SK7		472	9010	12.36	1.404	0.236	16.80
BCon1		502	8640	12.63	1.489	0.249	16.65
BCon4		466	8060	11.09	1.372	0.250	18.22
	CD @ 1%	10.02	9.48	122.74	0.17	0.02	0.01

Performance of thermo-tolerant breed, WB5

Breed/ Gen. (Temp)	Season/year	Fec (No.)	ERR (No.)	ERR Wt. (kg)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)
SK4C	Mar-April 2020	458	6744	7.93	1.218	0.229	18.80
GEN3	(Parental Stocks)	483	6622	10.01	1.467	0.296	20.08
F_1	May-June2017	340	8250	13.41	1.625	0.326	20.06
BC_1	Aug-Sept 2017	447	8722	12.24	1.403	0.250	17.82
BC_2	Oct-Nov 2017	498	7275	11.33	1.229	0.240	19.53
BC_3	Mar-April 2018	424	9500	13.23	1.418	0.274	19.32
BC_4	May-June 2018	422	9500	14.10	1.402	0.264	18.83
BC_5	Aug-Sept 2018	477	8344	12.24	1.303	0.224	17.19
BC_6	Feb-Mar 2019	634	8884	12.53	1.429	0.273	19.13
BC_6F_2	June-July 2019	567	6489	11.89	1.461	0.279	18.75
BC_6F_3	Aug-Sept 2019	550	7800	12.89	1.399	0.276	19.72
WB5	**Mar-April 2020**	**510**	**7600**	**10.32**	**1.307**	**0.260**	**19.92**
	CV (%)	17.35	11.34	6.32	7.25	10.18	4.58
SK6	Mar-April 2020 (Controls)	486	8240	11.56	1.426	0.243	17.04
SK7		472	9010	12.36	1.404	0.236	16.80
BCon1		502	8640	12.63	1.489	0.249	16.65
BCon4		466	8060	11.09	1.372	0.250	18.22
	CD @ 1%	10.02	8.70	141.29	0.15	0.02	0.01

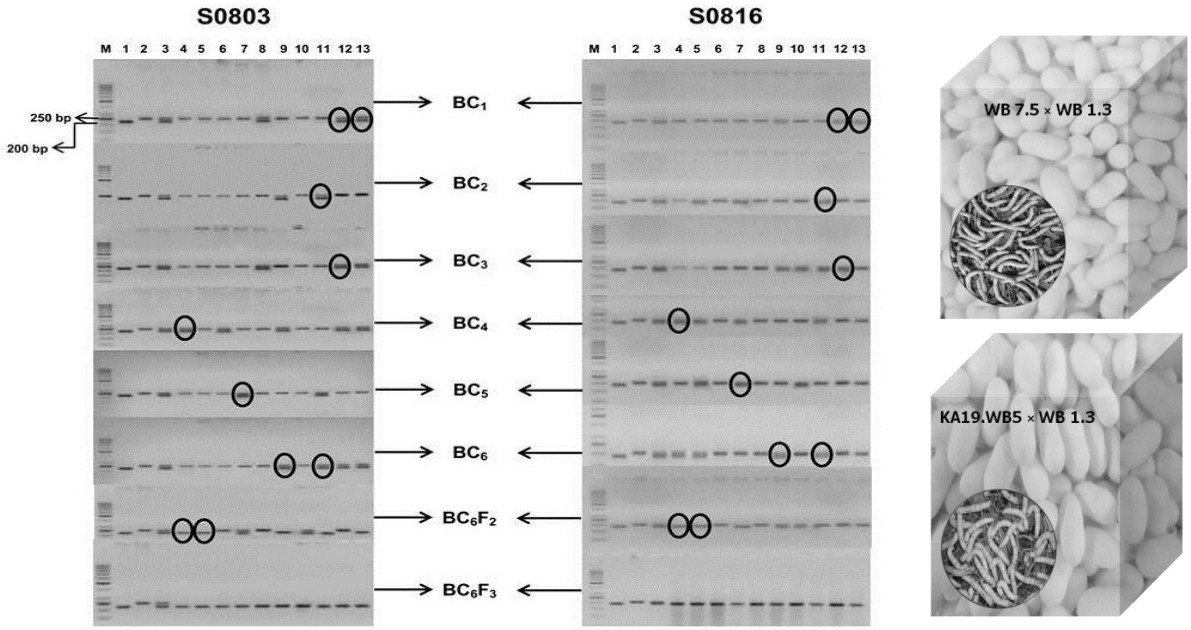
Performance of thermo-tolerant breed, WB7

Breed/ Gen. (Temp)	Season/year	Fec (No.)	ERR (No.)	ERR Wt. (kg)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)
BHR3	Mar-April 2020	496	6925	8.53	1.312	0.231	17.60
GEN3	(Parental Stocks)	483	6622	10.01	1.467	0.296	20.08
F_1	May-June2017	501	8500	12.97	1.526	0.291	19.07
BC_1	Aug-Sept 2017	502	8878	11.71	1.319	0.250	18.95
BC_2	Oct-Nov 2017	491	9525	12.97	1.407	0.269	19.12
BC_3	Mar-April 2018	521	7889	11.56	1.414	0.306	21.64
BC_4	May-June 2018	502	8000	12.90	1.442	0.298	20.67
BC_5	Aug-Sept 2018	499	8563	12.88	1.395	0.265	19.00
BC_6	Feb-Mar 2019	594	9172	12.21	1.432	0.282	19.69
BC_6F_2	June-July 2019	517	7222	12.11	1.340	0.225	18.65
BC_6F_3	Aug-Sept 2019	526	8000	14.10	1.463	0.309	20.42
WB7	**Mar-April 2020**	**509**	**6520**	**9.10**	**1.376**	**0.285**	**20.67**
	CV (%)	5.67	8.01	5.89	4.14	9.44	4.82
SK6		486	8240	11.56	1.426	0.243	17.04
SK7	Mar-April 2020	472	9010	12.36	1.404	0.236	16.80
BCon1	(Controls)	502	8640	12.63	1.489	0.249	16.65
BCon4		466	8060	11.09	1.372	0.250	18.22
	CD @ 1%	10.02	10.21	147.59	0.23	0.03	0.01

Performance of Foundation Crosses (FCs) at Normal (25°C) & High Temperature (36°C)

Foundation Cross (FC)	Season	Fec. (No.)	Rearing Temp.	ERR (No.)	ERR Wt. (kg)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)
WB1 x WB3	Oct-Nov 2019	480	25°C	90	13.41	1.533	0.289	20.11
			36°C	72	11.04	1.437	0.286	18.65
WB7 x WB5		525	25°C	91	13.12	1.514	0.303	20.01
			36°C	70	10.20	1.417	0.263	18.56
KA19 x WB5		495	25°C	84	11.11	1.415	0.279	19.71
			36°C	54	8.31	1.301	0.210	16.14
SK6 x SK7		512	25°C	75	9.558	1.384	0.257	18.56
			36°C	68	7.764	1.292	0.208	16.09
BCon 1 x BCon4		501	25°C	70	8.331	1.398	0.263	18.81
			36°C	45	5.972	1.211	0.204	15.70
CD @ 1%			Temp.	0.635	0.08	0.008	0.004	0.316
			Temp. X FC	1.099	0.14	NS	0.007	0.547

Performance of Thermo-tolerant Double Hybrids															
Hybrid	Season	Fec. (No.)	ERR (No.)	ERR Wt. (kg)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)	FL	NBFL	Denier	Rend-itta	Reel (%)	Silk Reco-very (%)	Neat-ness (%)	Clean-ness (%)
WB7.5 x WB1.3	Jan-Feb 2020	528	8500	14.52	1.661	0.347	20.89	826	826	2.92	6.52	81	73	91	92
	Mar-April 2020	512	6750	12.53	1.529	0.298	19.48	781	781	2.93	7.25	79	72	90	91
CV (%)		1.54	11.48	7.35	4.14	7.60	3.49	2.80	2.80	0.17	5.30	1.25	0.69	0.55	0.55
KA19.WB5 x WB1.3	Jan-Feb 2020	511	7800	12.31	1.517	0.301	19.84	725	725	2.90	7.14	79	70	90	91
	Mar-April 2020	485	5500	10.50	1.432	0.280	19.55	685	685	2.98	8.21	72	70	90	91
CV (%)		2.61	17.29	7.94	2.88	3.61	0.74	2.84	2.84	1.36	6.97	4.64	0.71	0.55	0.55
SK6 x SK7	Jan-Feb 2020	489	7550	10.25	1.303	0.217	16.65	783	783	2.90	7.99	72	69	90	90
	Mar-April 2020	515	7188	9.373	1.342	0.232	17.28	690	690	2.73	7.59	77	76	81	91
CV (%)		2.59	2.46	4.47	1.47	3.34	1.86	6.31	6.31	3.02	2.57	3.36	4.83	5.26	0.55
BCon1 x BCon4	Jan-Feb 2020	495	6533	9.251	1.314	0.215	16.36	781	781	2.93	7.07	72	69	91	91
	Mar-April 2020	530	4892	7.482	1.252	0.211	16.85	682	341	2.81	8.14	82	78	80	82
CV (%)		3.41	14.36	10.57	2.42	0.94	1.48	6.77	39.22	2.09	7.03	6.49	6.12	6.43	5.20



AIB 3619: Development of silkworm congenic breeds from a gene pool with higher genetic plasticity (Phase-II)

[July 2017 to 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)

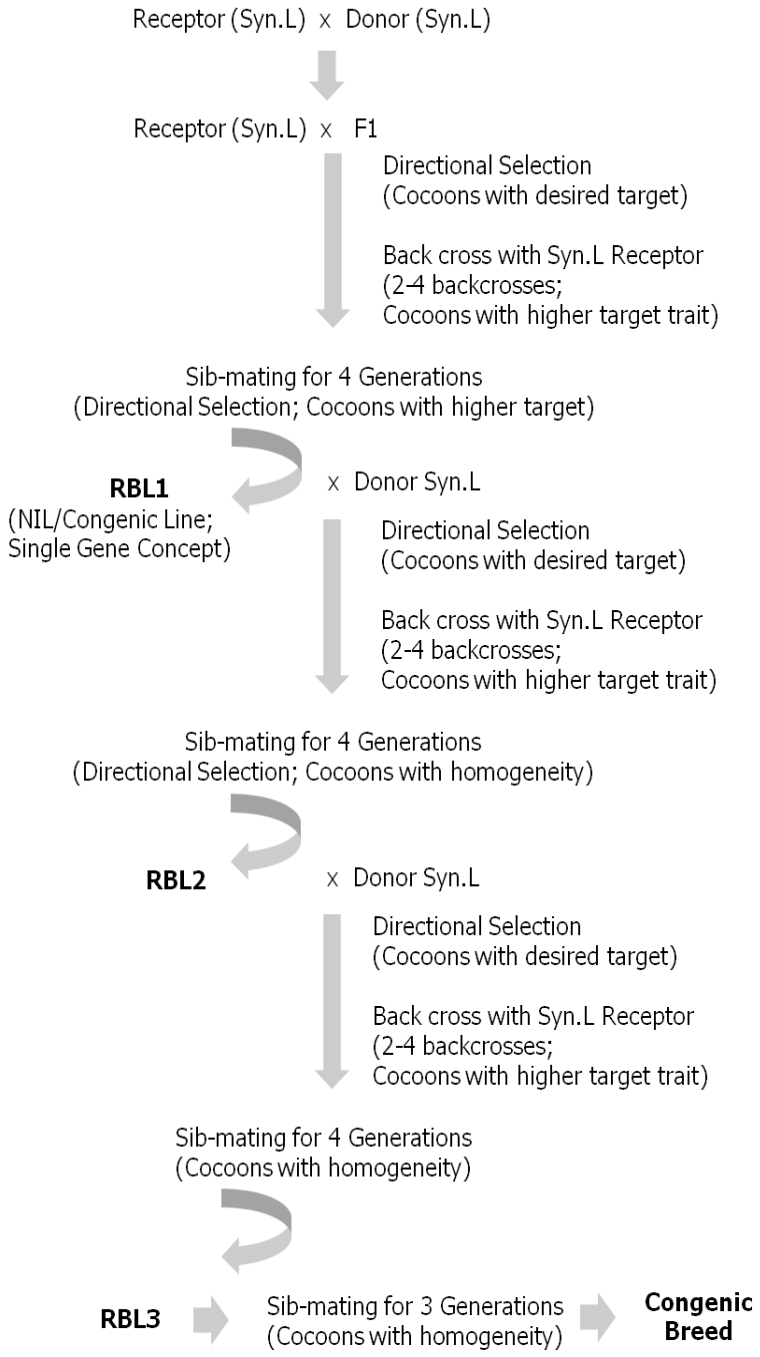
Objective: To develop congenic multivoltine for high shell weight and bivoltine breeds for high survival from the six-way converged gene pool.

Two bivoltine and three multivoltine six-way converged lines were developed in the Project AIB-3480 (Phase I). These parental lines were utilized to develop multivoltine for high shell weight and bivoltine congenic breeds for high survival as per the following breeding plan.

At each generation, the cocoons were selected based on the targeted traits and the selected ones were retained for oviposition. From the RBL2 onwards, the more emphasis was given on the homogeneity of the batches for all the morphological, quantitative and qualitative traits.

The characteristics (shell wt: >0.24g; survival: >90%) for the congenic lines were achieved with RBL3 and the lines were subjected to stabilization and evaluation.

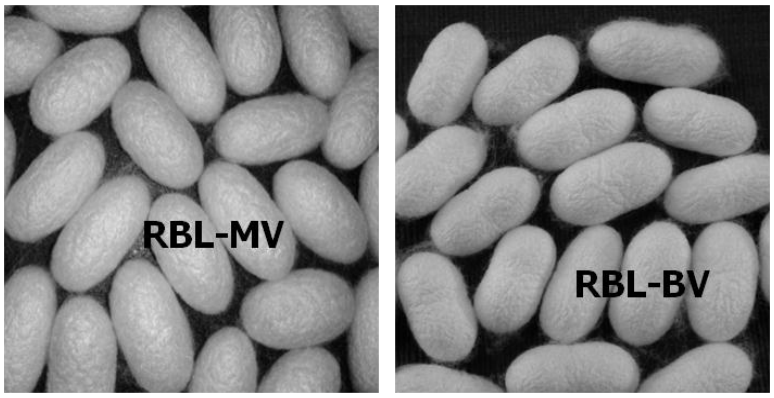
Breeding Plan for Development of Congenic Breeds



Performance of RBL/ Congenic Multivoltine Line

Season	Fec. (No.)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)	ERR (No.)	ERR wt. (kg)	Pupation (%)
MV6-way (Receptor)	404	1.097	0.146	14.22	8700	8.97	95.00
BV6-way (Donor)	439	1.216	0.213	17.52	8267	9.64	90.00
F1 (Aug-Sept16)	625	1.557	0.279	17.92	9667	13.57	98.00
BC1 (Oct-Nov16)	495	1.720	0.260	15.12	9467	15.83	95.00
BC2 (Jan-Feb17)	555	1.526	0.237	15.53	8850	13.40	92.00
BC3 (Ap-May17)	462	1.514	0.233	15.39	8967	13.50	94.00
BC3-S1 (June-July18)	512	1.419	0.239	16.84	8933	12.52	92.00
BC3-S2 (Aug-Sept17)	566	1.302	0.226	17.36	8833	11.07	94.00
BC3-S3 (Nov17)	542	1.343	0.237	17.79	8833	11.72	92.00
BC3-S4 (Jan-Feb18)	492	1.331	0.228	16.98	9033	11.40	93.00
RBL1-F1 (Apr18)	480	1.621	0.259	16.80	9167	13.40	94.00
RBL1-BC1 (June-July18)	501	1.593	0.271	17.01	8967	13.50	95.00
RBL1-BC2 (Aug-Sept18)	551	1.631	0.260	15.94	9033	13.45	93.00
RBL1-BC3 (Nov-Dec18)	449	1.613	0.262	16.24	9400	13.98	96.00
RBL1-BC3-S1(Feb-Mar19)	477	1.370	0.260	18.98	9600	13.90	96.00
RBL2-F1 (Apr-May19)	503	1.488	0.259	17.40	9267	13.12	93.00
RBL2-BC1 (June-July19)	517	1.267	0.199	15.71	9400	11.90	98.00
RBL2-BC2 (Aug19)	382	1.166	0.184	15.78	9267	10.56	96.00
RBL2-BC2-S1 (Oct-Nov19)	493	1.443	0.250	17.30	9267	13.37	95.00
RBL2-BC2-S2 (Jan-Feb20)	390	1.203	0.212	17.62	9367	11.22	96.00
RBL3-S3 (Mar-Apr 20)	458	1.262	0.224	17.75	9067	11.30	97.00

Performance of RBL/ Congenic Bivoltine Line							
Season	Fec. (No.)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)	ERR (No.)	ERR wt. (kg)	Pupation (%)
BV6-way (Receptor)	439	1.216	0.213	17.52	8267	9.64	90.00
MV6-way (Donor)	404	1.097	0.146	14.22	8700	8.97	95.00
F1 (Aug-Sept16)	581	1.560	0.313	20.06	9567	14.03	96.00
BC1 (Oct-Nov16)	488	1.562	0.272	17.41	9033	13.37	93.00
BC2 (Jan-Feb17)	482	1.517	0.246	16.22	8900	13.30	91.00
BC3 (Ap-May17)	476	1.468	0.237	16.14	8800	12.70	94.00
BC3-S1 (June-July18)	498	1.415	0.239	16.89	9000	12.52	94.00
BC3-S2 (Aug-Sept17)	472	1.375	0.234	17.02	9033	12.27	95.00
BC3-S3 (Nov17)	468	1.321	0.276	20.89	9167	11.89	94.00
BC3-S4 (Jan-Feb18)	525	1.245	0.252	20.24	8900	12.37	95.00
RBL1-F1 (Apr18)	521	1.590	0.281	17.67	9133	13.27	94.00
RBL1-BC1 (June-July18)	489	1.431	0.252	17.61	9300	11.73	95.00
RBL1-BC2 (Aug-Sept18)	498	1.459	0.265	17.71	8833	12.27	93.00
RBL1-BC3 (Nov-Dec18)	556	1.510	0.280	18.54	9300	14.03	94.00
RBL1-BC3-S1(Feb-Mar19)	632	1.250	0.245	19.60	9567	13.45	96.00
RBL2-F1 (Apr-May19)	511	1.506	0.262	18.39	9267	13.68	93.00
RBL2-BC1 (June-July19)	512	1.309	0.21	16.04	9500	13.26	96.00
RBL2-BC2 (Aug19)	384	1.304	0.287	22.00	7533	9.58	82.00
RBL2-BC2-S1 (Oct-Nov19)	342	1.656	0.34	20.53	6400	10.12	88.00
RBL2-BC2-S2 (Jan-Feb20)	591	1.373	0.280	20.39	9100	11.89	95.00
RBL3-S3 (Mar-Apr 20)	458	1.305	0.268	20.54	8667	10.92	92.00



After repeated back-crossings, the target character might come down or up or attain a plateau following 2-4 sib-matings and stabilize in the subsequent generations. In the present study, at RBL3, the targets of shell weight (0.22g) in multivoltine was achieved (0.224g); whereas in bivoltine the survival (>90%) only 86.67% could be achieved.

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 *(DBT Collaborative Project with SBRL-Bangalore, CSRTI-Mysore & CSRTI-Pampore)*

[April 2017 - September 2020]

Coordinator: V. Sivaprasad; CSRTI-Berhampore: Gopal Chandra Das (PI) & N Chandrakanth; 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 in field
- Continuous maintenance of MAS-N lines
- Co-ordination and statistical analysis of observation from lines reared at different stations

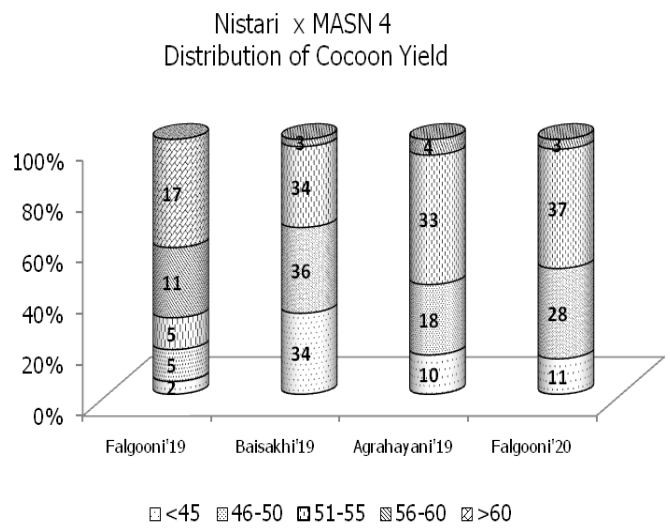
Three BmNPV resistant bivoltine breeds *viz*., MASN4, MASN6 & MASN7 were evaluated across different seasons at CSRTI-Berhampore during 2017-2019. MASN4 was found to be the better performer. CSR2, the control breed could not survive at all during unfavourable seasons.

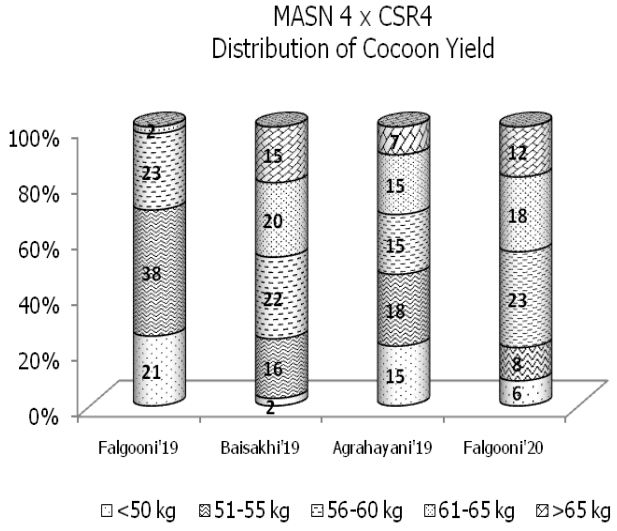
MASN hybrids *viz*., Bi x Bi: MASN4 x CSR4; Multi x Bi: Nistari x MASN4 were supplied by SBRL-Bangalore for evaluation at farmers' level in West Bengal during Oct-Nov 2018; Feb 2019; April 2019; Oct-Nov 2019 and Feb-March 2020. A total of 24200 dfls of MASN4 x CSR4 and 25,850 dfls of N x MASN4 were evaluated with farmers in Nov 2018-Feb 2020. During the current year, 9,250 dfls of MASN4 x CSR4 and 21,850 dfls of N x MASN4 were tested in the field level. MASN bivoltine hybrids performed better than SK6 x SK7 with regard to cocoon yield with 9.7% improvement; while SK6 x SK7 hybrids recorded higher survival. Incase of Multi x Bi hybrids, N x MASN4 performed better with regard to yield with 9.96% improvement and cocoon quality than the ruling crossbreed (N x SK6.7).

Further field testing with the farmers would be undertaken in 2020-21 with MASN4 x CSR4 and Nistari x MASN4 for documenting the consolidated performance in West Bengal.

MASN Hybrid Performance at Farmers Level (2018-20)

Season	Hybrids	Dfls (no.)	Farmer (no.)	Fec.	Hatch (%)	Yield/ 100 dfls (kg)	SCW (g)	SSW (g)	Shell (%)	FL (m)	Denier	Ren-ditta	Silk Rec. (%)
Agrahayani (Nov 2018)	MASN x CSR4	7450	84	610	82.9	52.7 (25-61)	1.889	0.382	20.22	798	2.54	8.09	76.0
	SK6.7	300	3	490	88.0	50.0 (48-54)	1.487	0.274	18.43	790	2.52	8.12	76.0
	t stat (p value)			0.001	0.329	0.521	0.140	0.049	0.054	0.228	0.747	0.804	0.725
Falgooni (Feb 2019)	MASN x CSR4	7500	75	600	94.0	60.7 (50-80)	1.813	0.350	19.33	713	2.50	7.80	77.0
	SK6.7	1200	12	497	96.0	56.7 (52-58)	1.464	0.251	17.19	702	2.53	7.90	78.0
	t stat (p value)			0.001	0.218	0.010	0.001	0.003	0.007	0.205	0.202	0.133	0.036
Agrahayani (Nov 2019)	MASN x CSR4	5100	70	620	94.6	55.3 (33-66)	1.629	0.346	21.24	838	2.82	6.92	66.1
	SK6.7	2000	20	510	91.0	52.50 (35-56)	1.508	0.278	18.44	741	2.74	7.87	68.5
	t stat (p value)			0.003	0.316	0.004	0.98	0.025	0.071	0.008	0.316	0.045	0.162
Falgooni (Feb 2020)	MASN x CSR4	4150	67	600	94.0	59.8 (42-70)	1.605	0.340	21.18	709	2.51	8.07	76.7
	SK6.7	500	10	520	97.0	52.40 (45-65)	1.506	0.253	16.80	706	2.53	8.08	77.3
	t stat (p value)			0.044	0.060	0.0001	0.219	0.029	0.007	0.851	0.533	0.946	0.230
Falgooni (Feb 2019)	N x MASN	4000	40	480	96.0	59.3 (45-79)	1.795	0.320	17.86	707	2.48	9.04	76.0
	N x SK6.7	900	9	455	95.8	49.7 (46-53)	1.452	0.237	16.29	653	2.48	9.20	75.0
	t stat (p value)			0.195	0.918	0.001	0.001	0.001	0.002	0.001	0.872	0.263	0.290
Baishaki (Apr 2019)	N x MASN	10000	107	480	96.0	47.2 (33-57)	1.750	0.310	17.82	609	2.41	9.28	67.0
	N x SK6.7	900	9	455	95.8	44.6 (36-50)	1.562	0.262	16.77	570	2.62	9.78	67.0
	t stat (p value)			0.111	0.069	0.187	0.009	0.001	0.124	0.025	0.064	0.080	0.934
Agrahayani (Nov 2019)	N x MASN	4350	69	550	97.7	50.7 (37-59)	1.834	0.296	16.14	726	2.53	8.31	72.8
	N x SK6.7	2000	20	430	92.0	46.0 (34-58)	1.468	0.234	15.94	569	2.67	10.03	66.5
	t stat (p value)			0.076	0.001	0.006	0.002	0.007	0.857	0.018	0.028	0.003	0.019
Falgooni (Feb 2020)	N x MASN	7300	79	500	97.0	50.3 (38-57)	1.678	0.285	16.98	654	2.50	9.21	75.3
	N x SK6.7	500	10	420	98.0	48.5 (40-53)	1.537	0.244	15.88	649	2.49	9.51	75.7
	t stat (p value)			0.005	0.435	0.213	0.001	0.169	0.545	0.662	0.824	0.134	0.686
CV (%) Across Seasons	MASN x CSR4			2.94	6.75	13.50	7.46	7.48	5.13	7.21	4.75	5.84	5.32
	SK6.7 (Ctrl)			5.00	4.88	10.02	3.75	6.30	7.62	5.25	3.70	2.83	4.43
	N x MASN			7.71	1.67	13.95	4.14	4.99	4.69	7.53	3.24	4.30	5.59
	N x SK6.7 (Ctrl)			7.17	3.04	18.29	4.21	9.48	8.47	12.81	5.16	4.76	6.16





Continuous/Other Activities

Identification of markers for high humidity tolerance in silkworm breeds

Raviraj V.S., N. Chandrakanth, V. Lakshmanan and V. Sivaprasad

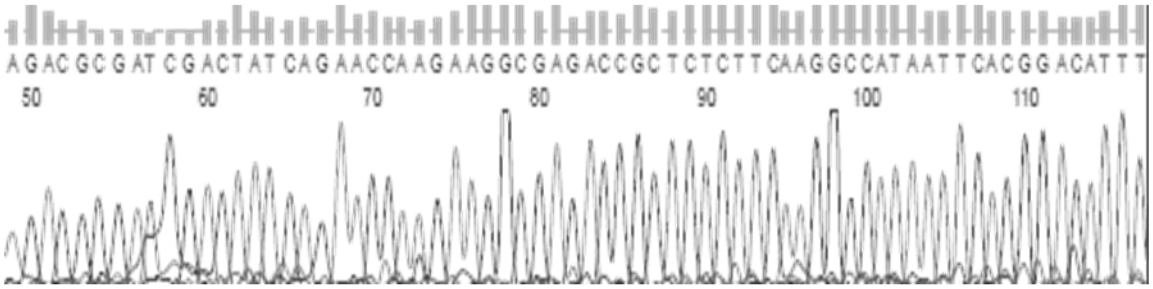
Objective: To identify markers for tolerance to high temperature and high humidity in silkworm

The growth of bivoltine silk production in E & NE India lags behind drastically in comparison to Southern states due to non-availability of suitable bivoltine hybrids and bivoltine foundation crosses (SK6 x SK7 & BCon1 x BCon4) are reared in limited quantities currently. The major constraints in bivoltine popularization are adverse adverse climatic conditions (high temperature & high humidity). DNA markers (S0803 & S0816) for tolerance to high temperature were identified and are being utilized to develop silkworm hybrids tolerant to high temperature at CSRTI-Berhampore. Preliminary studies at CSRTI-Mysore shown that *pyrexia* gene (a transient receptor potential channel) might be associated with tolerance to high humidity in silkworm. To overcome these limitations and continuously rear bivoltine hybrids in these harsh climatic conditions throughout the year, studies needs were planned to integrate conventional breeding (directional selection) for improved productivity and advanced genome technologies such as MAS (marker assisted selection) at CSRTI-Berhampore.

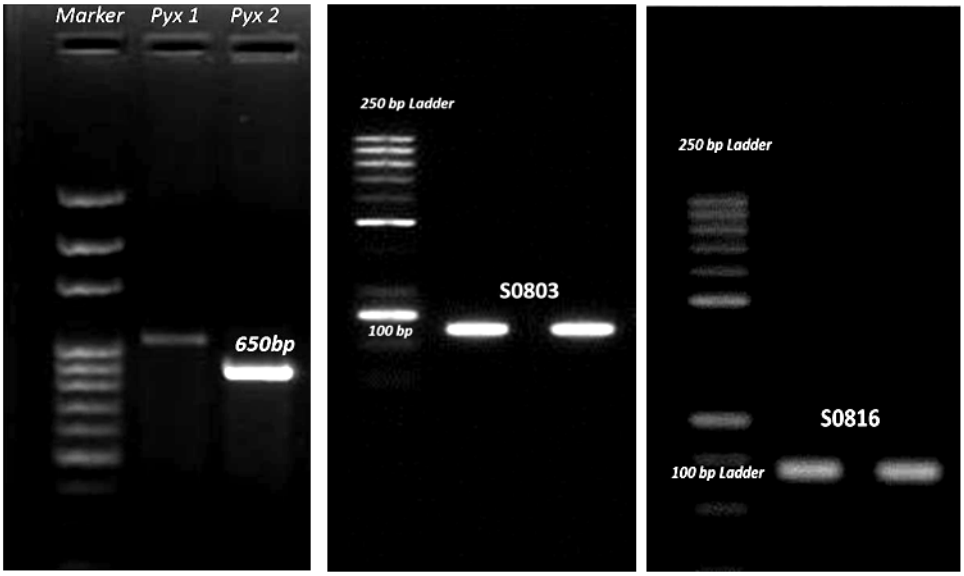
Identification of markers for high humidity stress

Pyrexia gene sequence retrieved from repositories was utilized to match Sanger sequencing data by bioinformatics analysis. Potential gene markers i.e., specific markers/primers (Pyx1 & Pyx2) have been designed for high humidity tolerance. These markers were validated with the populations which have survived at high humidity and high temperature. Pyx1 & Pyx2 gene sequences have been registered with NCBI (MT221438 & MT221439). These primers are being utilized further to select populations/broods with tolerance to high humidity.

Designing of Markers Specific to *pyrexia* Gene
(Chromatogram based on Sanger DNA Sequence**)**



PCR for Gene Markers for High Humidity Tolerance (Pyx1 & Pyx2)
& High Temperature Tolerance (S0803 & S0816)



Validation of markers for high humidity & high temperature

A total of 27 bvioltine breeds from different R&D institutes were screened for tolerance to high humidity (85±5%) & high temperature (35±5˚C) in simulated conditions during June-July 2019, Aug-Sept 2019 & Mar-April 2020. The populations survived from June-July 2019 season were utilized to produce next-generation layings. Marker assisted selection (MAS) was performed on Aug-Sept 2019 & Mar-April 2020 batches (male & female moths) utilizing markers for tolerance to high humidity & high temperature. Popular bivoltine foundation crosses parents *i.e.*, SK6, SK7, BCon1 & BCon4 were maintained as controls. Bivoltine breeds *viz.*, N2, N5, WB1 & WB3 expressed tolerance to both high humidity and high temperature. Sk6, SK7 and BCon1 showed tolerance to high temperature only. Tolerance to high humidity (85±5%) & high temperature (35±5˚C) was not recorded in CSR6, CSR26, CSR27, CSR51, CSR53, N1, MASN4, MASN6, HTH1, HTH3, HTH5, HTH6, HTH10, BHP1, BHP3, BHP8, BHP9, WB5, WB9 & BCon4. The broods with tolerance to high humidity

(85±5%) & high temperature (35±5˚C) are being maintained further for developing breeds/hybrids tolerant to high humidity & high temperature.

Performance of Bivoltine Silkworm Breeds with Tolerance to High Humidity (85±5%) & High Temperature (35±5˚C)

Breed	Season	Pupation (%)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)	MAS	
						HH	HT
N2	June-July 2019	49.83	1.31	0.305	23.28		
	Aug-Sept 2019	21.66	1.19	0.247	20.60	✓	✓
	Mar-April 2020	38.33	1.29	0.320	24.79	✓	✓
	CV (%)	31.59	4.16	10.83	7.57		
N5	June-July 2019	22.33	1.18	0.214	18.13		
	Aug-Sept 2019	48.00	1.21	0.227	18.77	✓	✓
	Mar-April 2020	32.33	1.21	0.243	20.05	✓	✓
	CV (%)	30.87	53.47	81.00	4.20		
WB1	June-July 2019	70.63	1.29	0.229	17.68		
	Aug-Sept 2019	71.41	1.29	0.230	17.69	✓	✓
	Mar-April 2020	55.83	1.36	0.272	19.92	✓	✓
	CV (%)	10.87	2.55	8.220	5.72		
WB3	June-July 2019	72.21	1.44	0.273	18.98		
	Aug-Sept 2019	69	1.51	0.260	16.96	✓	✓
	Mar-April 2020	25.77	1.18	0.252	21.24	✓	✓
	CV (%)	38.05	10.15	3.310	9.17		
SK6 (Control)	June-July 2019	67.00	1.21	0.190	15.32		
	Aug-Sept 2019	69.22	1.43	0.248	17.37		✓
	Mar-April 2020	57.25	1.19	0.222	18.62		✓
	CV (%)	8.06	10.43	13.21	7.95		
SK7 (Control)	June-July 2019	83.33	1.16	0.180	15.83		
	Aug-Sept 2019	89.23	1.41	0.226	16.02		✓
	Mar-April 2020	95	1.37	0.266	19.37		✓
	CV (%)	5.34	10.22	19.21	9.52		
B.Con1 (Control)	June-July 2019	48.00	1.22	0.200	16.69		
	Aug-Sept 2019	35.33	1.42	0.235	16.51		✓
	Mar-April 2020	64.33	1.24	0.224	18.11		✓
	CV (%)	24.12	8.52	8.150	4.18		

Improvement of Nistari Lines

Thangjam Ranjita Devi, Anil Kumar Verma, Gautam Mitra and V. Sivaprasad

Objectives: To improve Nistari lines for improved survival and silk productivity

Mulberry sericulture in E & NE India is dominated by crossbreeds of Nistari; the native race is particularly the backbone of mulberry sericulture in West Bengal and is reared traditionally for hundreds of generations and well adapted to the local environmental conditions despite low productivity and inferior quality of silk. However, Nistari lines (marked & plain; named as Debra, Chalsa, Balapur, Marked, Plain etc.) and its crossbreed productivity have deteriorated due to excessive inbreeding and lack of race maintenance. Under the circumstances, studies have been initiated to improve Nistari lines for survival, larval duration, silk productivity and silk characteristics through inbred-line isolation utilizing directional selection (survival, shell ratio, silk filament length). Nistari lines were collected from different sources *i.e.*, CSRTI-BHP, CSGRC-Hosur, NSSO-WB, DOS-WB & RSRS-KA. The lines were reared in different season's *viz.*, Bhaduri (June-July), Shravani (Aug-Sep), Agrahayani (Oct- Nov), Falguni (Jan-Feb) & Baisakhi (Mar-Apr). The data on rearing and reeling performance was documented.

Laboratory Performance of Nistari lines (2013-2018)

Line	Parameter	Passport	CSGRC-Hosur	CSRTI-BHP	NSSO-WB	DOS-WB
Nistari (Plain)	Fecundity (No)	390	370	360	350	345
	Pupation Rate (%)	86	76	81	79	78
	Avg. Coc. Wt (g)	1.00	0.78	1.00	0.88	0.79
	Avg. Shell Wt (g)	0.10	0.08	0.095	0.11	0.11
	Shell Ratio (%)	10.0	10.47	9.50	12.80	13.92
	Filament Length (m)	332	280	300	290	278
	Reelability (%)	73.1	70	70	70	70
Nistari (Marked)	Fecundity (No)	392	387	390	360	310
	Pupation Rate (%)	81.4	70	81	75	77
	Avg. Coc. Wt (g)	0.90	0.85	0.95	0.81	0.84
	Avg. Shell Wt (g)	0.100	0.08	0.1	0.1	0.12
	Shell Ratio (%)	11.11	9.08	11.21	12.34	14.2
	Filament Length (m)	286	270	260	270	258
	Reelability (%)	73.65	68	70	68	65

Two each of marked and plain lines have been identified to be promising and better than the other Nistari lines in the field. These selected lines were further subjected to directional selection for the morphological and economic traits (cocoon shape, volume, built & uniformity; cocoon weight, shell weight, shell ratio & filament length). Cold reeling was adopted for determining the filament length of males and females for each of the selected marked and plain lines. After the cold reeling, the pupae corresponding to the desired filament length was identified and kept at room temperature for moth emergence. The emerged moths were utilized for pairing

and oviposition; the dfls were preserved as per standard protocols and utilized for maintaining the next generation.

Evaluation of Nistari Lines (2019-2020)

Line	Parameter	Fecundity (No)	Pupation Rate (%)	Larval period (days)	ERR by Wt. (kg)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)
Marked	Benchmark Trait values	392-400	81-83	22	7.29-9.1	0.9-1.1	0.1-0.115	11-12
	Expected Trait values	410-450	>90	22	10.8-11.7	1.2-1.3	0.15-0.16	13-14
	CSRTI-BHP	478 ± 8.72	96.67 ± 1.45	22	9.9 ± 0.09	1.18 ± 0.07	0.17 ± 0.02	14.12 ± 0.91
	CSGRC-Hosur	384.3 ± 8.62	70.92 ± 1.59	22	7.17 ± 0.15	0.86 ± 0.04	0.08 ±.02	9.69 ± 1.35
	NSSO-WB	369 ± 8.54	76.33 ±1.53	22	7.6 ± 0.20	0.81 ± 0.02	0.10 ± 0.01	11.93 ± 0.49
	DOS-WB	391.67 ± 7.64	78.33 ± 1.53	22	7.7 ± 0.26	0.82 ± 0.02	0.11 ± 0.02	12.93 ± 1.54
	RSRS-KA	482.67 ± 6.66	96.43 ± 1.40	22	9.61 ± 0.35	1.07 ± 0.04	0.13 ± 0.02	12.15 ± 1.82
Plain	Benchmark Trait values	382-390	86-88	22	7.3-9.7	0.9-1.21	0.1-0.125	11-12.5
	Expected Trait values	400-450	> 90	22	10.8-11.7	1.2-1.3	0.15-0.16	13 -14
	CSRTI-BHP1	443.2 ± 11.85	96.45 ± 1.19	22	9.17 ± 0.72	1.12 ± 0.08	0.14 ± 0.02	12.84 ± 0.50
	CSGRC-Hosur	377.33 ± 7.02	71.26 ± 1.18	22	7.07 ± 0.12	0.76 ± 0.05	0.08 ± 0.01	10.14 ± 1.34
	NSSO-WB	369 ± 8.54	76.33 ± 1.53	22	7.60 ± 0.2	0.81 ± 0.02	0.10 ± 0.01	11.93 ± 0.49
	DOS-WB	401.00 ± 9.17	78.80 ± 2.59	22	7.63 ± 0.60	0.80 ± 0.01	0.10 ± 0.01	12.55 ± 1.25
	RSRS-KA	446.47 ± 7.40	96.73 ± 1.16	22	9.33 ± 0.29	1.14 ± 0.10	0.15 ± 0.02	12.90 ± 0.68

Season-Wise Performance of Nistari Lines (2019-2020)

Line	Season	Fec. (No)	Pupation Rate (%)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)	Filament length (m)
IN-M1	Bhaduri	516	97.80	1.20	0.17	14.33	
	Shravani	535	97.28	1.42	0.22	15.49	
	Agrahayani	507	98.00	1.50			411.60
	Falguni	514	97.00	1.12			453.75
	Baisakhi	495	98.00	1.15	0.16	13.72	
	Mean	513.40	97.62	1.28	0.18	14.08	432.67
	CV (%)	2.84	0.46	13.38	16.67	0.64	6.89
IN-M2	Bhaduri	481	97.60	1.13	0.15	13.27	
	Shravani	468	97.40	1.26	0.19	15.08	
	Agrahayani	470	95.00	1.42			373.00
	Falguni	504	97.00	1.13			393.03
	Baisakhi	484	95.00	1.15	0.16	14.35	
	Mean	481.4	96.40	1.22	0.17	13.96	383.02
	CV (%)	2.67	1.34	10.28	11.76	0.14	3.70
IN-P1	Bhaduri	368	97.80	1.06	0.11	10.37	
	Shravani	486	96.93	1.11	0.13	11.71	
	Agrahayani	447	96.00	1.16			350.20
	Falguni	466	96.00	1.05			378.10
	Baisakhi	490	95.00	1.04	0.15	13.97	
	Mean	451.4	96.35	1.084	0.13	11.99	364.15
	CV (%)	11.0	1.1	4.64	15.38	15.09	3.83
IN-P2	Bhaduri	465	97.80	1.05	0.13	12.38	
	Shravani	442	95.50	1.20	0.16	13.33	
	Agrahayani	472	95.00	1.48			339.43
	Falguni	476	95.00	0.96			365.00
	Baisakhi	432	96.00	1.10	0.14	12.61	
	Mean	457.4	95.86	1.16	0.14	12.09	352.22
	CV (%)	4.23	1.21	17.25	7.14	4.053	5.13

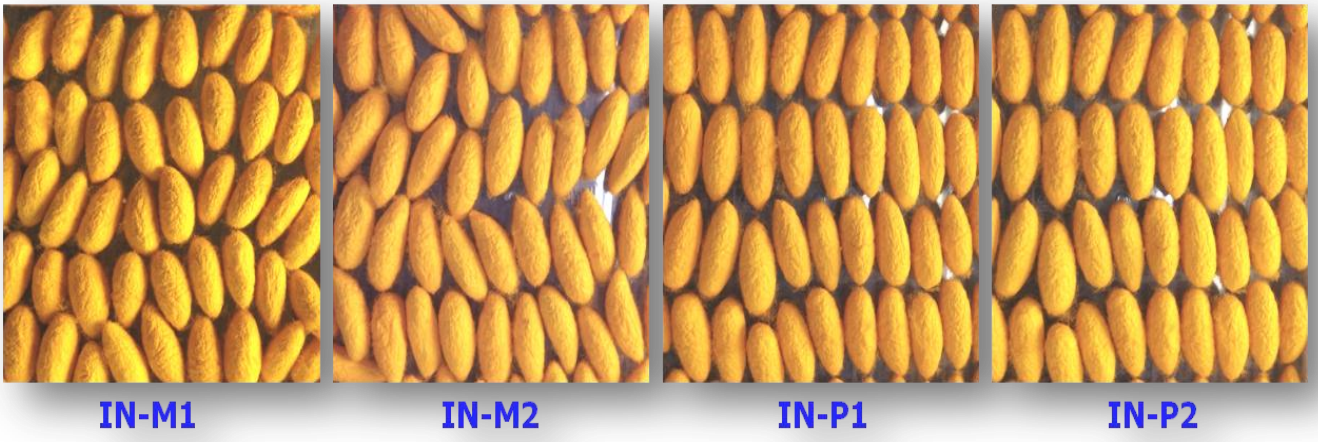
Correlation of Filament Length & Cocoon Weight in Nistari Lines (Agrahayani & Falguni 2019-2020)

Line	Source	Female		Male	
		$\hat{r}$	Estimate of Filament Length based on Avg. Cocoon Wt.	$\hat{r}$	Estimate of Filament Length based on Avg. Cocoon Wt.
IN-M1	Debra (BHP)	0.35†	439.58	0.33†	503.38
IN-M2	Chalsa (BHP)	0.39*	371.21	0.08	424.32
IN-P1	Nistari (Plain-BHP)	0.60**	361.80	0.39†	397.04
IN-P2	Nistari (Plain-KA)	0.40*	331.86	0.27	414.66

† (P≤0.10); *(P≤0.05);** (P≤0.01)

The degree of relation between filament length and cocoon weight reflects the significant positive association across in Nistari lines, except in Chalsa & plain males. Based on average functional relationship (by regressing filament length on cocoon weight), filament length of each line was estimated across sex/crops. The highest filament length estimation was noticed in Nistari-Debra line as compared to the others, which is nearer to the real values of filament length.

These improved Nistari lines (IN-M1, IN-M2, IN-P1 & IN-P2) would serve as initial stocks to develop improved Nistari lines with high survival and resistance to BmNPV with better qualitative and quantitative characters and silk productivity and improved hybrids in the proposed project to be undertaken in 2020-21.



Maintenance of Silkworm Germplasm

23 multivoltine and 29 bivoltine silkworm germplasm breeds are maintained at CSRTI-Berhampore. Five crops were reared in case of multivoltines and two incase of bivoltine (Agrahayani-2019 & Baisakhi-2020) have been undertaken. The rearing performance has recorded and documented.

Performance of Multivoltine Germplasm (2019 - 20)

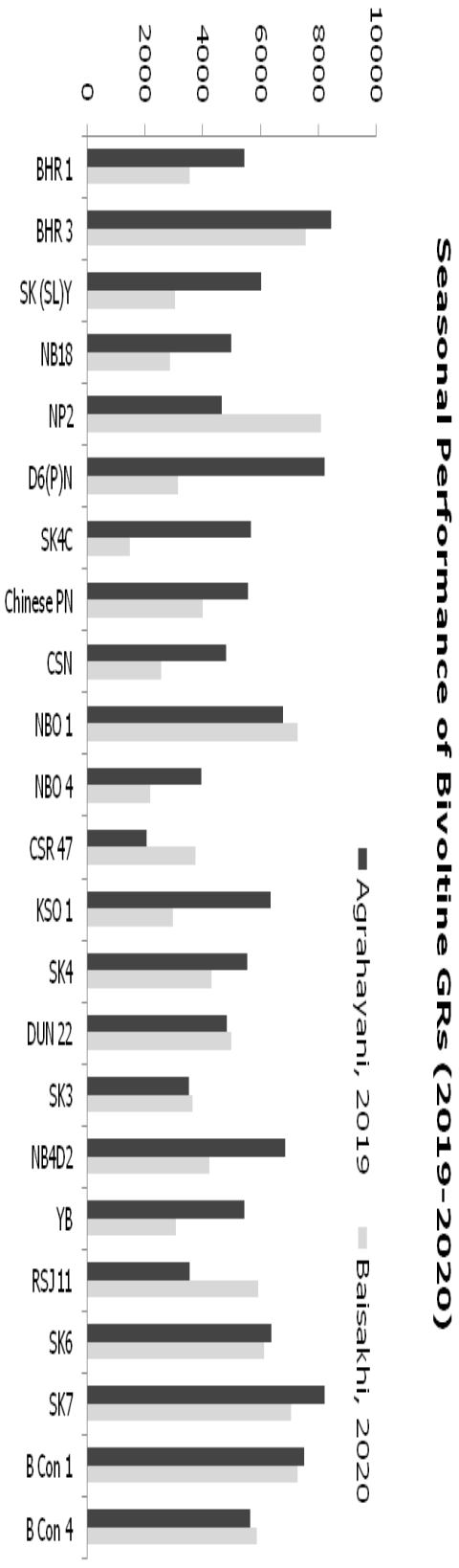
Race/Breed	Fecundity (No.)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)	ERR Wt. (kg)	Pupation Rate (%)
Nistari (M)	376	1.116	0.124	11.11	10.17	96
Nistari (P)	411	1.181	0.144	12.19	10.63	94
Nistari (Chalsa)	455	1.138	0.153	13.44	10.43	95
Nistari (Debra)	525	1.143	0.149	13.04	10.47	93
Sarupat	452	1.121	0.141	12.58	10.27	93
M12W	475	1.119	0.142	12.69	09.97	93
Cambodge	495	1.279	0.165	12.90	11.70	94
CB5	486	1.593	0.239	14.88	14.27	92
M12W	479	1.279	0.170	13.29	11.60	93
M6M81	496	1.253	0.199	15.88	11.10	92
M6DPC	458	1.349	0.181	13.42	12.27	93
OS-616	505	1.218	0.184	15.11	11.07	95
MCon1	475	1.309	0.202	15.40	11.87	92
MCon4	498	1.388	0.211	15.20	12.63	93
M2	449	1.302	0.201	15.44	12.73	94
G	523	1.439	0.201	13.97	13.03	92
PM	419	1.156	0.141	12.20	10.40	94
O	515	1.511	0.219	14.49	13.87	93
M15	519	1.411	0.189	13.39	12.73	94
M6DPE	511	1.477	0.222	15.03	13.13	92
M6DPC(Green)	486	1.177	0.155	13.17	10.70	94
MH1	496	1.512	0.219	14.48	13.80	92
BL67	488	1.236	0.184	14.89	10.47	90

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

Performance of Bivoltine Germplasm (2019 - 20)

Race/Breed	Fecundity (No.)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)	ERR Wt. (kg)	Pupation Rate (%)
KPG A	509	1.267	0.212	16.73	7.45	57.33
Gen 3	480	1.435	0.277	19.30	9.01	59.33
CSN	478	1.315	0.229	17.41	6.75	48.17
NBO 1	426	1.325	0.223	16.83	9.44	67.67
NBO 4	470	1.312	0.217	16.54	5.53	39.67
SK3	406	1.264	0.231	18.28	4.59	35.33
KSO 1	446	1.402	0.263	18.76	9.21	63.50
BHR 1	501	1.355	0.277	20.44	7.72	54.33
BHR 3	551	1.346	0.239	17.76	11.81	84.50
SK (SL)Y	509	1.368	0.247	18.06	8.44	60.17
J 112	336	1.143	0.197	17.24	6.96	58.00
NB18	369	1.339	0.231	17.25	7.11	50.00
NP2	473	1.263	0.236	18.69	6.12	46.67
D6(P)N	485	1.211	0.203	16.76	10.94	82.17
SK4C	506	1.283	0.215	16.76	7.40	56.67
JPN	456	1.218	0.230	18.88	5.88	47.33
Chinese PN	487	1.343	0.236	17.57	7.81	55.67
CSR 47	472	1.266	0.235	18.56	2.64	20.67
SK4	406	1.172	0.191	16.30	6.72	55.33
DUN 22	519	1.273	0.212	16.65	6.31	48.33
NB4D2	513	1.313	0.251	19.12	9.61	68.67
YB	425	1.314	0.226	17.20	7.61	54.33
RSJ 11	443	1.474	0.273	18.52	5.32	35.50
SK6	500	1.207	0.197	16.32	8.31	63.81
SK7	470	1.258	0.196	15.58	10.65	82.11
BCon 1	542	1.317	0.218	16.55	10.14	75.20
BCon 4	456	1.343	0.244	18.17	7.86	56.33

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



Exploratory studies on Identification of superior bivoltine foundation cross as a male component to improve cross-breed productivity in E & NE India (Concept Note CSB/BER/RCN017)

V. Lakshmanan, N. Chandrakanth, A.K. Verma, T. Ranjitha Devi, Raviraj V.S, and V. Sivaprasad

Bivoltine male parents are utilized in Multi x Bi hybrids typically to exploit hybrid vigour and express to improve productivity and silk quality. The agro-climatic conditions in East & NE India are not being conducive for bivoltine hybrids and as a result, only crossbreeds are preferred by the farmers (>95%) especially in West Bengal. Currently, the foundation crosses *viz.,* SK6 x SK7 and BCon1 x BCon4 are being utilized to produce Nistari x BV hybrids. The productivity potential of these FCs is very moderate and the resultant Nistari crossbreed is also with moderate productivity. For a longtime, West Bengal is unable to generate bivoltine seed cocoons due to limitations and still not being self-sufficient. Utilizing productive bivoltine breeds of southern origin is frought with problems as their adoptability in East & NE India was not satisfactorily till date. The improvement in productivity of Nistari crossbreeds in this region is quite necessary and is a long standing demand from the stakeholders. To address this requirement, a breeding programme was undertaken to develop a suitable bivoltine male component for crossbreed purposes utilizing breeds with new genetic background with higher fitness as well as productivity merits to improve the productivity in Nistari crossbreeds. The popular bivoltine breeds in the region i.e., SK6, SK7, BCon1 and BCon4 were utilized as maternal parental resources and productive bivoltine breeds from southern region (4S, BMFD1, CSR16, CSR51) for introgression of productive traits. The new breeding line such as BFC1 has shown good promise with better productivity with 12Y. Further hybrid evaluation is under progress with other multivoltine breeds.

Performance BFC lines @ CSRTI-Berhampore (March-April 2020)

Breed	Parentage	Larval Marking	ERR by No	ERR By Wt (Kg)	Cocoon Wt. (g)	Shell Wt. (g)	Shell Ratio (%)
BFC1	BCon1 x 4S	Plain	9166	13.310	1.449	0.262	18.08
BFC2	SK6 x 4S	Plain	8333	11.060	1.224	0.249	20.34
BFC6	SK7 x CSR51	Marked	8933	12.980	1.424	0.266	18.68
BFC7	BCon1 x CSR16	Marked	9080	13.350	1.473	0.300	20.36
BFC15	SK6.BMFD1 x SK7.BMFD1	Plain	9100	12.330	1.330	0.276	20.75
BFC18	BCon1.4S x BCon1.BMFD1	Plain	8400	11.030	1.239	0247	19.93
BFC19	BCon1.4S x BCon1.BMFD1	Marked	8933	12.760	1.391	0.282	20.27
SK6		Plain	8240	11.560	1.350	0.228	16.88
SK7		Plain	9010	12.360	1.341	0.222	16.55
BCon1		Plain	8640	12.630	1.389	0.228	16.41
BCon4		Plain	8060	11.090	1.323	0.238	17.98

Basic Seed Supply

A total of 8900 P1/P2 dfls of multivoltine (M6DPC: 4000; M12W: 300; MCon4: 300 dfls; Nistari: 4300 dfls) and 2775 dfls of bivoltine (SK6, SK7, BCon1, BCon4, FCs) basic seeds were supplied to NSSO, DoSs and Registered Seed Producers in different seasons based on demand. A cocoon yield of 20-30kg/100 dfls (multi) & 35-40 kg/100dfls (Bi) were recorded and the seed cocoons generated were utilized for the production of multi x bivoltine hybrids for commercial purposes.

POST COCOON TECHNOLOGY

Concluded Projects

Pilot Study: 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; Oct 2018-Jan 2019) and S. Mazumdar (RSTRS-Malda)

Objectives:

- Optimizing the cocoon preservation and finding out critical issues for yarn quality

Commercial multi x bi hybrid cocoons (Nistari x SK6.SK7) were procured during favourable (Agrahayani 2018) and unfavourable (Bhaduri 2019) seasons. The cocoon lots were hot air-dried and thirteen treatments were imposed. The treatments included preservation of cocoons for different periods *viz*., T1: control, `0' days; T2: 15days; T3: 30days; T4: 45days; T5: 60days; T6: 75days; T7: 90days in Hessian (H) and similarly in Low Density Polyethylene (LDPE) bags *i.e.*, T8-T13.

Influence of Cocoon Storage on Mulberry Cocoon Silk Reeling & Quality

Sea-son	Treat-ments	Reel-ability (%)	Ren-ditta	Silk Rec. (%)	Waste on Silk Wt. (%)	Avg. Size (denier)	Tenacity (gms/ denier)	Elong-ation (%)	Size Deviation	Even-I	Clean-ness (%)	Neat-ness (%)	Breaks
Agrahyani	T1	80	8.1*	77.1	29.7	25.5	3.6*	18	2.9*	25*	83.0	83	10*
	T2	80	8.1*	76.3	31.1	24.3	3.5*	20*	1.6	30	82.5*	85	10*
	T3	78	8.3	75.9	31.7	22.9	3.5*	19	2.3	38	81.5	86	11
	T4	80	8.3	77.5*	29.1	24.9	3.4	20*	2.4	35	80.5	85	10*
	T5	78	8.4	77.1	29.7	23.7	3.4	19	2.8*	39	80.0	85	11
	T6	79	8.6	77.5*	29.1	21.8*	3.5*	18	2.0	33	81.0	86	10*
	T7	81*	8.4	77.6*	28.8*	23.1	3.4	18	1.8	38	79.5	85	10*
	T8	79	8.4	76.5	30.7	22.3	3.4	19	2.1	39	82.0	86	11
	T9	78	8.5	76.5	30.7	23.3	3.5*	18	2.4	37	81.0	87*	10*
	T10	79	8.1*	75.8	31.9	24.5	3.3	19	2.9	37	80.5	86	10*
	T11	81*	8.7	75.9	31.2	24.1	3.3	19	2.4	36	80.5	84	11
	T12	77	8.7	76.9	29.9	24.2	3.5	19	1.7	39	79.5	85	10*
	T13	75	9.4	74.9	33.4	25.9	3.5	19	1.8	35	80.0	86	10*
	Avg.	78.4	8.5	76.6	30.5	23.9	3.5*	19	2.2	35	80.8	85	10
Bhaduri	T1	56	22.3	58.9	70.3	27.8	3.2	17	4.7	48	79.7	80	14
	T2	50	23.0	59.1	85.7	26.3	3.1	16	4.2	47	79.0	81	14
	T3	53	23.6	55.9	78.9	26.3	3.0	17	5.1	49	79.0	80	16
	T4	48	28.5	55.3	81.1	29.6	3.1	16	4.5	48	79.7	81	15
	T5	47	30.9	50.5	98.2	24.3	3.2	17	3.6	47	79.3	81	14
	T6	50	30.5	45.3	121.3	30.3	3.0	15	5.2	50	79.0	80	17
	T7	44	34.5	36.6	174.0	26.8	3.2	17	3.3	45	78.7	82	12
	T8	50	25.3	53.9	78.9	28.9	3.2	16	3.9	48	79.0	81	15
	T9	48	25.6	50.3	81.9	27.4	3.2	16	3.7	45	79.3	81	13
	T10	51	28.2	54.4	83.9	29.9	3.2	17	3.8	47	79.7	81	13
	T11	48	29.8	50.3	98.7	28.8	3.1	17	4.1	47	79.3	80	14
	T12	51	29.0	46.3	116.2	29.0	3.2	17	3.6	45	79.3	82	13
	T13	56	28.7	50.3	134.0	27.6	2.8	12	4.6	48	79.0	81	13
	Avg.	50	27.7	51.3	100.2	27.9	3.1	16	4.16	47	79.2	81	14
CD @ 5%	Season	0.85	0.24	0.77	1.00	0.30	0.05	0.21	0.04	0.55	1.00	1.02	0.14
	T x S	1.20	0.34	1.09	1.41	0.43	0.06	0.30	0.06	0.77	1.41	1.44	0.20

The cocoon lots were reeled under standard conditions on a Cottage Basin through out-sourcing with a progressive reeler in Malda. The processed lots were evaluated for silk reelability and quality characteristics to determine the effect of preservation and recommend best practices for reeling cocoons in unfavourable seasons. No significant variations were observed in the reeling performance as well as yarn quality in Agrahayani, except cocoons preserved in LDPE bags (T13) with slightly higher renditta which might be due to cumulative moisture effects during 90 days preservation. However, deterioration of reeling performance was observed in the cocoons preserved in Bhaduri season and maximum reduction in reelability was observed for the cocoons stored in Hessian Bags. But with regards to yarn quality, no significant differences were observed among the treatments.The cocoons produced during unfavourable seasons performed poorly for reeling characteristics resulting in high renditta and low silk recovery as well as poor yarn quality (grade E); while grade C in favourable season. It can be concluded that the cocoons produced in favourable seasons could be hot air-dried and stored over a period of 90 days either in Hessian or LDPE bags without affecting silk reeling as well as quality. In unfavourable seasons cocoons could be stored in LDPE (plastic) bags to avoid absorbance of air moisture or for immediate reeling for better returns.

Continuous /Other Activities

Evaluation of experimental cocoon lots

A total of 442 cocoon lots (Multi x Bi: 122; Bi: 320) from different laboratories under various projects/programmes were evaluated for post-cocoon parameters. Further, cold reeling and single cocoon reeling assessments were carried out for experimental purposes and data was communicated to the concerned laboratories.

Reeling Performance of Popular Hybrids @ Field Level (Mean±SD; 2019-2020)

	Hybrids	Lots (n)	Avg. FL	NBFL	Denier	Ren-ditta	Reel-ability (%)	Re-covery (%)	Neat-ness (%)	Clean-ness (%)	Even-ness (%)	Shell Ratio (%)
Bivoltine	SK6 x 7	24	726.2± 49.96	642.75± 83.12	2.65± 0.15	8.20± 0.61	74.84± 2.00	70.84± 2.96	88.29± 1.54	90.08± 1.66	89.08± 1.47	17.22± 1.42
	BCon1 x BCon4	8	753.63± 45.62	695.88± 76.86	2.72± 0.13	7.90± 0.45	73.81± 1.55	71.88± 1.90	89.25± 0.83	89.88± 0.93	90.13± 0.60	17.71± 1.44
ICB	N x MASN	2	725.63± 4.50	655.00± 7.00	2.53± 0.02	8.31± 0.08	75.06± 0.57	72.73± 0.70	90.5± 0.50	91.0± 0.01	89.5± 0.50	16.54± 0.01
	N x SK6.7	8	613.52± 105.18	564.13± 98.18	2.57± 0.14	9.14± 0.71	72.57± 3.28	68.02± 2.93	87.38± 1.11	89.88± 0.78	89.38± 1.58	16.19± 1.09
	M6DPC x SK6.7	7	663.59± 76.77	594.29± 53.73	2.6± 0.13	9.24± 0.26	73.37± 0.95	70.58± 1.51	86.57± 0.49	89.29± 1.28	88.14± 1.36	15.36± 0.17

SILKWORM PATHOLOGY

Concluded Projects

ARP3590: Studies on the efficacy of phototrophic bacterial extracts as feed supplement for management of diseases in silkworm, B. mori L.

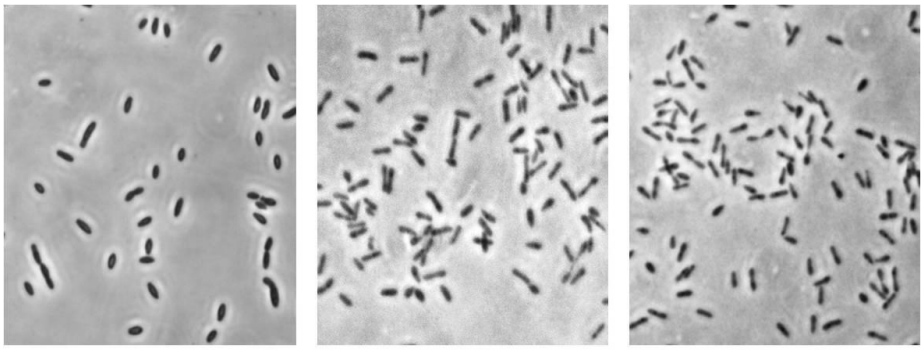
[October 2016 - September 2019]

PI - K. Rahul, CI - Zakir Hossain (Oct 2016 - April 2018) and M. Rabha (April 2019 - Sept 2019)

Objectives:

- To screen the efficacy of phototrophic bacterial extracts as feed supplements for disease management in silkworm
- To prepare metabolite profiling of silkworm when fed on normal and phototrophic bacterial extract enriched diet

Phototrophic bacteria are physiologically and phylogenetically diverse clade of Gram negative bacteria with a unique ability to perform photosynthesis under anoxic conditions in the presence of light employing bacteriochlorophylls and without emancipation of oxygen. The bacterial biomass of phototrophic bacteria is widely exploited for various applications including feed fortifiers in aquaculture, pisciculture, poultry, single cell proteins, biocolorants, antioxidants, source of vitamins, hormones, quinones etc. Presence of biological cofactors, digestible cell wall, carotenoids and being nutrient rich make them possible candidates for being explored as feed supplements. Phototrophic bacterial strains were isolated and cultured in minimal salts media; identified by 16S rRNA gene sequencing analysis. Physiological and biochemical characterization was carried out and growth response was turbidimetrically determined.



Marichromatium sp. *Rhodopseudomonas* sp. *Rhodobacter* sp.

The isolated phototrophic bacteria were grown under ambient conditions and bacterial biomass was harvested by centrifugation at 10,000 rpm for 10 min. The cell pellet was washed with sterile water, dried and diluted to different concentrations (0.5, 1, 2, 5%). Three phototrophic bacterial strains isolated were identified as *Marichromatium* sp., *Rhodobacter* sp. and *Rhodopseudomonas* sp. The bacteria were sprayed on to mulberry leaves, air-dried and fed to the silkworms (SK6 x SK7; 1st day III instar; 3 seasons). Mulberry sprayed with sterile water was maintained as control. Rearing and reeling performance data were recorded and analysed statistically.

Salient Characteristics of Phototrophic Bacteria

Phototrophic Bacteria	Cell shape	Gram staining	Motility	Optimum		Saline require-ment (%)	Carbon sources	Nitrogen source
				pH	Temp. (°C)			
Rhodobacter sp.	Rod	Gram – ve	Non-motile	7	30	1	Pyruvate Malate	Ammonium chloride
Rhodopseudomonas sp.			Motile	7	25	Non-obligatory	Pyruvate	
Marichromatium sp.			Motile	6	30	2	Fructose Glucose	

Major silkworm pathogens *viz*., *Staphylococcus* ($1.7x10^7$ cfu/ml), BmNPV ($1x10^7$ polyhedra/ml), BmDNV1 & BmIFV (10^{-2} dilution) and *N. bombycis* ($1x10^7$ spores/ml) were smeared onto the mulberry leaves individually, air-dried and fed to the III instar silkworms (SK6 x SK7; 1ml/100 larvae). *B. bassiana* ($2.5x10^6$ conidia/ml), the fungal pathogen suspension was smeared directly onto the silkworm larval surface as it infects *via* per cutaneous route. Mulberry leaf fortified with phototrophic bacteria was fed to one batch of larvae and the other with mulberry leaves sprayed with sterile water which served as control (5 replications/50 larvae). The silkworm larvae were reared up to 10 days under standard rearing conditions. The development of disease symptoms and larval mortality in each treatment were recorded. Ten days after treatments, the remaining silkworms were also tested for the presence of different pathogens to determine the healthiness of larvae.

Effect of FS on Silkworm Rearing & Reeling Traits

Feed Supplement @ 2%	Larval wt. (g)	ERR (%)	Cocoon wt. (g)	Shell wt.(g)	Shell (%)	Fil. length (m)
Rhodopseudomonas sp.	3.87	84.8	1.446	0.259	17.911	768
Rhodobacter sp.	3.94	82.2	1.419	0.246	17.336	742
Marichromatium sp.	3.86	76.9	1.401	0.229	16.345	676
Control	3.85	80.4	1.442	0.249	17.267	756
SEm±	0.05	1.52	0.022	0.004	0.234	7.398
CD@5%	NS	5.036	NS	0.013	0.774	24.50

The three isolated phototropic bacterial toxicity and their efficacy as supplements through feed (FS) individually and in combination were evaluated. None of the bacterial feed supplements (FS) inflicted toxic effect nor significantly improved the economic traits in silkworm. The silkworm larvae fed with mulberry fortified with *Rhodopseudomonas* sp. (2%) performed relatively better and improved ERR was recorded. *Rhodopseudomonas* FS was utilized to study effectiveness against silkworm pathogens.

Rhodopseudomonas feed supplement was found to be effective against the bacterial pathogen, *Staphylococcus* sp. only. The survival increased by 16% in batches that were inoculated with the pathogen and fed with FS over control batches reared on normal diet. The feed supplement was not effective against other silkworm pathogens.

Effectiveness of *Rhodopseudomonas* Feed Supplement against Major Silkworm Pathogens

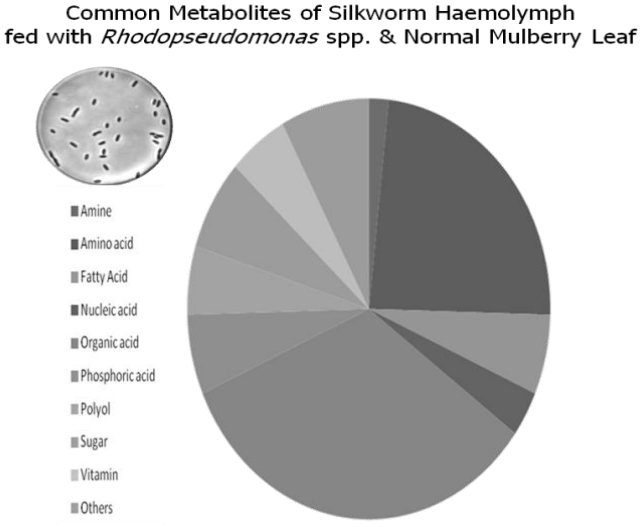
Pathogens	ERR%		P value of t statistic	Sig. @ 5%
	Normal Diet	Fortified Diet		
Staphylococcus sp.	51.3 (0.38)	61.1 (0.51)	0.001	*
B. bassiana	43.5 (0.96)	41.3 (0.69)	0.12	NS
BmNPV	54.1 (0.83)	57.5 (1.46)	0.11	NS
BmDNV1	34.7 (0.83)	37.5 (1.46)	0.11	NS
BmIFV	23.3 (0.96)	21.5 (0.69)	0.12	NS
N. bombycis	48.4 (2.51)	45.3 (2.63)	0.44	NS

Metabolite Profile

The haemolymph from silkworm larvae (SK6 x SK7; V instar 3rd day) fed on normal and phototrophic bacteria-fortified mulberry leaf (*Rhodopseudomonas spp.)* was collected and freezed in liquid nitrogen. Metabolites were extracted by methanol (200µl) and subjected to LC-MS analysis. The methanolic extract derivatized by silylation with N, O-bis (trimethylsilyl) trifluoro-acetamide (BSTFA) was subjected to GC-MS analysis. The metabolite annotation of GC-MS data was performed with National Institute of Standards and Technology library, whereas LC-MS data was annotated with METLIN. A total of 196 and 216 metabolites were detected from the haemolymph of silkworms fed on normal and phototrophic bacterial fortified diet. Based on annotation with NIST and METLIN databases, 124 and 127 metabolites respectively were identified. About 90% (114) were shared in common; 72 and 89 were unidentified. The identified metabolites could be broadly categorized into amines, aminoacids, fatty acids, nucleotides, organic acids, phosphoric acid, polyols, sugars and vitamins groups.

Inference

Three phototrophic bacteria isolated were identified through systematic studies as *Marichromatium* spp., *Rhodopseudomonas* spp. and *Rhodobacter* spp. None of the phototrophic bacterial feed supplements exerted toxic effects nor significantly improved the rearing and reeling traits in silkworm. The survivability increased by 16% in batches fed with *Rhodopseudomonas* sp. feed supplementation against *Staphylococcus* sp. No significant differences were observed in metabolites of silkworm fed on normal and phototrophic bacterial fortified diets.



Ongoing project

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 broad spectrum room disinfectant for eradication of silkworm pathogens
- To develop bed disinfectant for the management of silkworm diseases

Disinfection plays an imperative role in successful harvest of silkworm cocoon crops. Most of the disinfectants developed and used in sericulture currently are either formaldehyde or chlorine or phenol based formulations and each one has advantages and disadvantages. Eastern and North Eastern regions of India employ 5% bleaching powder and chlorine dioxide as liquid spray disinfectants for the disinfection of rearing room and rearing appliances. Several compounds/chemicals were evaluated to identify promsing substances which could inactivate all the major silkworm pathogens. Two chemicals *viz*., A (oxidizing) & B (wetting) were evaluated further by *in vitro* inactivation studies to identify an effective formulation named as NIRMOOL for the disinfection of silkworm rearing house & rearing appliances.

The silkworm pathogen suspensions (Bacteria: *Staphylococcus* sp. & *B. thuringiensis* at 1.7 x 10^7 cfu/ml; Fungi: *B. bassiana* at 2 x 10^7 conidia/ml; Microsporidia: *N. bombycis* at 1 x 10^7 spores/ml; Viruses: BmNPV at 1x10^7 Polyhedra/ml) were suspended in 1ml of NIRMOOL for a period of 10 minutes at room temperature (25±1°C). Appropriate negative controls or mock inocula were utilized and the inactivation studies were conducted. The inactivated samples were subjected to light microscopy (600X) to record changes in the cellular morphology of pathogens upon treatment with NIRMOOL. The bacterial and fungal cultures that were treated were subjected to *in vitro* culture studies at 30 °C for two days and the growth was recorded against untreated controls. NIRMOOL completely dissolved the BmNPV polyhedral bodies, disintegrated *N. bombycis* spore integrity, distorted structural integrity of *B. bassiana* conidia, aggregated *B. thuringiensis* and *Staphylococcus*. It also effectively inhibited the growth of *B. thuringiensis, Staphylococcus* and *B. bassiana*.

The aforesaid pathogen suspensions (BmNPV, BmDNV1, BmIFV, *Bacillus thuringiensis*, *Staphylococcus* spp. *and Nosema bombycis*) were smeared onto the mulberry leaves individually and air-dried to conduct *in vivo* studies. The treated mulberry leaves were fed to the III instar silkworm larvae (Nistari X SK6.SK7; 25 larvae each in 3 replications were maintained for each treatment). A batch of larvae fed with untreated mulberry leaves and untreated pathogen inocula were maintained as experimental controls. *B. bassiana*, the fungal pathogen suspension was smeared directly onto the silkworm larval surface as it infects *via* per cutaneous route. The silkworm larvae were reared up to 10 days under standard rearing conditions. The observations

recorded data include the development of disease symptoms and larval mortality in each treatment/replication. The incidence of silkworm diseases was recorded for respective treatments based on typical disease symptoms, microscopic examination of haemolymph/midgut and immuno-diagnosis in case of BmDNV1 and BmIFV. Upon completion of ten days, the remaining silkworms were tested for the presence of different pathogens to determine healthiness of larvae. NIRMOOL effectively inactivated all the silkworm pathogens tested as no silkworm larvae was affected with any disease as in the case of untreated mulberry leaves.

Disease Incidence (%)

Treatment	Nuclear polyhedrosis (NP)	Denso-nucleosis (DN)	Infectious Flacherie (IF)	Bacterial Toxicosis (BT)	Bacterial Flacherie (BF)	White Muscardine (WM)	Pebrine (PEB)
NIRMOOL	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Untreated Mulberry	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Untreated Pathogens	88.00± 2.31	81.33± 9.61	69.33± 7.06	74.67± 5.81	76.00± 4.62	84.00± 4.62	92.00± 2.31

The aforesaid pathogen suspensions were smeared onto paraffin sheets individually and air-dried to conduct simulated-contamination studies. One set of paraffin paper sheets were disinfected with 5% bleaching powder; one set with the developed formulation, NIRMOOL; one sheet with pathogen suspension (treated with distilled water; control) were maintained and reared in the rearing house following standard rearing conditions. Silkworm rearing was conducted with Nistari x SK6.SK7 on to the sets of paraffin sheets (one dfl each in 5 replications were maintained for each treatment). The overall rearing performance including the cocoon harvest details was recorded. The incidence of silkworm diseases was also recorded for respective treatments. The data for each treatment was pooled for analytical purposes.

Efficacy of NIRMOOL in Disinfection of Rearing House (Simulated Conditions)

Treatment	Disease Incidence (%)								ERR (No.)	ERR (kg)	Single Cocoon Wt. (g)	Single Shell Wt. (g)	Shell Ratio (%)
	NP	DN	IF	BT	BF	WM	PEB	Total					
NIRMOOL	6.72	0.09	0.02	0.15	4.80	0.04	0.00	11.82	8590	12.21	1.42	0.23	16.19
5% Bleaching Powder	6.27	0.18	0.17	0.28	4.58	0.02	0.00	11.50	8623	12.62	1.45	0.24	16.55
Control	15.99	0.18	0.11	6.92	11.57	9.01	0.68	44.46	5320	6.71	1.21	0.18	14.87
SEm±	0.54	0.04	0.03	0.69	0.68	0.37	0.11	0.79	162.2	0.31	0.06	0.01	0.36
CD@5%	1.8	NS	NS	2.31	2.27	1.23	0.37	2.61	756.4	1.443	Non-Significant		

NIRMOOL was as effective as 5% bleaching powder to prevent the occurrence of silkworm diseases during rearing, which is represented by ERR by number. Silkworm rearing rooms at CSRTI-Berhampore were disinfected with 5% bleaching powder and the newly developed formulation, NIRMOOL individually for laboratory evaluation (3 crops). 5 dfls each of crossbreed (Nistari x SK6.SK7) were reared following the standard rearing conditions to record overall rearing performance.

Efficacy of NIRMOOL in Disinfection of Rearing House (Lab Trials)

Parameter	5% Bleaching Powder	NIRMOOL	P value	Signifi-cance @ 5%
ERR by No.	8303	8293	0.93	NS
ERR by wt. (kg)	12.28	12.61	0.02	*
Single Cocoon Wt. (g)	1.453	1.501	0.25	NS
Single Shell Wt. (g)	0.244	0.253	0.23	NS
Shell Ratio (%)	16.79	16.85	0.87	NS
Filament Length (m)	638	648	0.87	NS
Denier	2.63	2.62	0.62	NS
Reelability (%)	73	73	1	NS

NIRMOOL was effective in the management of silkworm rearing across all the important pre- and post cocoon parameters recorded, which is on par with the existing formulation, 5% Bleaching Powder. NIRMOOL is also being evaluated further in rearing rooms at CSRTI-BHP, DoS/NSSO farms for generation of data on effectiveness to disinfect rearing house and appliances. NIRMOOL was distributed to selected farmers (5 Nos) for preliminary evaluation during Resham Krishi Mela (Berhampore). NIRMOOL commercialization and documentation of technical knowhow is under progress. NIRMOOL would be evaluated further under OST/OFT. Patent documentation for NIRMOOL is also being prepared for protection of intellectual property rights (IPR).

With regard to the development of bed disinfectant formulation, three carrier materials (C1, C2 & C3) in solitude & combinations (CF4, CF5, CF6 & CF7) were evaluated for determining toxicity to healthy silkworms at every instar and slaked lime was maintained as control. Carrier material [CF-4: 75% C2 + 25% C3] was identified as the most promising component with 92.85% ERR. Further designing and evaluation of bed disinfectant formulations against silkworm diseases through disease spread experiments is under progress.

Two eco-friendly disinfectant formulations (SS1: A @ 1% + B @ 0.5%; SS2: A @ 0.5% + B @ 0.5%) were also developed for surface sterilization of silkworm eggs. The egg sheets (Nistari;10 Dfls; 5 replications/treatment) were immersed in disinfectant solutions individually and reared following standard conditions. 2% formalin was maintained as control. The preliminary evaluation shows that the two formulations, SS1 & SS2 performed on par with the control; did not hamper the hatching of silkworm eggs (~96% hatching) and could be reared successfully without any disease incidence.

Ongoing project

AIT08005MI: Development and evaluation of Bidensovirus resistant silkworm hybrids developed from marker assisted breeding lines Phase II *(Coll. with SBRL-Kodathi & CSRTI-Mysore)*

[March 2020 – Feb 2023]

K.S. Tulsi Naik (PI-SBRL-Kodathi), A. Ramesha (CI-SBRL-Kodathi); M.N. Chandrashekar, M.S. Ranjini (CIs-CSRTI-Mysore), K. Rahul, M. Rabha (CIs-CSRTI-Berhampore)

Objectives

- Evaluation of BmBDV resistant lines/hybrids at respective locations with virus exposure studies
- BmBDV marker inheritance analysis in hybrids
- Maintenance of BmBDV lines at breeding units with MAS

BmBDV resistant lines/hybrids developed by SBRL-Bangalore are being collected for evaluation at CSRTI-Berhampore with virus exposure studies and to generate data for determining their utilization in Eastern and North Eastern zone.

Continuous/Other Activities

Silkworm disease monitoring of seed and commercial crops in East & NE states

Executive Authority: Dr. V. Sivaprasad, Director-CSRTI-Berhampore

Investigators: CSRTI-Berhampore: K. Rahul, M. Rabha; Incharges of RSRS-Kalimpong, RSRS-Koraput, RSRS-Jorhat & CMERTI-Lahdoigarh: RSRS-Imphal; Incharges of RECs @ Mothabari-West Bengal, Shillong-Meghalya, Dimapur-Nagaland, Agartala-Tripura, Aizawl-Mizoram, 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: Swapan Kr. Maity (Murshidabad), Biplab Sarkar (Birbhum), Debasis Chanda (Nadia), Abhijit Goswami (Malda), Sujit Saha (U & D Dinajpur), Probodh Kr. Sahu (Jalpaiguri), Sanjib Kr. Barman (Cooch behar), Prahllad Lama (Darjeeling) & Sajal Roy (Midnapore)

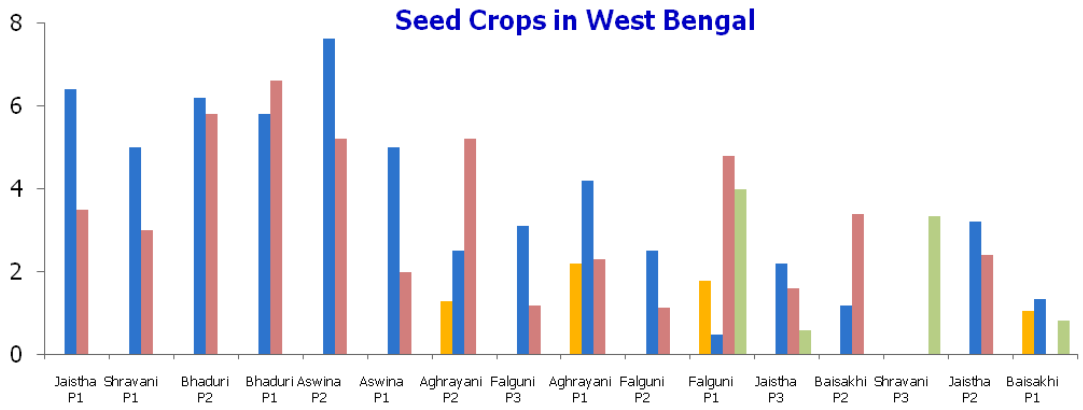
Objectives

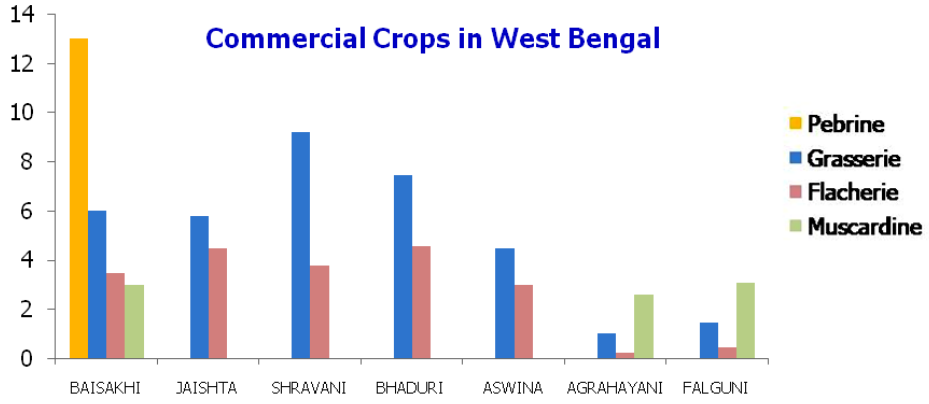
- To estimate the prevalence of silkworm diseases (seed & commercial crops) in E & NE states
- To suggest remedial measures on spot to the farms/farmers for the management of silkworm diseases and prevent disease outbreak(s)

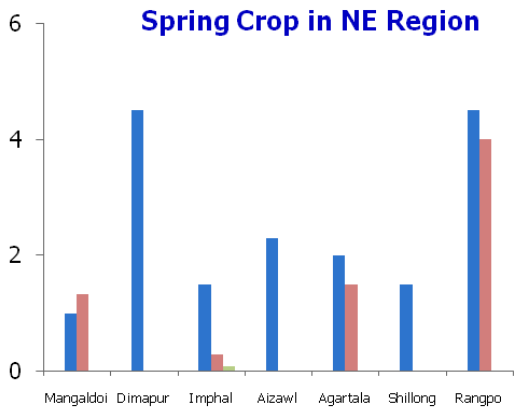
Silkworm disease monitoring programme across Eastern and NE India was undertaken with an aim to manage incidence of silkworm diseases co-ordinated by Central Silk Board (CSRTI-Berhampore & NSSO-Bangalore) and respective state DoSs. A total of 977 seed crop samples were examined during the year in West Bengal and pebrine incidence was recorded in 14 samples. Mortality recorded due to grasserie and flacherie was highest in all the crops with an average

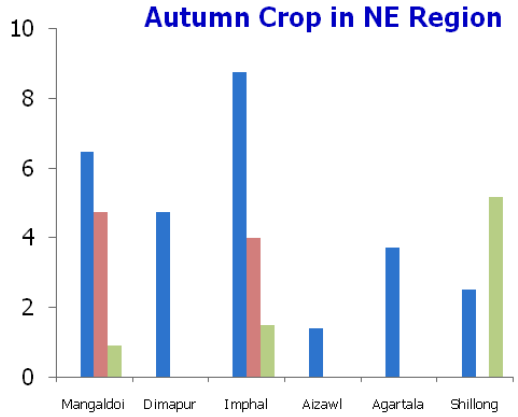
incidence of <12%. The basic seed farms were suggested with appropriate preventive and remedial measures to minimize disease incidence/spread and prevent outbreak(s) in the particular crop as well as next crops.

Silkworm Disease Monitoring









The disease incidence recorded in commercial cocoon crops reared during Agrahayani and Falguni in West Bengal was <5% and >10% during unfavorable conditions (April-Oct), respectively. Mortality due to grasserie followed by flacherie at high temperature (>35°C) coupled with high humidity (>85%) conditions were recorded. Around 3% muscardine incidence was recorded especially during Nov-April at low temperature and high humidity. The average incidence of silkworm diseases in different states (Assam, Nagaland, Manipur, Mizoram, Tripura, Meghalaya & Sikkim) were also recorded during spring and autumn crops. The mortality due to silkworm diseases was <5% during spring crop, except in Sikkim (8.5%). Crop losses to a tune of ~10% majorily due to grasserie and flacherie in Darrang and Imphal during autumn crop; <5% in Dimapur, Aizawl and Agartala were recorded. 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.

Pebrine monitoring in West Bengal

Pebrine monitoring was regularly and stringently undertaken at CSRTI-Berhampore with each and every crop including silkworm genetic resources (Bivoltine & Multivoltine) and RSRS-Kalimpong, Seed multiplication units (14 BSFs; CSB & DoS) and other laboratory rearings following prescribed methdology. Besides, samples received from DoS farms & seed/commercial rearers were also examined for pebrine incidence. Forty six samples were found infected with *N. bombycis* during the current year. Necessary eradicative and preventive measures were suggested to the concerned units/stakeholders for further monitoring and management.

Pebrine Monitoring in West Bengal

Sources	Samples Examined	Samples (+ve)
P3 farms of DoT(S)	30	0
P2 farms (NSSO & DoT-S)	179	2
P1 farms (NSSO & DoT-S)	768	12
Commercial Crops	115	6
Farmers/RSPs	56	26
CSRTI-Berhampore	53	0
Total	1201	46


Microscopic Examination @ Pebrine


Certificate Distribution-DoS Officials

EXTENSION

T. D. Biswas, G. C. Das (from Sept 2019) and Shafi Afroz (from Aug 2019)

Unit	Scientists	Tech. staff	TSFW/ SFW	Farm based units	
				Total (Acre)	Mulberry (Acre)
REC-Mothabari (West Bengal)	Dr. S. Chakrabarty Sci-D (I/C)	12	5	1	0.5
REC-Bhandra (Jharkhand)	Dr. Ghanshyam Singh Sci-D (I/C)	5	23	7	4.5

Extension Communication Programmes (ECP)

CSRTI-Berhampore and its nested units conducted need-based technologies in mulberry and silkworm crop production, management and marketing in Eastern and North Eastern states.

State	Unit	AP		FD		FRD		GD		TD		Total	
		#	F	#	F	#	F	#	F	#	F	#	F
West Bengal	CSRTI-BHP	4	429	4	418	4	210	20	497	3	157	41*	2719*
	RSRS-Kalimpong	2	192	1	60	2	88	12	496	2	85	19	921
	REC-Mothabari	3	320	4	450	4	243	21	609	4	236	36	1858
Jharkhand	REC-Bhandra	2	109	2	111	1	62	8	210	1	56	14	548
Odisha	RSRS-Koraput	3	290	2	207	3	185	20	581	2	96	30	1359
Assam incl. BTC	RSRS-Jorhat	2	103	1	80	3	110	7	239	2	85	16	677
	REC-Mangaldoi	1	95	2	126	3	129	12	351	3	125	21	826
Sikkim	REC-Mamring	1	75	1	96	1	38	6	263			9	501
Mizoram	REC-Aizwal	1	100	2	100	1	44	10	201	1	50	15	495
Tripura	REC-Agartala	2	200	2	200	3	150	10	252	2	100	19	902
Meghalaya	REC-Shillong	2	103	1	48	1	56	8	172	2	92	14	471
Nagaland	REC-Dimapur	1	100	1	40	1	53	6	125	1	31	10	349
Arunachal Pradesh	REC-Sille	1	96	1	88	2	102	7	211	1	50	8	377
Total		25	2212	24	2024	29	1470	147	4207	24	1163	255	12084

#: Events; F: Farmers; AP: Awareness prog.; FD: Field day; FRD: Farmers' day; GD: Group discussion; TD: Technology demos; *Exhibitions (#6; 1008 F)

Resham Krishi Mela

CSRTI-Berhampore across different states conducted eleven Resham Krishi Mela's covering 2761 farmers for updating the knowledge of new technologies developed in mulberry sericulture.

State	Unit	Date	Events (Farmers)	RKM Highlights
West Bengal	CSRTI-BHP	24.01.2020	3 (1276)	• Release of Nirmool, an eco-friendly disinfectant • Exhibited C-2038 mulberry variety • Exhibited 12Y x BV, an improved crossbreed • Demonstrated Suvarna & Suroneer prototype • Exhibited Bio-Control Agents • Demonstrated Chawki & Self-rearing technology • Distribution of Soil Health Cards (SHC) • Release of 24 leaflets
	RSRS-Kalimpong	05.03.2020		
	REC-Mothabari	16.01.2020		
Jharkhand	REC-Bhandra	19.02.2020	1 (139)	• Exhibited latest sericulture technologies
Odisha	RSRS-Koraput	12.02.2020	1 (239)	• Demonstration of High Bush & Tree type mulberry • Exhibited bivoltine double hybrid
Assam inc. BTC	RSRS-Jorhat	14.02.2020	2 (467)	• Exhibited C-2038 & C-2028 mulberry varieties • Demonstrated Self-rearing technology • Demonstrated chawki rearing technology
	REC-Mangaldoi	30.01.2020		
Sikkim	REC-Mamring	03.03.2020	1 (120)	• Popularization of latest sericulture technologies
Mizoram	REC-Aizwal	12.02.2020	1 (136)	• Exhibited bamboo basket for cocoon transportation
Tripura	REC-Agartala	09.01.2020	1 (260)	• Exhibited crossbreeds, PM×SK6.7 & 12Y x BV
Nagaland	REC-Dimapur	11.12.2019	1 (124)	• Popularization of latest sericulture technologies

Feedback recieved from the stakeholders on latest sericulture technologies discussed, displayed and exhibited during ECPs/RKM. Feedback information was collected for addressing issues. Perception of knowledge about recent mulberry cultivation technologies was 32-68% and with regard to silkworm rearing, 34-86% farmers were well aware of productivity improvement through technology adoption; whereas only 12-14% farmers perceived low knowledge gain in respect of plastic collapsible mountages and cocoon harvesting technology.

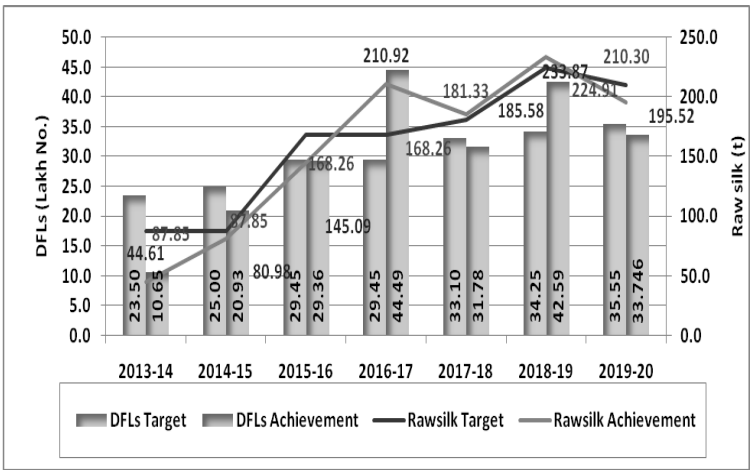
Cluster Promotion Programme (CPP) in East & North-East India

Bivoltine Cluster Promotion Programme (BV-CPP), a nation-wide mega mulberry sericulture development programme is implemented by Central Silk Board 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 and North Eastern Zone, CPP is being implemented in 13 clusters covering seven states (West Bengal: 4; Assam: 3; Manipur: 2; one each in Odisha, Mizoram, Nagaland & Tripura).

Performance of clusters: E & NE zone clusters recorded 195.52 MT (92.97%) raw silk production (BV-102.87MT & ICB-92.65MT) against the target of 210.30 MT; which is 38.35 MT (16.40%) less as compared to the previous year, 2018-19 (annual target-224.91MT) due to crop loss by the flooding and improper schedules of brushing in E & NE region. During 2019-20, a total of 34.017 lakh dfls (BV: 16.235 & ICB: 17.782) were reared against the target of 35.55 lakh dfls (BV: 27.30 & ICB: 8.25). The overall achievement in dfl brushing was 95.69% and lower bivoltine brushing(s) (59.46%) were achieved. A total of 1539.64 MT of cocoons were produced by 13 clusters including 757.39MT (49.19%) bivoltine and 782.24MT (50.81%) ICB silk.

Particulars of CPP-CDFs in E & NE clusters (2019-20)		
Clusters	CSB	DoS
West Bengal		
Malda	Dr. S. Chakraborty, Sci-D, REC-Mothabari; satadal.chak@gmail.com; 9474580417	Shri Santosh Kumar, DD(T)[I/C], Malda; malseri2@gmail.com; 9732119762
Murshidabad	Dr. T.D. Biswas, Sci-D, CSRTI-Berhampore; tdattabiswas@rediffmail.com; 9126331586	Shri S. Goswami, DD(T)[I/C], BHP; berseri1@gmail.com; 9434723095
Birbhum	Dr. Manoja Patnaik, Sci-D, SSPC-Kalitha manoja_ctp@rediffmail.com; 9434747385	Dr. T. Mukherjee, DD(T)[I/C], Birbhum; birseri@gmail.com; 8250893776
Nadia	Mr. G. C. Das, Sci-D,CSRTI-Berhampore; gopaldascsb@rediffmail.com; 9434229425	Mr. Supratim Das, DD(T), Nadia; nadiseri@gmail.com; 9830105014
Odisha		
Kashipur	Shri. Khasru Alam, Sci-B, RSRS-Koraput; rsrskoraput@gmail.com; 7001255105	Shri Bhagaban Nayak; AD (Seri)-Koraput; 6370534144
Assam & BTC		
Darrang	Dr. B. K. Basumatary, Sci-D, REC-Darrang, basumatary.bene@yahoo.com; 9435304453	Mr. Jogesh C. Talukder, ADS-Mangaldoi, adsofficemld@gmail.com; 9101407835
Jorhat	Dr. P. Kumaresan, Sci-C, RSRS-Jorhat; rsrsjor.cdsb@nic.in; 8903264292	Shri Kishore Sharma, ADS-Jorhat; kishores armabordoloi@gmail.com; 9435518260
Udalguri	Mr. B.N. Chowdhuri, Sci-D, RO-Guwahati (upto Apr'19); bidyutnc10@yahoo.com; 9435054191	Shri Anjan Kumar Chakraborty, AD(Seri)-Udalgiri; 9435181586
Mizoram		
Aizawl	Dr. L. Pachuau, Sci-D, REC-Aizawl; thlatea@rediffmail.com; 9435087588	Mr. Lalremsiama, DD-Chaltlang; 9436199948
Manipur		
Ukhrul	Dr. L. Somen Singh, Sci-D, RTRS-Imphal; somenlaishram@yahoo.com;9436033596	Sri C. M. Paul, DD-Ukhrul; 7085164519
Churachandpur	Dr. L. Somen Singh, Sci-D, RTRS-Imphal; somenlaishram@yahoo.com;9436033596	Mr. G. Vunglian, AD-Churachandpur; 9862113806
Nagaland		
Paren	Dr. Kartick Neog, Sci-D, REC-Dimapur; recdimapur.nagaland@gmail.com; 7085055608	Mr. Yashimeren, DSO-Dimapur, yashilongchar@gmail.com;9436436237
Tripura		
Champaknagar	Dr. N. Biswas, Sci-D,REC-Agartala; sgbcrsti@rediffmail.com; 9615179959	Mr. Jyoti Bikash Chakma, SS-Agartala; 9436509681

Bivoltine raw silk production is 102.87 MT in comparison to 115.86 MT @ renditta of 7.02, which is 12.99MT (11.2%) lesser than the previous year mainly due to the poor achievement (49.84%) of NE clusters (Jorhat, Aizwal, Paren & Tripura) and 8.80% achievement in Kasipur cluster (Odisha). In case of Odisha, sudden withdrawal of Aug-Sept seed crop and improper scheduling of autumn crop severely affected the performance.



ICB Raw Silk Production in East & North East Zone (2019-20)

Cluster	Dfls(Lakh)		Cocoon Production (MT)	Yield/ 100 dfls (kg)	Raw Silk (MT)			
	Target	Ach.			Target	Ach.	% Ach.	% IO 2018-19
West Bengal								
Malda	2.0	3.69	150.38	40.65	8.0	16.43	205.38	- 48.64
Murshidabad	2.0	2.30	113.20	49.22	8.0	13.32	166.46	- 24.86
Birbhum	2.0	6.66	301.06	45.19	8.0	35.42	442.73	- 19.96
Nadia	2.0	2.86	135.70	47.38	8.0	17.75	221.90	- 8.26
Odisha								
Kashipur	0.25	0.004	0.09	21.50	0.8	0.01		
Assam & BTC								
Darrang	0.0	0.20	8.80	44.00	0.0	1.17		
Udalguri	0.0	0.50	17.50	35.00	0.0	2.50		
Mizoram								
Aizawl	0.0	0.25	11.82	47.28	0.0	1.47		
Tripura								
West Tripura	0.0	1.30	43.70	33.53	0.0	4.58		
Total/Avg.	8.25	17.78	782.25	44.04	32.8	92.65	282.46	- 18.24

Considering the status of existing clusters of the Eastern and NE states, with regard to the estimated bivoltine raw silk production targets were achieved by only four clusters (Malda, Murshidabad, Churachandpur & Ukhrul). Majority of the states utilize SK6 x SK7 & FC x FC2 hybrids for bivoltine and Nistari x SK6.7, M6DPC x SK6.7, PM x CSR2 & PM x FC2 for producing ICB silk. In case of Manipur, C x J hybrid produced by DoS-Manipur is also utilized for the production of bivoltine silk. West Bengal, Orissa & Assam state clusters are currently proficient in harvesting successful bivoltine hybrids and the average yields are higher than the benchamark values.

Raw Silk Production in E & NE India (MT; 2019-2020)

State	Cluters	Non-cluster
West Bengal	125.76	1473.08
Odisha	0.23	1.99
Assam incl. BTC	32.32	20.35
Manipur	20.80	95.19
Mizoram	7.11	85.89
Nagaland	2.03	9.97
Tripura	7.25	86.75
Total	195.52	1773.22

Bivoltine Raw Silk Production in East & North East zone (2019-20)

Cluster	Dfls(Lakh)		Cocoon Production (MT)	Yield/ 100 dfls (kg)	Raw Silk (MT)			
	Target	Ach.			Target	Ach.	% Ach.	% IO 2018-19
West Bengal								
Malda	2.50	2.70	122.28	45.37	20.20	17.10	84.65	0.12
Murshidabad	2.25	2.16	120.96	56.01	18.40	16.32	88.70	25.25
Birbhum	1.00	0.55	28.50	51.82	8.20	3.80	46.34	-13.83
Nadia	1.00	0.78	41.81	53.30	8.20	5.62	68.54	-5.32
Odisha								
Kashipur	1.00	0.03	1.61	51.87	2.50	0.22	8.80	-15.38
Assam & BTC								
Darrang	2.25	1.86	92.91	49.95	15.50	12.39	79.94	-3.50
Jorhat	2.00	0.83	40.33	48.36	14.00	4.75	33.93	-9.52
Udalguri	2.25	1.65	53.52	62.96	14.50	11.51	79.38	11.21
Mizoram								
Aizawl	2.80	0.92	45.17	49.10	16.00	5.64	35.25	-28.61
Nagaland								
Paren	2.25	0.65	15.26	23.48	10.00	2.04	20.40	-71.15
Manipur								
Churachandpur	2.75	1.80	85.28	47.38	17.50	10.33	59.03	-16.63
Ukhrul	2.75	1.80	86.46	48.04	17.50	10.48	59.89	-14.87
Tripura								
West Tripura	2.50	0.50	23.30	46.60	15.00	2.67	17.80	-59.85
Total/Avg.	27.3	16.23	757.39	49.37	177.50	102.87	57.95	-11.21

Multimedia Activities (2019-2020)

Radio Programmes

Units	Topics	Language & Channel
CSRTI-BHP	Palur chash theke arthik labh; Polupalaner Khuntinati; Gura polupalaner unnata padhati; Parinata polupalaner unnata padhati; Guti bonar adarsha paribesh ebng suto katayer bibhinna padhatti; Palu palane mahilader bhumika; Unnata prajatir palu pushun-o-income baran; Tunt gacher khatikark poka-o-segulir daman padhati	Bengali (Kishan Bani Prachar Taranga-MSD)
REC-Mothabari	Palur rog-o-tar pratikar	
REC-Aizawl	Family participation for getting success crop in silkworm rearing MugaPangangChhungkawintodelhna	Mizo (AIR-Aizawl)
REC-Dimapur	Radio talk series on Sericulture (3)	English (AIR- Kohima)
REC-Sille	Radio talk series on Sericulture (3)	English (AIR-Itanagar)
TV Programmes		
CSRTI-BHP	Resham Krishi Mela 2020 Crop Seminar/ Alochana Chakra, Episode-I Crop Seminar/ Alochana Chakra, Episode-II	Bengali (Imagin TV & DD-Bangla)
REC-Aizawl	Sericulture hmalaknachungchng	Mizo (DDK-Aizwal)
Video Films		
CSRTI-BHP	Cocoon marketing Post cocoon technologies	Bengali
YouTube		
CSRTI-BHP	History of Murshidabad Silk Mulberry Disease and Management Mulberry Pests and Management Room Disinfection & Silkworm disease	Bengali
Facebook @ East North East Silk		
Whatsapp @ CSRTI-Berhampore and Sub-units of CSRTI-Berhampore		

m-Kisan

m-Kisan portal is being utilized to communicate with the farmers on mulberry sericulture technologies, pre- and post-crop measures to be adopted and forecasting/forewarning of pests/diseases. The farmer's database was enriched by 895 against the target of 800 during the year and 71 calendar-specific sericulture related messages covering silkworm rearing and mulberry cultivation were communicated to a total of 5753 farmers in six languages (Bengali, English, Hindi, Nepali, Odia & Manipuri).

CAPACITY BUILDING & TRAINING

S. Chottopadhyay, S. Sarker and Parameswaranaik J (from Aug 2019)

Systematic training was imparted to the respective stakeholders on different activities of sericulture along with practical demonstrations and hands-on programmes. A structured course, 15-months Post Graduate Diploma in Sericulture (PGDS) is offered to the participants across the country under affiliation to Kalyani University (Kalyani, West Bengal). Different HRD programmes were organized for capacity building of stakeholders and transfer of technology for the development of sericulture in Eastern and North Eastern India. A total of 3056 candidates were trained against the target of 2050 through PGDS, FST, TOP, STEP, PCT, EDP, intensive training, exposure visit, non-CBT & need based programmes etc. Coordination of Seri Resource Centres (SRCs; 6 Nos in West Bengal) established to train farmers under Silk Samagra were undertaken.

PGDS in Mulberry Sericulture	
I Semester (6months; 200 h theory + 200 h practical)	PGD101: Introductory Sericulture & Mulberry Production PGD102: Crop Protection PGD103: Cocoon Poduction PGD104: Silkworm Breeding, Genetics & Seed Production PGD105: Mulberry Production (Practical) PGD106: Mulberry Crop Protection (Practical) PGD107: Cocoon Production (Practical) PGD108: Cocoon crop protection, Silkworm Breeding & Genetics (Practical)
II Semester (6 months; 200 h theory + 100 h practical)	PGD201: Mulberry Breeding, Genetics & Physiology PGD202: Post-cocoon Technology & Byproduct Development PGD203: Extension Management & Seri Management PGD204: Computer, Economics & Statistics PGD205: Mulberry B & G & Physiology, Comp., Econ., & Stats (Practical) PGD206: Silkworm seed production and post cocoon technology (Practical) PGD 207: Study tour,Sessional record, Viva-Voce etc.
PGD208: Dissertation (3 months)	Various Disciplines of Mulberry Sericulture

PGDS Admissions (2018-19 & 19-20)		
State	July 2018 Batch (37)	July 2019 Batch (40)
Arunachal Pradesh	3	8
Assam	21	10
Jharkhand	1	
Manipur	4	5
Mizoram	7	7
Nagaland	1	9
West Bengal		1

The PGDS course includes two semesters and dissertation work with well-planned and comprehensive syllabus covering all aspects of mulberry sericulture in coordination with Kalyani University. It also includes 15-day exposure visit in each semester to major mulberry & non-mulberry sericulture areas. Majority of the students are sponsored by DoSs of respective state governments and few self-funded individuals. The students are taught by experienced scientific personnel working at CSRTI-Berhampore, CSB units and honorary faculties from reputed institutions. The students are evaluated

through semester-end examinations (theory & practicals). Students undertake dissertation/practical course work for 3 months under the supervision of faculty in various disciplines. Students need to submit dissertation/report, which is evaluated by the examiners nominated by Kalyani University. Those who successfully complete the course are awarded PGDS. Top three students are also felicitated by Central Silk Board (Bangalore) by conferring Gold, Silver & Bronze medals; besides Rs. 15,000 cash award provision to the toppers in the first semester.

PGDS Dissertation Studies (2018-19)

#	Student	Title	Supervisor
1.	Archim Rongpipi	Determination of adoption level of selected sericultural practices in commercial zone of Murshidabad district of West Bengal	Dr. Dipesh Pandit
2.	Arunima Nath	Assesment of total phosphorous status of mulberry growing soils with low avaible phosphorous in Gangetic plains of West Bengal	Dr. Vijay, V
3.	Chesong Timung	Nutritional and palatability studies of drought tolerant mulberry genotypes	Dr. Suresh, K
4.	Derfugwra Brahma	Nitrate reductase activity in mulberry and association with mulberry yield/quality	
5.	Dipika Kurmi	Extraction of sericin from *Bombyx mori* cocoon	Dr. Mihir Rabha
6.	Esther Lalchhanhimi	Expression & classification of esterase heat shock and hardening in *Bombyx mori*	Dr. N. Chandrakanth
7.	Esther Lalmuanpull	Cellular variations induced in silkworm by flacherie infection: A preliminary study	Dr. Pooja Makwana
8.	Himadrita Baruah	Comparative study on rearing performance of Nistari lines and molecular screening for thermo tolerance	Dr. Anil Kumar Verma
9.	Hirashmita Talukdar	Formulation and evaluation of multi-nutrtient foliar application in mulberry	Dr. R. Mahesh
10.	Hunmily Englengpi	Statistical investigation on cocoon price behaviour in Kaliachak market (Malda Dist.)	Dr. Manjunatha, G.R
11.	Iftikar Hussain	Studies on comparative performance of tray & shelf rearing at farmer's level	Dr. Tapti Datta Biswas
12.	Irene Lalrindiki	Isolation and molecular identification of fungi associated with mulberry root rot	Dr. Anil Pappachan
13.	Jhuma Paul	Identification of high humidity tolerant silkworm breeds based on phenotype	Dr. Raviraj, V.S
14.	Julfa Yasmin Ahmed	Mass production of biological control agent, green lace wing for management of thrips infestation in mulberry in eastern region	Smt. Radha
15.	Kadom Kropi	To assess soil fertility status of different mulberry gardens in CSRTI-Berhampore	Miss Immanuel, C.H
16.	Kadum Taki	Isolation and characterization of phosphate solubilising endophytic bacteria associated with mulberry roots	Dr. Vijay, V
17.	Kago Yamung	Effect of cooking and adjustment treatment on reeling and raw silk parameters of multi X bi cocoon produced in humid spinning conditions	Mr. Goutam Mitra
18.	Kameri Ronghangpi	Microbial population and morphological diversity in the rhizosphere, rhizoplane and phylloplane of different varieties of mulberry	Dr. Aparna Kopparapu
19.	Karabi Saikia	Comparative efficacy of few eco-friendly disinfectants against silkworm pathogens	Dr. K. Rahul
20.	Khangembam Bably Devi	Nutritional assessment of new mulberry genotypes for mulberry improvement	Dr.Deepika, K.U
21.	Lalchungpuii	Effect of high temperature & high humidity prevailing during jaistha (May-June) on cocoon spinning and fibre characters in bivoltine silkworm hybrids	Dr. V. Lakshmanan
22.	Lalhriatkima	Critical analysis on adoption level of sericulture technologies in Mizoram	Dr. Parameswaranaik, J
23.	Lalrinnungi	Evaluation of employment generation of PGDS course	Dr. Manjunatha, G.R
24.	Lamyaphi, M.S	Effect of different Nitrogen levels on growth & yield of mulberry genotypes	Dr. Deepika, K.U
25.	Longri Engti	Evaluation of mulberry varieties for chawki rearing performance	Dr. R. Mahesh
26.	Marmi Thaosen	Evaluation of promising silkworm breeds/hybrids for resistance to BmNPV	Mr. G.C. Das
27.	Melissa Lalremruati	Evaluation of customized fertilizers in comparison with conventional fertilizers on leaf yield and quality of mulberry leaves	Dr. R. Mahesh
28.	Mirdalin Kropi	An evaluatory study on BmNPV tolerence in new bivoltine silkworm breeds	Dr. V. Lakshmanan
29.	Moamongba	Isolation, Identification and characterization of bacteria causing silkworm flacherie	Dr. K. Rahul
30.	Padmini Baruah	Comparative physiological & biological traits of authorized mulberry varieties	Mr. Yallappa, H
31.	Pawan Kumar	Performance of cocoon yield of newly evolved multivoltine M6DPC at p 1 level and its grainage performance for preparation of cross breed dls (M6DPCX SK6XSK7)	Dr. S.N. Bagchi
32.	Pura Jailyang	Leaf qualities studies among colchiploids of mulberry	Mr. D. Chakraborty
33.	Sarsi Im Teron	Appraisal on entrepreneurial behaviour of sericulture farmers in Assam	Dr. Parameswaranaik, J
34.	Songja Bey	Isolation and molecular identification of mulberry leaf endophytes with antigungal activities against *Paramyrothecium roridum* causing brown leaf spot	Dr. Anil Pappachan
35.	Swapnalee Deka	Studies on effect of cold reeling on different traits of silk bave of mulberry cocoon	Mr. Goutam Mitra
36.	Themlingthei, M.S	Screening of nistari lines for humidity related gene(s)	Dr. T. Ranjita Devi
37.	Waikhom Surmila	Effect of high temperature on haemocyte counts in *Bombyx mori*	Dr. N. Chandrakanth

Farmers Skill Training (FST)	
Discipline	Farmers
Chawki Silkworm Rearing (10d)	149
Late Age Silkworm Rearing (10d)	140
Mulberry cultivation(5d)	19
IDPM (5d)	46

The objective of Farmers' Skill Training programme is to enhance the knowledge of sericulture through theoretical and practical training and improve the income levels. FST duration is 5-10 days and 354 farmers were trained in different aspects of mulberry cultivation and silkworm cocoon production. Farmers' Skill Training programmes were also organized in REC-Mangaldoi (Assam), REC-Mothabari (West Bengal), REC-Mamring (Sikkim) in addition to CSRTI-BHP.

Technology Orientation Programme

Technology Orientation Programmes (TOP) are of 3-5 days duration, which aim to upgrade the knowledge of officers/officials from CSB/DoS to the recent technologies developed by the Institute. The main purpose of TOPs is to promote enterprises to achieve the set targets in different states. A total of 139 personnel were trained against the set target of 100 in various disciplines. Apart from the CSRTI-BHP, TOPs were also organized at REC-Mangaldoi (Assam), REC-Mothabari (West Bengal), REC-Mamring (Sikkim).

Skill Training and Entrepreneurship Programme

Skill Training and Entrepreneurship Programme (STEP; one day) with an objective to orient and skill update the knowledge of NGOs & SHGs members with regard to group performance and communications skills. Forty six personnel were trained on different aspects in mulberry sericulture.

Intensive Training Programme

Intensive training programmes (30 days) are scheduled with an objective to impart basic training on overall aspects of mulberry sericulture to farmers and enthusiastic students. Twenty one personnel were trained on all round aspects of mulberry sericulture.

Post Cocoon Technology

PCT programmes (5 days) aim to impart practical training to the stakeholders on latest aspects of post cocoon technologies and 95 personnels were trained during the year. Apart from CSRTI-BHP, programmes were also organized at REC-Mothabari and REC-Agartala (Tripura).

Seed Act Awareness Programme

Seed Act Awareness Programmes aim to impart training on Central Seed Act and its implementation to the registered seed rearers, chwaki silkworm rearers and private graineurs. A total 235 personnel were trained in four centers *viz*., Dimapur & Kohima (Nagaland), Agartala (Tripura) and Aizwal (Mizoram). These programmes were organized in coordination with NSSO-Bengaluru and SSPC-Berhampore.

Seri Resource Centre

SRCs established under Silk Samagra in West Bengal and Bihar aims to impart basic training on different aspects of sericultural technologies developed by CSRTI-BHP. These programmes are conducted by the SRC owner/lead farmer in the village in co-ordination with DoS/CSRTI-BHP for the benefit of other seri-farmers. A total of 600 personnel in 30 batches (30 batches @ 20 farmers per batch/year) were covered at the six training venues.

SRC	District/State	SRC Owner	Contact
Bankipur	Murshidabad	Anisur Rahaman	7407979087
Mollikpur		Md Rejaul Seikh	9735403222
Alinagar	Malda	Md Sufian Ali	9734016330
B. Hazitola		Md. Kased Ali	9734046100
Barbakpur	Nadia	Md K. Seikh	7872870731
Panishal	Kissanganj	Md Lukman Ali	8768925133

Other Training Programmes

Non-CBT (5-10 days) and need based training (6-10 days) programmes have been conducted on demand for imparting training on latest technologies in mulberry sericulture to the officers/officials/students/stakeholders/unemployed youth on payment basis. A total of 678 personnel were trained in 23 batches/programmes. Besides these, four special training programmes (5 day-Orientation & 10 days Hands-on-Training) were conducted at three locations (Sille, Pasighat & Aalo) in Arunachal Pradesh and sensitized all together 268 sericulture farmers. The orientation training programmes were also conducted to 169 UP sericulture farmers in 6 batches from Basti, Kushinagar, Banaras, Balarampur & Gorakhpur. Hands-on-Training was provided to 22 seri-graduates of Raiganj University on intensive sericulture practices for Bv silkworm rearing (15 days).

Entrepreneurship Development in Sericulture

The off-campus training programme on "Entrepreneurship development in sericulture" was organized in collabartaion with National Institute of Agricultural Extension Management (MANAGE)-Hyderabad at Dimapur, Nagaland (14-18 Oct.2019) for 25 DoS officials with an objective to orient the extension personnel towards entrepreneurship development in sericulture and share selected sustainable models of seri-enterprises in the field.

Cocoon Handicafts Training

Cocoon handicrafts training programs were organized in two locations (Patna & Berhampore) for 124 participants in 5 batches from Bihar were skilled in cocoon handicrafts making by utilizing waste silk cocoons. The programmes were sponsored by Bihar Rural Livelihoods Promotion Society-JEEVIKA. Several products viz., garland, rakhi, greeting cards etc. were produced by the trainees and displayed in different exhibitions by 'Jeevika' and well appreciated by the visitors including the Prime Minister of India on livelihood improvement of farm-women of Bihar (Mann ki Baat; 23rd Feb 2020; *https://www.youtube.com/watch?v=_WgoYaFIfGI*) and Chief Minister of Bihar.

Exposure Visits

Exposure visits (3 days) to best practicising areas with an aim to impart basic knowledge on mulberry sericulture on latest technologies to the farmers, students & DoS officials. A total of 267

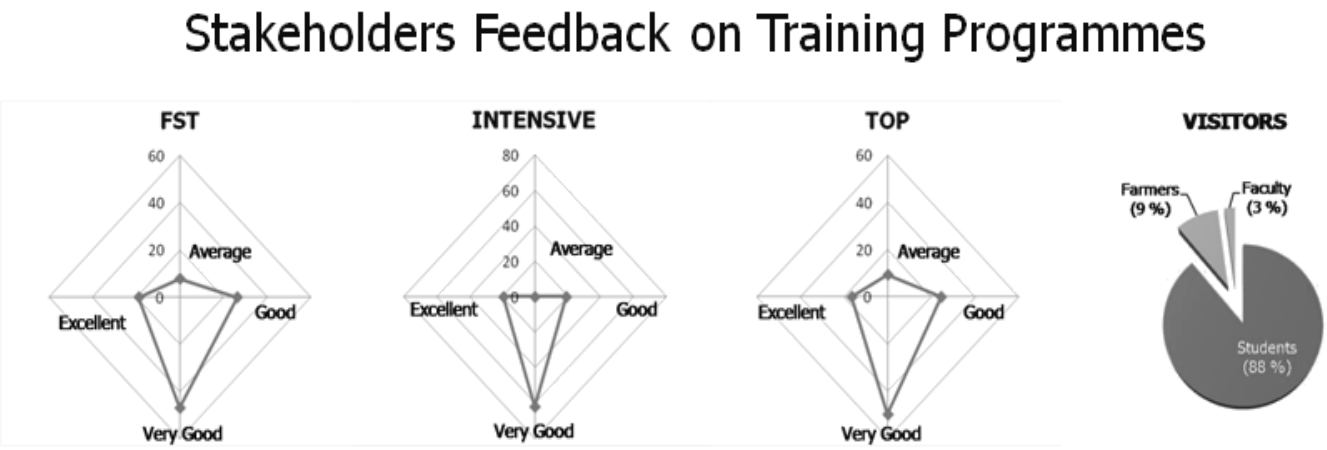
personnel undertaken exposure visits organized by REC-Mamring (Sikkim), REC-Aizwal (Mizoram), REC-Shillong (Meghalaya) & REC-Sille (Arunachal Pradesh).

Visitors Service

A total of 276 visitors (students from universities/colleges/schools/organizations; farmers; reelers etc.) availed visitiors services at CSRTI-Berhampore on mulberry sericulture.

Special Activities on Women Empowerment & Development of SC/ST/Weaker Sections

Prog.	Male					Female					Grand Total
	Gen	SC	ST	OBC	Total	Gen	SC	ST	OBC	Total	
PGDS (2018-19)	1		9	1	11	1	1	16	8	26	37
PGDS (2019-20)	3		13	2	18	5		13	4	22	40
FST	43	57	6	27	133	82	35	7	97	221	354
PCT	27	13	1	16	57	12	5	3	18	38	95
TOP	86	20	5	11	122	8		4	5	17	139
MDP	15	3			18	8	2		18	28	46
NBP	96	67	12	37	212	146	79	14	227	466	678
EV/VS	62	41	8	96	207	103	67	87	79	336	543
ITP	5	3	1	3	12		9			9	21
SRC	208	67	21	113	409	54	35	65	37	191	600
Seed Act	26	7	91	17	141	29	11	35	19	94	235
OTP			55					213			268
Total	572	278	222	323	1340	448	244	457	512	1448	3056



CAPACITY BUILDING OF SCIENTIFIC PERSONNEL (2019-2020)

#	Personnel	Topic	Period	Institute
1	Dr. V. Vijay, V, Sci-C	DUS - Co-Nodal Centre Establishment (PPVFRA)	10 - 15 June 2019	CSRTI-Mysore
2	Mr. Khasru Alam, Sci- B Dr. T. Datta Biswas, Sci-D Dr. V. Lakshmanana, Sci-D Dr. S. Chattopadhyay, Sci-D Dr. A. K. Verma, Sci-D Dr. D. Pandit, Sci-D Dr. D. Chakravarty, Sci-D Mr. Zakir Hossain, Sci-D Mr. G. C. Das, Sci-D Dr. S. Sarkar, Sci-D Dr. K. Suresh, Sci-C Dr. G.R. Manjunatha, Sci-C Dr. Shafi Afroz, Sci-C Dr. R. Mahesh, Sci-C Dr. V. Vijay, Sci-C Dr. N. Chandrakanth, Sci- C Dr. K. Rahul, Sci-C Dr. Anil Pappachan, Sci- B	Orientation Training Programme on Central Seed Act	6 - 7 Jan 2020 9 - 10 Jan 2020	DoS-Odisha & CSB-Bhubaneshwar DOS-WB & CSB-Kolkata
3	Dr. G.R. Manjunatha, Sci-C	Climate Change: Impact Assessment & Adaptation through Resilient Agro-techniques	13 - 17 Jan 2020	UAHS-Shivamogga
4	Dr. N. Chandrakanth, Sci-C Dr. Deepika K U, Sci-B	Mutation Breeding	20 - 30 Jan 2020	BCKV-Mohanpur


PGDS Students (2018-19)


PCT Training @ REC-Agartala


Chawki Rearing @ CSRTI-BHP


Orientation Training @ REC-Sille


National Institute of Agricultural Extension Management
Central Sericultural Research and Training Institute, Berhampore
(Central Silk Board, Ministry of Textiles, Govt. of India)
Entrepreneurship Development Training
@ Dimapur-Nagaland

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 (State)	Scientists	Tech. Staff	Admin. & Supp. Staff	TSFW/ SFW	Farm Based Units	
					Total Area (Acres)	Mulberry (Acres)
RSRS-Jorhat (Assam)	Mr. P. Kumaresan Sci-C Mr. Chandan Maharana Sci-B (March-Aug 2019)	12	4	19	12.10	7.5
RECs						
Agartala (Tripura)	Dr. Narayan Biswas Sci-D (from Aug 2019)	3		3	1.0	0.5
Aizawl (Mizoram)	Dr. L. Pachuau Sci-D	2	1			
Dimapur (Nagaland)	Dr. Kartik Neog Sci-D (from May 2019)	6		4	10.0	3.5
Mongaldoi (Assam & BTC)	Mr. B. K. Basumatary Sci-D	6		1	7.0	5.1
Shillong (Meghalaya)	Dr. Collins Z Renthil Sci-D	3		1	1.7	1.5
Sille (Arunalchal Pradesh)	Mr. Lohit Sonowal Sci-C	4		5		

Concluded Research Projects

PPA 3622: Popularization of high bush mulberry plantation technology in Majuli, River Island of Brahmaputra, Assam

[Sept 2017-May 2019 (Aug 2020)]

P. Kumaresan (PI; Nov 2018) and Chandan Maharana (March-Aug 2019)

Objectives

- To assess growth characters, leaf yield of high bush mulberry and cocoon productivity
- To assess the mulberry pest and diseases in different seasons
- To popularize the high bush mulberry plantation technique in Majuli

Farmers were identified in Majuli for establishing mulberry plantation and S1635 saplings were distributed. Few farmers also practicised intercropping with vegetables like cowpea, pumpkin etc. Below ETL incidence of *Pseudocercospora* leaf spot, powdery mildew, brown leaf rust and no pest infestation was observed. The mid-course monitoring/review of project was made to terminate the activities as plantations of specific mulberry variety were not established and the existing plantations were also not in good shape. The RAC suggested popularizing C-2028, a flood tolerant variety at Majuli Island through ToT programmes. Accordingly, 2000 saplings of C-2028 (CSRTI-BHP) were distributed to 20 farmers of Majuli with the support of DoS and the planatations are being monitored. C-2028 plantations at Majuli (9 farmer's maintained 80-100% survival) and further 4000 cuttings are in nursery, which will be supplied during May-June 2020 in cocordination with SSPC-Jorhat.

Ongoing Research Projects

PRE02001SI: Management of Pink Mealy Bug - Maconellicoccus hirsutus (Green) of mulberry with barrier system

[July 2018 - June 2021]

P. Kumaresan (PI; from Nov 2018) and Chandan Maharana (March-Aug 2019)

Objectives

- To increase silk production by reducing mulberry crop loss due to infestation of pink mealy bug
- To find out minimum strategy to combat 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 per treatment). Barrier with neem cake + 0.3% chloropyriphos (T3) was effective. The Chloropyriphos 20 EC was replaced with Spinosad. Barrier with neem cake + Spinosad 45%SC (T3) was effective and controlled 60% pest population.

Treatment	Mealybug Reduction (%)
T1: lime powder + Spinosad 45%SC	46.94±0.17
T2: Paddy husk ash + Spinosad 45%SC	56.00±0.43
T3: Neem cake + Spinosad 45%SC	60.00±0.52
T4: Sawdust + Spinosad 45%SC	55.00±0.88
T5: No barrier + Spinosad 45%SC	18.52±0.34

BPP 05014 CN: Standardization of processing and production of consumable beverage from mulberry leaves and blending with green tea *(Coll. with AAU & TTRI-Jorhat)*

[March 2020 – June 2021]

Co-ordinator: Mishra R K; CSB: Chutia M, Sathyanarayana K, Prashanth S & Kumaresan P;
AAU-Jorhat: Gogoi A S, Barua S C, M Deka & P Das; TTRI-Jorhat: R C Gogoi & D J Hazarika

Objectives

- To standardize protocol for preparation of mulberry leaf for production of herbal tea with mulberry leaf and mulberry green tea
- Organoleptic properties will be evaluated by the professional tea tasters based on their scores on the sample
- Samples recommended by the tasters will be subjected to biochemical evaluation and customer acceptance

The role of RSRS-Jorhat in the project is to supply mulberry leaf to TTRI-Jorhat and AAU-Jorhat for production of mulberry tea and green tea for necessary evaluations. Different mulberry varieties (G4, G2 & V1) were obtained from CSRTI-Mysore and plantations were established in paired row system (3'x2'+5'). The plantations are being following standard cultural operations. Tender leaves of S-1635 and K2 have been supplied to the collaborators (6 spells @ 1kg) for standardizing the tea evaluation. A full-fledged project in collaboration with TTRI-Jorhat and AAU-Jorhat is just initiated.

Collaborative R&D Projects/Activities

RSRS-Jorhat is involved in the collection of data from experiments/farmers/DoS in the following R&D projects/programmes.

- PIB 3576: Evaluation of new mulberry genotypes for improvement in productivity and quality
- PPS 3600: Soil health card preparation for mulberry growing soils in E & NE India
- AIB 3617: Identification of region specific bivoltine hybrids suitable for highly fluctuating and seasonally variable climatic conditions of E & NE India
- AIB3616: On-farm Trial of multivoltine silkworm breeds/hybrids developed for high shell percentage and neatness of silk filament
- AICEM-IV (All India Co-ordinated Experimental Trial for Mulberry varieties)
- Forewarning of mulberry pest & diseases of E & NE India
- Survey, surveillance and monitoring of silkworm diseases in seed & commercial crops
- Extension, training & tranfer of technology (OST & OFT)

EXTENSION ACTIVITIES

RSRS-Jorhat and various RECs have undertaken various extension/capacity building/developmental activities/programems in different states in North Eastern region.

Activity	Achievement
ToT	Popularization of new improved mulberry varieties: 2.04 acres Popularization of Silkworm hybrids: 36700 dfls of ICB & BV hybrids Popularization of Chawki Rearing: 3 CRCs with SK6.7 in Spring crop @ Assam and Tripura Demonstration of Bio-Control Agents: 63 farmers covering 23.66 acres Popularization of Collapsible Plastic Mountages & Shoot Feeding: 30 farmers with SK6.SK7
ECPs	ECPs: 93 Events (4575 farmers); RKM cum Exhibition:4/861
CPP	Eight Clustes in NE states of India BV: 10.01 lakh dfls; Cocoon Yield 46.98kg/100 dfls & Raw Silk Production 59.81 MT ICB: 2.25 lakh dfls; Cocoon Yield 40.01kg/100 dfls & Raw Silk Production 9.72 MT
NERTPS	Technical guidance of mulberry sericulture (ISDP & IBSDP) in NE states
Training	Programmes *viz*., FST, TOP, PCT, EDP, Exposure visit & Seed Act (479 beneficiaries)

RSRS-KORAPUT

Units (State)	Scientists	Tech. Staff	Admin. & Supp. Staff	TSFW/ SFW	Farm Based Units	
					Total Area (Acres)	Mulberry + Vanya (Acres)
RSRS-Koraput (Odisha)	Dr. S. K. Misro, Sci-D (upto May 2019) Mr. Khasru Alam, Sci-B	15	4	22	50	10 + 3.5

Concluded Projects

PPA 3613: Studies on drum kit drip irrigation with hydrogel on yield and water use efficiency of mulberry

[Dec 2017 - Nov 2019]

K. Alam (May-Nov 2019), S.K Misro (Dec 2017-May 2019) and K.C. Brahma (Dec 2017-May 2018)

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
- To study cost of production of mulberry leaf by hydrogel application

Studies were conducted to determine the water use effcicency of mulberry by applying hydrogels with drum kit irrigiation. Established mulberry plantation (S-1635; 3' x 3' spacing) at RSRS-Koraput was utilized in RBD layout with four replications in three irrigation regime and two hydrogel application treatments. Data was collected and analyzed for mulberry growth and yield parameters including silkworm productivity.

Influence of hydrogel application with drum kit irrigation on Mulberry growth & yield

Treatment	Leaf yield (ton/ha/crop)	Primary branches (Nos)	Plant height (cm)	Total shoot Length (cm)	Moisture (%)
AI	4.25	6.77	157.02	875.61	80.18
AI+H	4.78	7.29	172.00	1056.99	80.19
DI	5.13	6.79	160.43	913.61	81.04
DI+H	4.88	6.72	169.29	949.93	80.69
NI	3.20	6.39	141.93	711.71	78.86
NI+H	3.44	6.22	157.61	777.49	78.73
SEm±	0.13	0.22	3.20	32.41	0.31
CD @ 5%	0.38	0.64	9.53	96.32	0.94
CV%	6.05	6.48	4.01	7.36	0.79

Two years (2017-2019) pooled data reveals that mulberry yield and plant growth attributes were significantly influenced by irrigation and hydrogel application. Daily irrigation (DI) and daily irrigation with hydrogel application (DIH) recorded higher leaf yield (5.13) and (4.88), but on par with alternative day irrigation with hydrogel application AIH (4.78); no significant differences were observed between DI and DIH, but AIH showed significant variation as compared to AI in leaf yield, primary branches, plant height and average total shoot length. AIH has recorded maximum number of primary branches (7.29), mean plant height (172) and average total shoot length (1056.99). Average moisture content in the hydrogel and irrigation treatments did not vary much.

Influence of hydrogel application with drum kit irrigation on Water use efficiency (WUE)

Treatments	Total water Applied (mm)	Leaf yield (t/ha/yr)	WUE (kg/ha/mm)	% Improvement Over Ctrl.
AI	936	21.27	22	100.00
AI+H	936	23.92	25	127.27
DI	1109	25.65	23	109.09
DI+H	1109	24.41	22	100.00
NI	840	9.60	11	
NI+H	840	10.32	12	9.09

Water use efficiency (WUE) was calculated as the ratio of yield (kg/ ha) and total water used (mm) total water utilized was obtained by adding effective rainfall and amount of water applied. Maximum WUE was recorded in AIH (25kg/ha/mm) followed by DI (23). Increased leaf yield (12.46%) was recorded in AIH as compared to AI; ~15% less water consumption as compared to DI. The influence of hydrogel application on silkworm growth/productivity was studied utilizing bivoltine FC (BCon1 x BCon4) dfls (Oct-Nov 2019). AIH recorded maximum ERR (8667) whereas DI recorded maximum cocoon weight (2.03g) which could be attributed to higher leaf moisture content due to daily irrigation.

Influence of hydrogel application with drum kit irrigation on Silkworm Growth & Productivity including Economics

Treatments	Larval Wt. (g)	ERR (No.)	ERR Wt. (kg)	Cocoon Wt. (g)	Shell wt. (g)	Shell Ratio (%)	Cost of cultivation (Rs/ha)	Leaf yield (t/ha/yr)	Gross Return (Rs/ha)	C:B Ratio
AI	38.33	8053	15.84	1.854	0.310	16.81	78566.5	21.27	106250	1:1.35
AI+H	38.55	8667	16.08	1.827	0.321	17.68	86966.0	23.92	119500	1:1.37
DI	39.85	8213	16.32	2.030	0.330	16.24	89791.5	25.65	128250	1:1.43
DI+H	38.94	7893	15.60	1.880	0.314	16.72	95591.5	24.41	122000	1:1.28
NI	37.44	8507	16.80	1.765	0.297	16.98	43572.5	9.60	48000	1:1.10
NI+H	37.44	8267	16.08	1.883	0.325	17.27	50572.5	10.32	51600	1:1.02
SEm±	1.53	259	0.62	0.078	0.011	0.85				
CD @ 5%				NS						

The cost-effectiveness and applicability of hydrogel application in mulberry leaf production was estimated as per standard procedures. Hydrogel application with alternate day irrigation was cost-effective.

Inference:

- ✓ Alternate day irrigation with pusa hydrogel (superabsorbent polymer) improved mulberry growth and leaf yield with cost-effective returns
- ✓ Considering economic profile of farmers in Odisha, hydrogel application with reduced frequency of irrigation could be beneficial for rainfed mulberry with wider spacing/tree type cultivation

AIB 3614: Evaluation and Identification of Suitable bivoltine hybrids for Odisha

[Dec 2017 – Nov 2019]

K. Alam (June-March 2019), K.C.Brahma (Dec 2017-May 2018), S.K Misro (June 2018-May 2019) and N.B. Kar (Dec 2017-Jan 2019)

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

Silkworm hybrids developed by different R&D institutes were evaluated in Odisha agro-climatic conditions at RSRS-Koraput to identifty the best performing hybrid. Ten silkworm hybrids (CSRTI-Berhampore: SK6 x SK7 & BCon1 x BCon4; CSRTI- Mysore: CSR50 x CSR51, CSR16 x CSR17, GEN3 x Gen2, CSR2 x CSR4 & FC2 x FC1; RSRS-Dehradun: Dun6 x Dun22; APSSRDI-Hindupur: APS45 x APS12 & HTO5 x HTP5) were evaluated in three crops (Aug-Sept 2018; Oct-Nov 2018; Feb-Mar 2019). The rearing and reeling performance was documented for analysis and multiple trait evaluation index values were utilized to determine the best performing hybrid.

Crop-Wise Performance of Bivoltine Hybrids in Odisha (2018-2019)

Hybrids	Season	larval wt (g)	ERR (No)	ERR Wt (kg)	Coc. Wt. (g)	Shell Wt. (g)	Shell Ratio (%)	FIL (m)	NBFL (m)	Reel-ability (%)	Neat-ness	Mean MEI
FC1 x FC2	Feb-Mar	38.38	6922	12.71	1.53	0.35	22.60	1050	1050	75	81	58.08
	Aug-Sept	37.92	8758	16.84	1.87	0.40	21.24	875	715	75	81	60.15
	Oct-Nov	36.30	9694	17.44	1.85	0.42	22.67	885	443	76	75	55.83
	CV (%)	2.38	13.61	13.42	8.84	8.17	2.97	8.57	33.73	0.63	3.58	3.04
Gen3 x Gen2	Feb-Mar	38.80	8156	15.11	1.68	0.30	20.67	954	668	74	77	55.63
	Aug-Sept	42.48	8394	14.31	1.81	0.36	20.06	795	568	70	75	50.66
	Oct-Nov	36.34	6556	12.78	1.83	0.40	21.79	960	480	76	70	47.95
	CV (%)	6.44	10.60	6.87	3.64	11.23	3.44	8.46	13.43	3.40	3.98	6.19
HTO5 x HTP5	Feb-Mar	40.51	7456	12.00	1.43	0.29	20.11	1078	1078	74	77.00	53.47
	Aug-Sept	36.45	8337	13.39	1.93	0.38	19.45	830	711	76	77.00	54.98
	Oct-Nov	37.14	8506	14.94	1.79	0.36	20.33	969	484	76	68.00	50.29
	CV (%)	4.66	5.68	8.93	12.24	11.53	1.87	10.58	32.30	1.25	5.73	3.69
CSR16 x CSR17	Feb-Mar	39.46	8100	14.33	1.30	0.28	21.36	820	410	74	80	52.13
	Aug-Sept	39.17	7437	12.10	1.73	0.35	20.20	794	496	73	80	48.38
	Oct-Nov	35.78	8511	14.83	1.84	0.38	20.85	774	774	78	73	53.61
	CV (%)	4.38	5.52	8.63	14.48	12.89	2.28	2.37	27.74	2.88	4.25	4.28
CSR50 x CSR51	Feb-Mar	39.61	8144	13.78	1.33	0.29	22.13	593	425	72	80	50.08
	Aug-Sept	41.00	7348	10.87	1.77	0.36	20.06	824	588	72	78	48.80
	Oct-Nov	37.61	8933	16.44	2.00	0.38	21.31	893	501	76	75	56.39
	CV (%)	3.53	7.95	16.61	16.50	10.80	4.02	16.66	13.20	2.57	2.65	6.41
APS45 x APS12	Feb-Mar	39.98	7767	12.11	1.37	0.26	19.08	747	534	76	77	49.51
	Aug-Sept	34.31	8543	10.45	1.74	0.32	18.29	806	705	76	75	48.41
	Oct-Nov	38.08	7461	13.89	1.85	0.36	19.57	865	556	75	70	48.77
	CV (%)	6.29	5.75	11.56	12.36	12.66	2.78	5.98	12.69	0.62	3.98	0.94
Dun6 x Dun22	Feb-Mar	36.11	7500	10.67	1.26	0.23	17.85	890	875	76	79	47.52
	Aug-Sept	34.16	8592	15.29	1.89	0.34	17.95	755	539	71	78	48.92
	Oct-Nov	36.91	8422	14.67	1.79	0.36	20.25	944	472	75	74	49.87
	CV (%)	3.23	5.87	15.12	16.92	17.76	5.93	9.21	28.05	2.92	2.81	1.98
CSR2 x CSR4	Feb-Mar	34.25	7656	10.00	1.29	0.26	20.29	864	695	74	78	45.64
	Aug-Sept	41.62	7822	14.30	1.63	0.33	20.62	874	674	71	75	49.68
	Oct-Nov	36.83	6844	14.39	1.71	0.32	22.32	908	454	77	75	49.36
	CV (%)	8.13	5.74	15.88	11.93	10.03	4.22	2.14	17.94	3.31	1.86	3.80
BCon1 x BCon 4	Feb-Mar	38.09	6856	10.22	1.51	0.27	16.02	519	422	75	77	44.66
	Aug-Sept	34.48	8891	16.85	1.76	0.32	17.70	642	459	74	80	48.18
	Oct-Nov	38.30	9083	14.36	1.61	0.26	16.17	695	348	77	65	42.25
	CV (%)	4.74	12.17	19.80	6.44	9.26	4.56	11.92	11.26	1.66	8.76	5.41
SK6 x SK7	Feb-Mar	38.96	7167	10.11	1.31	0.23	15.52	689	589	74	81	43.28
	Aug-Sept	34.02	8371	13.24	1.64	0.24	14.61	673	480	73	82	41.84
	Oct-Nov	36.17	9083	14.93	1.63	0.28	16.94	810	405	77	75	45.68
	CV (%)	5.56	9.64	15.65	9.97	8.25	6.11	8.45	15.38	2.28	3.90	3.63

Overall Performance of Bivoltine Hybrids in Odisha (2018-2019)

Hybrids	larval wt (g)	ERR (No)	ERR Wt (kg)	Coc. Wt. (g)	Shell Wt. (g)	Shell Ratio (%)	FIL (m)	NBFL (m)	Reel-ability (%)	Neat-ness	Mean MEI
FC1 X FC2	37.37	8765	15.92	1.79	0.395	22.08	937	736	74.72	81.33	61.66
HTO5 x HTP5	37.54	8228	13.73	1.78	0.352	19.93	993	792	75.81	77.00	55.44
CSR50 x CSR51	39.37	8141	13.68	1.69	0.353	20.97	770	635	73.38	79.67	50.78
CSR16 x CSR17	37.87	7999	13.64	1.69	0.349	20.69	796	560	74.98	80.33	50.71
Gen3 x Gen2	39.29	7611	13.86	1.75	0.365	20.87	903	556	73.36	77.00	49.56
Dun6 x Dun22	35.65	8306	14.11	1.73	0.327	18.85	824	580	74.23	79.33	48.63
CSR2 x CSR4	38.23	7953	13.48	1.59	0.339	21.23	815	608	74.43	78.33	48.11
APS45 x APS12	36.95	7955	12.16	1.71	0.325	18.96	803	701	75.57	77.33	47.58
BCon1 x BCon4	36.73	8561	14.53	1.68	0.284	16.75	653	410	75.29	77.00	44.54
SK6 x SK7	35.87	8415	13.29	1.61	0.254	15.72	724	525	74.51	81.33	42.98
CD @ 5%	1.23	418.92	1.03	0.06	0.01	0.87	102.84	71.51	NS	NS	
CV%	1.93	3.00	4.38	2.15	2.30	2.60	7.35	6.88	2.97	9.76	

FC1 x FC2, Gen3 x Gen2 and HTO5 x HTP5 generally performed well in all the seasons in Odisha; while CSR16 x CSR17 also in October-November crop. FC1 x FC2 occupied the top position with an MEI of 61.66 followed by HTO5 x HTP5 (55.44), CSR50 x CSR51 (50.78) and CSR16 x CSR17 (50.71). Around 21% shell content was observed in FC1 x FC2, Gen3 x Gen2, CSR16 x CSR17 and CSR50 x CSR51. BCon1 x BCon4 and SK6 x SK7, the ruling foundation crosses reared in Eastern & NE India recorded 16-17% shell ratio only with 85% survival and were placed right at the bottom for their overall performance. Average and non-breakable filament lengths were >1050 in HTO5 x HTP5 and FC1 x FC2. Non-significant differences between the hybrids were observed for reelability and neatness. FC1 x FC2, bivoltine double hybrid which is quite popular in South/North India stood first for its overall performance in Odisha conditions also.

Inference:

- ✓ FC1 x FC2 has scored MEI values >50 for the maximum of 9 individual traits viz., single cocoon weight, single shell weight, shell ratio, cocoon yield by weight and number, average filament length, non breakable filament length, reelability and average neatness particularly with respect to overall performance irrespective of seasons

Collaborative R&D Projects/Activities

RSRS-Koraput is involved in the collection of data from experiments/farmers/DoS in the following R&D projects/programmes.

- PIB 3576: Evaluation of new mulberry genotypes for improvement in productivity and quality
- PIE 02002 SI: Evaluation of performance of mulberry genotype C-9 under red & laterite soils
- PPS 3600: Soil health card preparation for mulberry growing soils in E & NE India
- AIB 3617: Identification of region specific bivoltine hybrids suitable for highly fluctuating and seasonally variable climatic conditions of E & NE India
- AIB3616: On-farm Trial of multivoltine silkworm breeds/hybrids developed for high shell percentage and neatness of silk filament
- AICEM-IV (All India Co-ordinated Experimental Trial for Mulberry varieties)
- Forewarning of mulberry pest & diseases of E & NE India
- Survey, surveillance and monitoring of silkworm diseases in seed and commercial crops
- Extension, training & tranfer of technology (OST & OFT)

EXTENSION ACTIVITIES

RSRS-Koraput undertook various extension/capacity building/developmental activities/ programems in Odisha.

Activity	Achievement
New Mulberry Plantations	1 acre (S-1635) at farmers level
ToT	Popularization of Silkworm hybrids: 500 dfls of KDH/FCs
ECP	31 Events (1598 farmers) including RKM
CPP	3500 dfls (75 farmers); Avg. yield: 48.50kg/100 dfls Raw Silk Production: 241 kg
Eri Rearing	6470 cocoons and supply of 1150 dfls to DoS

RSRS-KALIMPONG

Units & Command area	Scientists	Tech. staff	Admin & Supp. staff	TSFW/ SFW	Farm based units	
					Total Acreage	Plantation Acreage
RSRS-Kalimpong (Hilly – West Bengal)	Mr. Zakir Hossain Sci-D Dr. Harish Babu, S Sci-B	12	9	19	30.37	5.22 (@Mulberry) 2.00 (@Muga)
REC-Mamring (Sikkim)	Mr. S. T. Lepcha, Sci-D (upto Aug'19)	3	2			

Continuous/Other Activities

Maintenance of Bivoltine Silkworm Germplasm Breeds

Objective: Maintenance of bivoltine germplasm under temperate conditions

Bivoltine germplasm breeds collected from various sources maintained at RSRS-Kalimpong were reared during spring (April-May) crop. The celluar rearings were conducted following standard rearing technology/ conditions. Data on rearing performance and cocoon characteristics were documented and verified against the passport data. The selected cocoons were utilized for seed production and dfls were preserved in different hibernation schedules. During the year, an additional crop was undertaken in summer season (June-July) in which 8 bivoltine breeds and 14 hybrids were reared satisfactorily. During spring season, 36 germplasm breeds along with 13 bivoltine and six multivoltine breeding lines and six bivoltine hybrids from CSRTI-BHP were reared for evaluation; while in autumn season, 24 bivoltine breeds and 6 hybrids were reared. 293 bivoltine dfls (36 germplasm breeds) produced in spring 2019 were preserved in cold storage for utilization in spring 2020. Further, a total of 1791 dfls (~1500 bivoltine pure lines/hybrids & multivoltine dfls) were supplied to CSRTI-BHP for field evaluation.

The rearing of multivoltine breeds such as Nistari and four other commercially exploited breeds during the summer season utilizing the CSRTI-BHP dfls was useful to maintain their racial characteristics in Kalimpong as compared to Berhampore conditions.

Performance of Bivoltine Silkworm Genetic Resources Spring 2019

Breed	Fec.	ERR byNo	ERR Wt (g)	SCW (gm)	SSW (gm)	Shell Ratio (%)
BCon1	497	9160	17.30	1.682	0.300	17.83
BCon4	599	9380	16.94	1.757	0.298	16.96
BHR1	588	8920	17.40	1.885	0.335	17.77
BHR2	533	9360	15.76	1.640	0.313	19.08
BHR3	570	9280	17.50	1.609	0.266	16.53
Changnang	513	9500	17.36	1.926	0.325	16.87
CSR2	499	5700	9.88	1.780	0.393	22.07
CSR6	539	7980	14.32	1.698	0.342	20.14
CSR27	596	4540	20.70	1.639	0.392	23.91
D4	578	8960	16.70	1.710	0.307	17.95
D6(m)	586	9020	15.38	1.728	0.293	16.95
D6(P)	566	9340	16.82	1.650	0.294	17.81
JD-6	519	9240	18.26	2.135	0.361	16.90
J122	593	8160	16.42	2.002	0.384	19.18
KPG-A	519	9240	16.38	1.828	0.312	17.06
KPG-B	487	9200	16.26	1.760	0.304	17.04
KPG-3	571	9160	16.20	1.595	0.309	19.37
KPG-4	608	8880	12.92	1.541	0.257	16.67
KPG-5	531	8500	14.68	1.695	0.377	22.24
KPG-7	584	9080	18.74	1.905	0.353	18.53
MC1	532	9200	14.70	1.529	0.289	18.90
MC2	501	8880	15.72	1.901	0.346	18.20
MJ1	525	9180	15.90	1.590	0.297	18.67
MJ2	555	9040	14.24	1.520	0.295	19.40
NB4D2	541	8700	14.34	1.456	0.264	18.13
NB18	504	9280	17.18	1.703	0.309	18.14
P5	605	9020	16.48	1.691	0.332	19.63
Pam 105	501	7680	13.22	1.684	0.247	14.66
SK6	623	9500	17.44	1.656	0.263	15.88
SK7	586	9520	16.28	1.560	0.260	16.66
SK4(II)	532	7980	14.00	1.744	0.318	18.23
SF19	597	8940	17.54	1.994	0.360	18.05
SH6	520	7840	16.56	2.097	0.378	18.02

Performance of Breeding Lines & Hybrids
Spring 2019

	Breed	Fec.	ERR byNo	ERR Wt (g)	SCW (gm)	SSW (gm)	Shell Ratio (%)
Bivoltine	SBK1	571	8640	15.76	1.733	0.337	19.44
	SBK2	582	8680	17.32	1.924	0.326	16.94
	SBK3	548	8900	16.64	1.808	0.327	18.03
	SBK5	570	9040	17.00	1.732	0.316	18.24
	SBK6	540	9180	17.80	1.839	0.314	17.07
	SBK7	479	8500	16.06	1.790	0.297	16.59
	SBK8	546	9200	17.98	1.846	0.341	18.47
	SBK9	590	8580	16.84	1.763	0.351	19.91
	WB1	573	9680	19.18	1.810	0.340	18.78
	WB2	567	9140	16.00	1.669	0.288	17.26
	WB3	497	9013	16.76	1.760	0.320	18.18
	WB5	419	8880	15.81	1.670	0.310	18.56
	WB6	617	9280	16.80	1.670	0.320	19.16
	WB7	539	8907	16.39	1.830	0.320	17.48
	WB8	441	8973	15.75	1.530	0.300	19.60
	WB9	533	9040	17.76	1.930	0.350	18.13
	BHP1	476	8770	16.62	1.880	0.350	18.61
	BHP2	543	9347	16.84	1.760	0.320	18.18
	BHP3	555	8213	16.04	2.010	0.420	20.89
	BHP8	605	8920	16.20	1.740	0.330	18.97
	BHP9	577	9480	17.81	1.630	0.320	19.63
	SK6 x SK7	528	9110	17.75	1.728	0.298	17.24
	BCon1 X BCon4	570	8670	17.44	1.754	0.309	17.62
	BHP2 X BHP8	478	9240	18.55	2.059	0.364	17.68
	BHP3 X BHP8	425	9050	19.33	2.026	0.377	18.61
	BHP 1.3 x BHP 8.9	498	9300	18.68	2.090	0.370	17.70
	BHP 3.2 x BHP 8.9	535	9184	19.38	2.030	0.360	17.73
	SBK1 x SBK8	514	9140	18.64	1.821	0.357	19.60
	SBK2 x SBK6	423	8800	18.24	2.101	0.355	16.90
	SBK2 x SBK8	459	9300	18.92	1.821	0.357	19.60
	SBK3 x SBK8	490	9040	17.86	1.881	0.326	17.34
	SBK5 x SBK9	510	8920	17.00	1.89	0.341	18.04
Multivoltine	N(M)	443	5347	6.09	1.080	0.110	10.18
	N(P)	422	6440	8.34	1.315	0.153	11.64
	M12W	467	7220	9.16	1.366	0.153	11.18
	MCon1	518	4420	6.60	1.540	0.207	13.44
	MCon 4	518	5740	8.79	1.608	0.206	12.81
	M6DPC	512	2987	3.66	1.130	0.130	11.50

Performance of Bivoltine Breeds & Hybrids

Season	Breed	Fec.	ERR byNo	ERR Wt (g)	SCW (gm)	SSW (gm)	Shell Ratio (%)
Summer 2019	WB3	617	6325	10.60	1.610	0.311	19.32
	WB5	525	4925	7.97	1.542	0.300	19.46
	WB7	528	1400	26.33	1.768	0.348	19.68
	WB9	460	7700	13.55	1.759	0.342	19.44
	BCon 14	518	5825	10.42	1.894	0.319	16.84
	SK67	508	4535	7.91	1.685	0.297	17.63
	BCon1 x BHR3	483	4775	9.20	1.825	0.351	19.23
	BCon4 x BHR3	453	4000	7.82	1.825	0.351	19.23
	BCon1 x J122	603	4275	8.30	2.013	0.398	19.77
	BCon4 x J122	489	9050	16.87	2.013	0.398	19.77
	KPG-A x SF19	562	4225	8.25	1.934	0.398	20.58
	SK6 x SK7	452	6325	11.02	1.665	0.291	17.48
	SH6 x Changnang	494	800	1.85	2.060	0.390	18.93
	BHR1 x BHR3	589	1900	3.82	1.987	0.367	18.47
	SK6 x J122	525	8325	15.87	1.993	0.414	20.77
	SK7 x J122	540	8300	13.92	1.993	0.414	20.77
	SBK5 x SBK7	614	8850	16.80	2.114	0.455	21.52
	WB3 x WB1	557	5350	10.07	1.910	0.366	19.16
	WB7 x WB9	593	8050	14.67	1.776	0.351	19.76
Autumn 2019	WB1	597	4825	8.42	1.838	0.299	16.26
	WB3	430	6575	10.96	1.637	0.286	17.47
	WB3(w)	508	8700	14.37	1.633	0.274	16.77
	WB5	437	7625	12.36	1.585	0.280	17.60
	WB5(w)	576	8425	13.51	1.571	0.265	16.84
	WB7	642	5575	10.59	1.832	0.343	18.72
	WB7(w)	582	4825	9.67	1.851	0.350	18.90
	WB9	464	5700	9.62	1.789	0.346	19.34
	WB9(w)	419	6200	13.72	1.768	0.326	18.43
	BCon14	523	4250	8.56	1.887	0.322	17.06
	BHR13	591	3400	6.80	1.829	0.298	16.29
	BJ	664	2400	3.89	1.615	0.314	19.44
	BJ(w)	628	5850	10.51	1.893	0.370	19.54
	BBHR	539	4150	8.36	1.685	0.289	17.15
	BBHR(w)	546	5425	11.19	1.953	0.350	17.92
	KA19	603	4925	8.41	1.810	0.350	19.33
	KA19(w)	641	3825	6.80	1.790	0.352	19.66
	P5	502	5300	9.24	1.632	0.330	20.22
	CHSHSF	640	2050	4.27	2.029	0.392	19.31
	SK67	587	7675	13.96	1.626	0.277	17.03
	SK67J	564	4900	7.99	1.767	0.327	18.50
	SK67J(w)	587	6325	12.08	1.714	0.309	18.02
	SF19	297	4325	8.16	1.924	0.397	20.63
	SK6 x SK7	530	7867	14.29	1.615	0.271	16.78
	BCon1 x BCon4	507	6544	12.90	1.903	0.329	17.28
	BHP2 x BHP8	517	844	1.25	1.565	0.293	18.72
	BHP3 x BHP8	404	5944	10.26	1.613	0.322	19.96
	BHP 1.3 x BHP 8.9	485	4922	8.66	1.680	0.304	18.09
	BHP 3.2 x BHP8. 9	535	2500	4.14	1.684	0.331	19.65
	KDH1	495	7850	15.78	1.827	0.369	20.19

Collaborative R&D Projects/Activities

RSRS-Kalimpong was involved in the collection of data from experiments/farmers/DoS in the following R&D projects/programmes.

- PPS 3600: Soil health card preparation for mulberry growing soils in E & NE India
- AIB 3617: Identification of region specific bivoltine hybrids suitable for highly fluctuating and seasonally variable climatic conditions of E & NE India
- Forewarning of mulberry pests & diseases of E & NE India
- Survey, surveillance and monitoring of silkworm diseases in seed and commercial crops
- Extension, NERTPS & Training.

EXTENSION ACTIVITIES

RSRS-Kalimpong and REC-Mamring have undertaken various extension/ capacity building/ developmental activities/ programems in hilly region of West Bengal and Sikkim.

Activity	Achievement
ECPs	29 Events (1611 farmers)
Training	10 days hands-on-training; 3 days farmer training cum exposure visit


RKM @ BHP


RKM @ BHP


UK Visitors @ CSRTI-BHP


Farmers Day @ Mamring


Awareness Programme @ Malda


कृषक दिवस
Farmers Day @ Bhandra


Awareness Programme @ REC-Mamring
AWARENESS PROGRAMME


Technology Demo @ Kalimpong


Technology Demo @ Malda


Awareness
Programme
@ Meghalaya


Group Discussion
Group
Discussion
@ Tripura


समूह परिचर्चा
GROUP DISCUSSION
Group Discussion@ Mizoram


Group Discussion @ Sikkim


Field Day
@ Assam


Field Day
@ WB

TRANSFER OF TECHNOLOGY

The following ToT programmes were undertaken for popularizing the recently developed sericultural technologies into the field in E & NE zone through on farm trails (OFT) during 2019-20. The programmes were implemented as per the specific guidelines and the beneficiaries were selected by the extension units in consultation with respective DoS.

OFT	Stakeholders (Target)	Findings/ Achievement
Popularization of Mulberry Variety, C-2038	126 farmers (14.40 acres)	Established 8.88 acres of C-2038 (West Bengal & Bihar).
Popularization of New Silkworm Hybrids	~100 farmers in four crops (20000 dfls)	2.03 lakh dfls M6DPC x SK6.7 produced by NSSO were reared in West Bengal and Tripura; 12(Y) x (BCon1.4) and BHP hybrids performed better than ruling hybrids.
Popularization of Chawki Rearing	10 CRCs	10 CRCs were enrolled for conducting BV hybrid and ICB rearings (10000 dfls)
Popularization of Suvarna + Souroneer	10 reelers	Prototype of fine-tuned version is under in-house evaluation.
Demonstration of Bio-Control Agents	150 (75 acres)	~7500 predators against mealybug/thrips were released/ distributed to 199 farmers.
Popularization of Collapsible Plastic Mountages & Shoot Feeding	100 (20000 dfls)	Assistance for collapsible mountages and shelf rearing provided to 110 famers in West Bengal, Jharkhand, Tripura and Assam. 10% higher cocoon yields and ~25% labour savings were recorded over the existing practices.

Popularization of newly authorized mulberry variety, C-2038

D. Chakravarty, Suresh, K. Yallappa, H., Deepika, K.U, Tapati D Biswas, B K Basumatary, P Kumaresan and G Singh

C-2038 planting materials were supplied to nested units from the cuttings supplied from nucleus seed plot of CSRTI-BHP. Planting materials (~52500) were distributed to 42 farmers during Oct-Nov 2019. Around 80-90% survival was recorded and the plantations were monitored by the extension units.

Units	Farmers		Nursery		Area (acres)	
	Target	Ach.	Target	Ach.	Target	Ach.
CSRTI-BHP	23	12	20700	34000	4.00	6.30
REC-Mothabari	23	6	20700	4000	4.00	0.46
RSRS-Koraput	10	0	3200	500		
REC-Bhandra	10	2	3200	4000	0.80	0.08
RSRS-Jorhat	60	22	34000	20000	0.80	1.24
REC-Mangaldoi					0.80	0.80
Total	126	42	71800	52500	14.40	8.88

Popularization of Chawki Rearing

Tapati Datta Biswas, Shafi Afroz, Satadal Chakraborty, G Singh, B K Basumatary and Narayan Biswas

Ten CRCs with a capacity of 1000 dfls/crop were identified as beneficiaries during Falgooni/Spring 2020 in West Bengal (4), Jharkhand (1), Tripura (1) and Assam BTC (2). The beneficiaries were assisted with region-specific dfls (Multi × Bi or Bi × Bi), foam pad, brushing nets, and chawki rearing costs (@Rs.5660/Crop). The chawki worms reared were distributed to the farmers after 2nd moult. The CRCs were monitored for chawki worms' quality.

Unit	CRCs	Season	Hybrid	Hatching (%)	Larval growth* (g)	Missing larvae (%)	Unequal larvae (%)
CSRTI-BHB	3	Falguni 2020	M6DPC× (SK6.7)	92.5 ±2.25	2.16 ±0.05	3.83 ±1.18	6.50 ±0.70
REC-Mothabari	3			92.5 ±2.5	2.32 ±0.10	3.08 ±0.88	1.50 ±0.50
REC-Bhandra	1	Spring 2020	SK6×SK7	97.0	3.38	5.04	2.05
REC-Mangaldoi	2			92.0 ±2.83	2.00 ±0.71	6.00 ±1.41	1.25 ±1.06
REC-Agartala	1			85.0	2.50	2.00	0.29

Note: Weight of hundred larvae under 2nd moult

Popularization of Collapsible plastic mountages & Shoot feeding (shelf rearing)

Tapati Datta Biswas, Shafi Afroz, Satadal Chakraborty, G Singh, B K Basumatary and Narayan Biswas

Shelf rearing (shoot feeding) technology was extended to 110 farmers against the target of 100 farmers during Falgooni/ Spring 2020 crop in West Bengal (60), Jharkhand (20), Tripura (10) and Assam BTC (20). The beneficiaries were assisted with shelf-preparation cost (@Rs. 8500/ farmer). Cocoon yield gains including 25% labour savings during late age rearing (>10%) was observed.

Unit	Season	Hybrid	Far-mers	Avg. Yield (Kg/100 dfls)		
				Shelf	Dala	Gain (%)
CSRTI-BHB	Falguni 2020	M6DPC× SK6.7	30	55.3	48.8	13.36
REC-Mothabari			30	38.8	33.8	14.81
REC-Bhandra	Spring 2020	SK6 × SK7	10	48.5	44.0	10.23
REC-Mangaldoi			20	49.4	42.5	16.20
REC-Agartala			10	44.6	40.2	10.95
			Total/Avg.	47.32	41.86	13.11
			CV%	12.91	13.13	

Demonstration of Bio-Control Agents

M.B. Radha, Dibyendu Sarkar, Shafi Afroz and V. Lakshmanan

Thrips incidence was noticed in Eastern & North Eastern India and bio-control agents were introduced for the management of thrips. Following the hands-on-training from RSRS-Salem (CSRTI-Mysore), mass production of *Chrysoperla sillemi (green lacewing)* Bio-Control agent was successfully established at CSRTI-BHP. A quantity of 617cc *Corcyra cephalonica* eggs were harvested and used for the multiplication and maintenance of *Chrysoperla*. ~75,000 *Chrysoperla* eggs were produced and utilized for the control of thrips in Institute's mulberry gardens and farmer's fields (124 farmers/44.11 acres). *Chrysoperla* Bio-Control agent is also being supplied to the farmers in West Bengal. *Scymnus* beetles were also produced and distributed to the farmers (75 farmers/10 acres) for the management of mealybug (tukra) infestations. The mass production system for both the biocontrol agents is established in the institute.

Popularization of 'Suvarna' (Motorized Charkha) & Souroneer

Gautam Mitra and Sourab Majumder

'Suvarna', the modified version of 'Katghai' (traditional charkha) developed by the institute was fine-tuned by modifying to an iron-framed model and driving arrangement for further convenience. The prototype model was demonstrated in Resham Krishi Mela held at Berhampore and also in the field for creating awareness among the stakeholders. The combination of 'Suvarna' with 'Souroneer' (solar water heating unit) is expected to reduce the cost of conversion by about 37% and improves the BCR; besides reducing drudgery and improving yarn quality. The establishment of 'Suvarna' with 'Souroneer' with the identified beneficiaries is under progress. The Suvarna prototype is being subjected to in-house evaluation at CSRTI-BHP.

Popularization of New Silkworm Hybrids

V. Lakshmanan, A.K. Verma, N. Chandrakanth, VS Raviraj, T Ranjita Devi, T.D. Biswas, Satadal Chakraborty, G Singh, B K Basumatary, Kartik Neog, Lohit Sonowal, P Kumareshan and Narayan Biswas

The multi x hybrids viz., M6DPC x SK6.7, 12Y x BFC1, 12Y x Bcon 1.4, CB5 x SK6.7 and N x SK6.7 and bivoltine hybrids/foundation crosses *viz.,* BHP 1.3 x 8.9, BHP 3.2 x 8.9, SK6 x SK7 & BCon 1.4, KDH were distributed to farmers in Eastern & North Eastern states West Bengal and Tripura. A total of 2.03 lakh dfls of new hybrids were reared by the farmers in the region. The data on performance of the new hybrids and ruling hybrids was collected from some of the farmers across the seasons. M6DPC x SK6.7, 12Y x BCon1.4 or 12Y x BFC1 and BHP double hybrids performed better than the ruling hybrids. M6DPC x SK6.7 is being produced by NSSO-SSPCs in West Bengal regularly for meeting the farmers requirement in West Bengal and Tripura. BHP3.2 x BHP8.9 has excelled over the control with an average cocoon yield of 52.16kg/100 dfls (11.21% more than SK6.7 and 19.90% more than BCon1.4) and fetched higher price for the cocoons in the market.

States	Hybrid	Season	Dfls	Yield/ 100 dfls (Kg)	Cocoon Wt (g)	Shell Wt (g)	Shell Ratio (%)
Nagaland	12Y x BV	Oct 2019	200	92.00	1.520	0.267	17.57
Tripura	M6DPC x SK6.7	July 2019	30000	39.00	1.362	0.245	18.00
	N x SK6.7	July 2019	5000	38.30	1.354	0.216	15.96
	12Y x BV	Oct 2019	400	42.86	1.420	0.266	18.70
	12Y x BV	Mar 2020	500	40.60	1.750	0.320	18.28
Arunachal Pradesh	12Y x BV	Mar 2020	100	56.00	1.341	0.217	16.23
Jorhat (Assam)	12Y x BV	Mar 2020	400	39.75 (32-60)	1.349	0.235	17.42
Mangaldoi (Assam)	12Y x BV	Mar 2020	100	46.50	1.340	0.280	20.89
Malda (WB)	12Y x BV	Feb 2020	400	45-50	1.830	0.316	17.27
	M6DPC x SK6.7	Feb 2020	3000	38.68 (30-57)	1.489	0.219	14.73
	N x SK6.7	Feb 2020	100	33.75 (30-50)	1.481	0.207	13.97
Murshidabad (WB)	12Y x BV	Feb 2020	250	61.40	1.672	0.306	18.30
	M6DPC x SK6.7	Feb 2020	3000	55.32 (44-65)	1.562	0.239	15.30
	N x SK6.7	Feb 2020	500	48.80 (48-53)	1.486	0.212	14.27
	12Y x BV	Mar 2020	500	59.62 (55-63)	1.604	0.279	17.39
Nadia (WB)	12Y x BV	Mar 2020	700	44.50 (40-49)	1.584	0.281	17.74
	N x SK6.7	Mar 2020	200	38.96	1.452	0.229	15.77
West Bengal	BHP 1.3 x 8.9	Nov 2019	200	38.25	1.657	0.303	18.28
	BHP 3.2 x 8.9	Nov 2019	840	52.16	1.788	0.345	19.29
	SK6 x SK7	Nov 2019	600	46.90	1.644	0.267	16.24
	BCon 1 x 4	Feb 2020	300	43.50	1.519	0.260	17.11


Popularization C-2038 Mulberry Variety
@ Bihar


ORC@ West Bengal


Shelf / Shoot Feeding
@ West Bengal


Plastic Mountages
@ West Bengal


Popularization of ICB @
Eastern India


Suvarna Prototype

NORTH EAST REGION TEXTILE PROMOTION SCHEME (NERTPS)

V. Sivaprasad, Dipesh Pandit and Manjunatha G R

NERTPS, an umbrella scheme of Ministry of Textiles, Govt. of India have approved 38 sericulture projects in the North Eastern States in potential districts under categories i.e., Integrated Sericulture Development Project (ISDP), Intensive Bivoltine Sericulture Development Project (IBSDP), Eri Spun Silk Mills and Aspirational Districts (2015-2018/2019). NERTPS focuses on providing special thrust for consolidation and expansion of mulberry, eri and muga sericulture with the basic objectives of uplifting of the overall socio-economic status sustainably. The project envisages holistic development of seri-industry in all spheres from plantation to fabric production with value addition at every stage. The project is proposed to bring ~38170 acres of plantation under mulberry, eri and muga sectors; contribute additional production of 2650 MT raw silk and generate employment for three lakh persons in NE India. CSRTI-Berhampore is involved in coordination of technical support and monitotring activities in mulberry sector.

ISDP: Eighteen ISDP projects are being implemented in Assam (including BTC), Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and Tripura to support 29,910 acres plantation of Mulberry, Eri & Muga predominantly. These projects are being implemented through respective DoSs including establishment of Silk Printing & Processing unit for Tripura, Soil to Silk for BTC (Assam), Post Cocoon Technology for Nagaland & creation of seed infrastructure to produce and ensure uninterrupted supply of quality seed (NSSO-CSB).

IBSDP: Ten projects are being implemented to produce for import substitute bivoltine silk covering 4900 acres of mulberry plantation benefitting around 10607 women beneficiaries in all the NE states, except Manipur.

Aspirational Districts: Five sericulture projects are being implemented in Assam, BTC, Mizoram, Meghalaya and Nagaland to develop silk industry in one/two blocks of the identified aspirational districts. These projects aims cover 3360 acres of plantation benefitting around 4185 beneficiaries.

An internal evaluation of various NERTPS projects, particularly ISDP & IBSDP in mulberry sector implemented, was conducted by CSRTI-Berhampore with close co-operation of respective DoS and CSB units. The assessment utilized well-structured schedule/questionnaire and site visits in Dec. 2019 on specific activities (kisan nurseries, plantations, vermi-compost units, irrigation & water conservation units, supply of rearing appliances, construction of rearing houses & mounting halls, CRCs, poly clinics, PCT infrastructure facilities & skill up-gradation programmes). The assessment teams have documented the physical progress, implementation levels, constraints in implementation, inputs and aspirations from various stakeholders. The performance of mulberry projects under NERTPS in the NE states was enlisted and the evaluation reports were submitted to the authorities for necessary interventions. Central Silk Board has commissioned a third-party evaluation of all the NERTPS projects as a whole in 2020.

NERTPS - Mulberry Internal Assessment Team	
Arunachal Pradesh	Mr. Zakir Hossain, Scientist-D (RSRS-Kalimpong) - Nodal Officer Shri Lohit Sonowal, Scientist-C (REC-Sille-Arunachal Pradesh) Dr. Anil Pappachan, Scientist-B (CSRTI-BHP)
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Manipur	Dr. S. Chattopadhyay, Scientist-D (CSRTI-BHP) - Nodal Officer Dr. L. Somen Singh, Scientist-D (REC-Imphal) Dr. N Chandrakanth, Scientist-C (CSRTI-BHP)
Meghalaya	Mr. D Chakravorty, Scientist-D (CSRTI-BHP) - Nodal Officer Dr. C.Z. Renthlei, Scientist-D (REC-Shillong-Meghalaya) Dr. K Rahul, Scientist-C (CSRTI-BHP)
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Sikkim	Dr. V. Lakshmanan, Scientist-D (CSRTI-BHP) - Nodal Officer Dr. Harish Babu S, Scientist-B (RSRS-Kalimpong)
Tripura	Dr. AK Verma, Scientist-D (CSRTI-BHP) - Nodal Officer Dr. Narayan Biswas, Scientist-D (REC-Agartala) Mr. Yallappa H, Scientist-B (CSRTI-BHP)

राजभाषा अनुभाग की उपलब्धियाँ (वर्ष 2019- 2020)

केन्द्रीय रेशम उत्पादन अनुसंधान एवं प्रशिक्षण संस्थान, बहरमपुर(प.बं.) में वर्ष 2019-20 के दौरान संघ की राजभाषा नीति का सम्यक अनुपालन किया गया। राजभाषा अधिनियम की धारा-3(3) एवं राजभाषा नियम-5 जैसे अनिवार्य प्रावधानों का शत-प्रतिशत अनुपालन सुनिश्चित किया गया है। राजभाषा हिन्दी के अन्य महत्वपूर्ण कार्यान्वयन बिन्दुओं/प्रावधानों पर भी कार्रवाई की गई। संस्थान में राजभाषा कार्यान्वयन समिति की बैठक का आयोजन कर राजभाषा प्रगति/कमियों की समय-समय पर समीक्षा, हिन्दी कार्यशाला का आयोजन हिन्दी पखवाड़ा/दिवस का आयोजन, हिन्दी भाषा प्रशिक्षण, हिन्दी पुस्तक/पुस्तिकाओं का संपादन, हिन्दी प्रतियोगिता का आयोजन एवं प्रोत्साहन योजनाओं का कार्यान्वयन किया 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) के अर्न्तगत आने वाले सभी कागजात यथा सामान्य आदेशअधिसूचना एवं संविदा करार विज्ञप्ति तथा प्रशासनिक एवं अन्य रिपोर्ट आदि ,सूचना ,नियम ,निविदा , अनिवार्य रुप से द्विभाषी में जारी किए गए।

- हिन्दी पत्राचार : वर्ष के दौरान 'क', क्षेत्र में स्थित केन्द्र/ राज्य सरकार को क्रमश: 86.25% तथा 'ग' क्षेत्र में स्थित केन्द्रीय सरकार के कार्यालयों को 67.89% पत्र हिन्दी में भेजें गए। इस प्रकार पत्राचार के मद में निर्धारित लक्ष्य से अधिक पत्राचार किया गया।

- हिन्दी प्रशिक्षण: आलोच्य अवधि के दौरान अधिकारियों/कर्मचारियों को हिन्दी शिक्षण के योजना के अधीन प्रशिक्षण कार्य जारी है। अब तक संस्थान के कुल 97.27% अधिकारी/कर्मचारी इस योजना के अन्तर्गत प्रशिक्षित हो चुके है।

- राजभाषा कार्यान्वयन समिति की बैठकों का आयोजन : राजभाषा नियम/अधिनियम के प्रावधानों के सम्यक अनुपालन एवं समय-समय पर राजभाषा कार्यों की प्रगति/कमियों की समीक्षा हेतु संस्थान में प्रत्येक तिमाही के दौरान विभागीय राजभाषा कार्यान्वयन समिति की बैठकों का आयोजन कर कार्यान्वयन की दिशा में आने वाली कठिनाइयों का निदान किया जाता है। वर्तमान वर्ष 2019-20 के अंतर्गत राजभाषा कार्यान्वयन समिति की चार बैठकों का नियमित आयोजन क्रमश: दिनांक 14.05.2019, 27.09.2019, 05.12.2019 एवं 23.03.2020 को किया गया तथा बैठक में लिए गए निर्णयों पर अनुवर्ती कारवाई की गई।

- हिन्दी कार्यशाला का आयोजन: संस्थान में कार्यरत अधिकारियों/कर्मचारियों को हिन्दी में कामकाज करने में सुगमता हेतु प्रत्येक वर्ष हिन्दी कार्यशाला का आयोजन किया जाता है। कार्यशाला का आयोजन कर्मचारियों की कार्य प्रकृति के अनुसार अलगपदधारियों के /तथा प्रशासनिक संवर्ग के अधिकारियों अलग समूहों में किया जाता है। तकनीकी- लिए राजभाषा के विविध पहलुओं पर क्रमशः17.06.2019, 19.08.2019 ,26.11.2019 एवं 17.03.2020 को हिंदी कार्यशाला आयोजित कर संस्थान के कुल 78 पदधारीगण [अधिकारी - 47 एवं पदधारी – 31] राजभाषा हिन्दी में प्रशिक्षित किए गए तथा आगे भी यह क्रम जारी है।

- अधीनस्थ कार्यालयों/केन्द्रीय रेशम बोर्ड के अन्य कार्यालयों आंबटित कार्यालयों में हिन्दी कार्यशाला: संस्थान की संबद्ध इकाइयों में भी संघ की राजभाषा नीति के सफल कार्यान्वयन हेतु हिन्दी कार्यशालाओं का आयोजन किया जाता है। इस क्रम में संस्थान के कुल 04 अधीनस्थ केन्द्रों में भी हिन्दी कार्यशालाओं का आयोजन किया गया।

- राजभाषा प्रोत्साहन योजना का कार्यान्वयन: संस्थान एवं इसके संबद्ध/अधीनस्थ केन्द्रों में कार्यरत अधिकारियों तथा कर्मचारियों में राजभाषा हिन्दी के प्रति अभिरूचि जगाने हेतु समयसमय पर विभिन्न राजभाषा - कार्यक्रम/प्रतियोगिता का आयोजन किया जाता है। इन कार्यक्रमों द्वारा कर्मचारियों को प्रोत्साहित/पुरस्कृत करने के अलावा हिन्दी में मूल रूप से टिप्पणआलेखन करने वाले अधिकारियों-/कर्मचारियों के लिए केन्द्रीय रेशम बोर्ड की उदारीकृत प्रोत्साहन योजना को भी लागू किया गया है जिसके अर्न्तगत निर्धारित शब्द संख्या हिन्दी में लिखने पर

अनुपातत: नगद प्रोत्साहन राशि (महत्तम रू 5000.00) प्रदान की जाती है। हिन्दी दिवस/पखवाड़ा ,2019 के अवसर पर वर्ष 2018-19 के दौरान मूल रूप से हिन्दी में कामकाज करने हेतु कुल 15 पदधारियों को पुरस्कृत किया गया।

- हिन्दी पुस्तक/ पुस्तिकाओं का प्रकाशन: संघ की राजभाषा नीति के अनुसार संस्थान में अंग्रेजी प्रकाशनों के अनुरूप वैज्ञानिक एवं तकनीकी/प्रशासनिक प्रकाशनों का हिन्दी रूपांतरण तथा मूल रुप से हिंदी में लिखित पुस्तकें आवश्यकतानुसार प्रकाशित की जाती है। वर्तमान वर्ष के अंर्तगत संस्थान की वार्षिक वैज्ञानिक एवं प्रशासनिक रिपोर्ट वर्ष 2018-19 का सारांश हिंदी में प्रकाशित करने के अतिरिक्त आलोच्य अवधि के दौरान रेशम कृषि मेला के अवसर पर "सी-2038 [हिंदी व बंगला], शहतूत के लिए कम लागत वाली ड्रिप फर्टिगेशन प्रणाली [हिंदी व बंगला], शेल्फ रेशम कीटपालन [हिंदी व बंगला], गुणवत्ता युक्त कोसा उत्पादन हेतु प्लास्टिक कॉलेप्सिबल चंद्रिका [हिंदी व बंगला], शहतूत पीड़को का जैव-नियंत्रण [हिंदी व बंगला], सुवर्णा तथा सौरोनीर [हिंदी व बंगला], M6DPC [हिंदी व बंगला], शहतूत पौध में मूल विगलन [बंगला]" शीर्षक से दस लीफ्लेट प्रकाशित की गई।

- नगर राजभाषा कार्यान्वयन समिति का गठन एवं उसकी बैठकों का आयोजन: वर्ष 1997-98 के शुरूआत में ही राजभाषा विभागमें नगर राजभाषा कार्यान्वयन नई दिल्ली द्वारा संस्थान के निदेशक की अध्यक्षता ,भारत सरकार , बैठकों के नियमित आयोजन तथा बहरमपुर नगर स्थित केन्द्रीय ,समिति के गठन सरकार के कार्यालयों/बैंकों/निगमों/उपक्रमों/संगठनों आदि में संघ की राजभाषा नीति के सफल कार्यान्वयन का अतिरिक्त दायित्व निहित किया गया। वर्ष के दौरान समिति की 36वीं बैठक दिनांक 19.08.2019 को संपन्न की गई। समिति के प्रयास से नगर स्थित केन्द्रीय सरकार के कार्यालयों/बैंकों/निगमों/उपक्रमों/संगठनों आदि में भी राजभाषा गतिविधियां बढ़ी है। इसके अतिरिक्त ,अपने कार्यालयो में हिन्दी दिवस-नगर के सदस्य कार्यालय अपने , संगो ,गिताप्रतियोष्ठी कार्यशाला एवं बैठकों का आयोजन कर रहे है। समिति की उक्त गतिविधियों के संचालन से संस्थान में राजभाषा कार्यान्वयन संबंधी कार्यमात्रा में भी अत्याधिक वृद्धि हुई है।

- राजभाषा नियम 10(4) के अर्न्तगत अधीनस्थ कार्यालयों को अधिसूचित किया जाना: संस्थान के संबद्ध/अधीनस्थ केन्द्रों में कार्यरत 80% कर्मचारियों को हिन्दी प्रशिक्षण दिलाने के पश्चात ऐसे कार्यालयों को मंत्रालय द्वारा राजभाषा नियम-10(4) के अधीन अधिसूचित करने की कार्रवाई की जाती है। इस क्रम में संस्थान के 05 संबद्ध कार्यालयों को अधिसूचित कराया जा चुका है।

- हिन्दी प्रतियोगिता का आयोजन: वर्ष 2019-20 के दौरान दिनांक 02.09.19 से 16.09.19 तक आयोजित हिन्दी पखवाड़ा के अन्तर्गत विभिन्न हिन्दी प्रतियोगिता एवं मुख्य समारोह का आयोजन किया गया। इन प्रतियोगिता में संस्थान के अधिकारियों/ कर्मचारियों ने उत्साह से भाग लिया। इस दौरान कुल 04 हिन्दी प्रतियोगिताओं क्रमश: शब्दावली 02/09/2019, निबन्ध 03/09/2019, सुलेख व श्रुतिलेख 04/09/2019 तथा हिंदी टिप्पण व आलेखन प्रतियोगिता 05/09/19 का आयोजन किया गया। प्रत्येक प्रतियोगिता के सर्वश्रेष्ठ प्रतिभागियों को प्रथम ,द्वितीय , तृतीय एवं सांत्वना पुरस्कार से पुरस्कृत किए गए।

- कंप्यूटर पर हिन्दी में कार्य: राजभाषा अधिनियम-1963 की धारा 3(3) का अनुपालन ,प्रपत्र का द्विभाषीकरण/फार्म , त्मक विवरण अधीनस्थ केन्द्रों की तिमाही रिपार्ट का समेकीकरण एवं अनुभागीय प्रगति रिपोर्ट के तुलना /संबद्ध संपादन/आदि के संकलन एवं पत्रिका के प्रकाशन 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 साथ ही साथ, संस्थान की राजभाषा कार्यान्वयन समिति की बैठको में हिन्दी प्रगति से संबंधित आकड़ों का प्रस्तुतीकरण पावर-प्वाइंट के जरिये किया जा रहा है। ज्ञातव्य है कि संस्थान में बहुभाषी पैकेज "यूनिकोड" का संस्थापन कंप्यूटर पर किया गया है जिससे शब्द प्रक्रमण के अलावा आकड़ों के प्रक्रमणआंकड़ों के समेकीकरण में सहुलियत ,आरेखीय निरूपण , एवं गति आई है।

STAFF PROFILE (2019-20) as on March 2020				
Designation	**MI**	**RSRS**	**REC**	**Total**
Director	1			1
Scientists				
Scientist-D	9	1	6	16
Scientist-C	8	1	1	10
Scientist-B	9	2		11
Technical				
Deputy Director (Comp.)	1			1
Junior Engineer	2			2
Sr. Technical Asst.			1	1
Technical Asst.	48	16	18	82
Sr. Field Asst.			1	1
Field Asst.	1	3	9	13
Technician	8	1		9
Asst. Technician	5	2		7
Multi Tasking Staff	7	17	11	35
Skilled Farm Worker	38	12	8	58
Time-Scale Farm Worker	42	50	34	126
Accounts & Administration				
Deputy Director	1			1
Assistant Director	4			4
Superintendent	3	2		5
Asst. Supdt.	11	3		14
Stenographer-Grade-I		2		2
Jr. Translator (Hindi)	1			1
Staff Car Driver Grade-I	1	2	1	4
UDC	3	4		7
Stenographer-Grade-II	1			1
Staff Car Driver Grade-II	1	2		3
Cook	1			1
Total	216	120	90	416

बजट / Budget 2019-20

शीर्ष /Head	राशि/ Amount (रु. लाख़ में/ Rs. in lakhs)
प्लान-वेतन/ Plan-Salary	3725.26
प्लान-सामान्य / Plan-Gen	394.22
प्लान-कैपिटल / Plan-Cap	46.77
उत्तर-पूर्वी-सामान्य /NE-Gen	11.91
उत्तर-पूर्वी - कैपिटल / NE-Cap	10.25
कुल /Total	4381.89

R & D PERSONNEL

Director

Dr. V. Sivaprasad

CSRTI-BERHAMPORE

Scientist-D

Dr. Anil Kr. Verma
Mr. Debashish Chakravarty
Dr. Dipesh Pandit
Mr. Gautam Mitra
Mr. Gopal Chandra Das
Dr. Lakshmanan Velusamy
Dr. Soumen Chattopadhyay
Dr. Tapati Dutta (Biswas)
Dr. Sukhabrata Sarker

Scientist-C

Dr. Chadrakanth N
Dr. Mahesh R
Dr. Manjunatha G. R
Dr. Pooja Makwana
Dr. Rahul K
Dr. Shafi Afroz [from Aug 2019]
Dr. Suresh K
Dr. Vijay V

Scientist-B

Dr. Anil Pappachan
Dr. Aparna Kopparapu
Dr. Deepika Kumar Umesh
Ms. Immanuel Chongboi Haokip [upto Dec 2019]
Dr. Mihir Rabha
Dr. Parameshwaranaik, J
Ms. Radha, M. B
Dr. Raviraj, V.S
Dr. Thangjam Ranjita Devi
Mr. Yallappa Harijan

RSRS-KALIMPONG

Mr Zakir Hossain, Scientist-D
Dr. S. Harish Babu, Scientist-B

RSRS-KORAPUT

Mr S.K. Misro, Scientist-D [upto May 2019]
Mr. Khasru Alam, Scientist-B

RSRS-JORHAT

Mr. P. Kumaresan, Scientist-C
Mr. Chandan M [upto Aug 2019]

REC-MOTHABARI

Dr. Satadal Chakrabarty, Scientist-D

REC-BHANDRA

Dr. G. S. Singh, Scientist-D

REC-MAMRING (RONGPO)

Mr. S.T. Lepcha, Scientist-D [Rtd. on Aug 2019]

REC-DIMAPUR

Dr. Karthik Neog, Scientist-D [from May 2019]

REC-MONGALDAI

Mr. B. K. Basumatary, Scientist-D

REC-SHILLONG

Dr. Collin Z. Renthlei, Scientist-D

REC-AIZWAL

Dr. L. Pachuau, Scientist-D

REC-SILLE

Mr. Lohit Sonowal, Scientist-C

REC-AGARTALA

Dr. Narayan Biswas, Scientist-D [from Aug 2019]

ADMINISTRATIVE PERSONNEL

Mr. Mirza Ibrahim Baig (DD-A&A)
Mr. Prasad P.K (DD-Computer)
Mr. Abdul Latif Qureshi (AD-A&A; from Dec 2019)
Mr. Asim Kumar Batabyal (AD-A&A; Rtd. on Sept 2019)
Mr. Biswajit Halder (AD-A&A, upto Feb 2020)
Mr. Ram Briksh Choudhary (AD-OL)
Mr. Sanatan Tiadi (AD-A&A)
Mr. Subhasish Ghosh (AD-A&A; Rtd. on March 2020)

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), IIPhase, IIFloor Shillong - 793 001, Meghalaya
Scientist – D Reginal Silk Technological Res. 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

AWARDS & REWARDS

AWARDS

Dr. Sivaprasad V
Outstanding Contribution in Sericulture Award
(ACRIL-2019 International Seminar; Crop & Weed Science Society, India)

Dr. Mahesh R
Young Scientist Award (Agronomy)
(Society for Biotic & Environmental Research, Tripura)

Dr. Parameswaranaik J
Young Scientist Award-2019 (Agriculture Extension)
(Agri & Envtl Tech Dev Society, Uttarakhand)

Dr. Manjunatha G R
Young Scientist Award (Agriculture Statistics)
(NCRTNFBASE-2020 National Conference; Academy for Environment & Life Sciences, Agra)

Dr. Manjunatha G R
Best Oral Presentation Award
(ACRIL-2019 International Seminar; Crop & Weed Science Society, India)

DOCTORAL DEGREE

Dr. Suresh, K (Genetics & Plant Breeding; UAS-Bangalore)
Dr. Rahul, K (Biotechnology; JNTU-Hyderabad)
Dr. Pooja Makwana (Biotechnology; Univesrsity of Mysore)
Dr. Shafi Afroz (Agriculture Extension; IARI-NewDelhi)

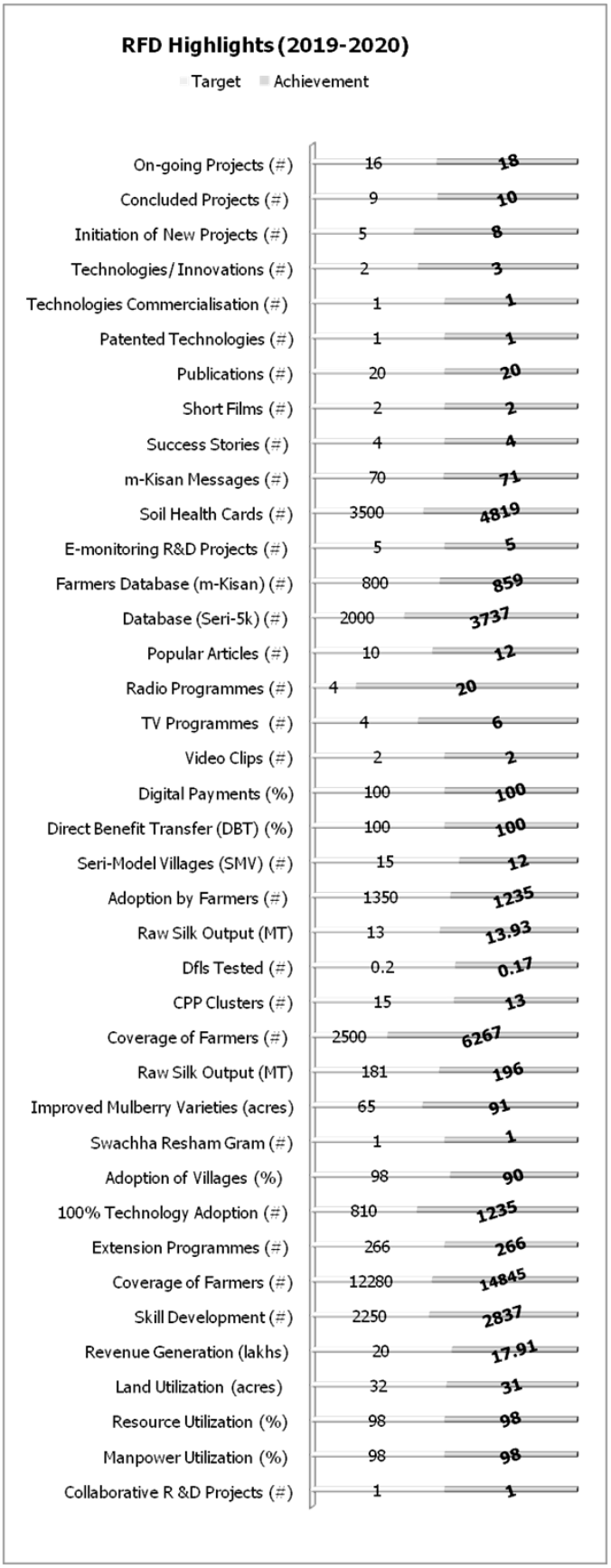
MFCS-PROMOTION

Scientist-C to Scientist-D

Dr. Sukhabrata Sarker
Dr. L. Pachuau

Scientist-B to Scientist-C

Dr. Chandrakanth, N
Dr. Manjunatha, G. R
Dr. Mahesh, R
Dr. Pooja Makwana
Dr. Vijay, V
Dr. Suresh, K
Mr. Shafi Afroz
Dr. Rahul, K



केरेउअवप्रसं-बहरमपुर की/ CSRTI-BERHAMPORE'S
आभार - विदाई / GRATEFUL FAREWELL

पदधारी /Employee	पदनाम /Designation	सेवानिवृत/ Retirement
श्री मुकुन्द दास/ Shri Mukunda Das	सहायक अधीक्षक (प्रशा.)/ Asst. Supdt (Admn)	मई /May 2019
श्री प्रदीप बनर्जी/ Shri Pradeep Banerjee	तकनीकी सहायक / Tech. Assistant	मई /May 2019
श्री शंकर विश्वास/ Shri Sankar Biswas	एमटीएस/MTS	जुलाई/July 2019
श्री असीम कुमार दास/ Shri Ashim Kumar Das	तकनीकी सहायक / Tech. Assistant	जुलाई/July 2019
श्री साइमन टी. लेप्चा/ Shri Simon T Lepcha	वैज्ञानिक-डी/Scientist-D	अगस्त/Aug 2019
श्री अशोक साहु/ Shri Ashok Sahoo	तकनीकी सहायक/ Tech. Assistant	अगस्त/Aug 2019
श्री नीलमणि चक्रबर्ती/ Shri Nilmoni Chakraborty	तकनीकी सहायक/ Tech. Assistant	सितम्बर/Sept 2019
श्री असीम कुमार ब्टब्याल/ Shri Asim Kumar Batabyal	सहायक निदेशक (प्रवले)/ Asst. Director (A&A)	अक्टू /Oct 2019
श्री संदीप कुमार राय/ Shri Sandip Kumar Ray	तकनीकी सहायक/ Tech. Assistant	अक्टू /Oct 2019
श्री शिबेस बिश्वास/ Shri Sibesh Biswas	तकनीकी सहायक/ Tech. Assistant	अक्टू /Oct 2019
श्री मो. अयुब अली खान/ Shri Md.Ayub Ali Khan	तकनीकी सहायक/ Tech. Assistant	नव/Nov 2019
श्री अरुप कुमार बसाक/ Shri Arup Kumar Basak	सहायक अधीक्षक (प्रशा.)/ Asst. Supdt (Admn)	नव/Nov 2019
श्री सुबल कुमार पाल/ Shri Subal Kumar Paul	तकनीकी सहायक/ Tech. Assistant	दिस/Dec 2019
श्री उत्तम कुमार मंडल/ Shri Uttam Kr Mandal	तकनीकी सहायक/ Tech. Assistant	जनवरी/Jan 2020
श्री सुब्रत भट्टाचार्य/ Shri Subrata Battacharya	तकनीकी सहायक/ Tech. Assistant	फरवरी/Feb 2020
श्री लोकेन कचारी/ Shri Loken Kachari	एमटीएस/MTS	फरवरी/Feb 2020
श्री सुरेश सरकार/ Shri Suresh Sarkar	एमटीएस/MTS	फरवरी/Feb 2020
श्री मनोरंजन ओरांव/ Shri Manoranjan Oraon	एमटीएस/MTS	फरवरी/Feb 2020
श्री घोष शुभाशीष/ Shri Ghosh Subhasish	सहायक निदेशक (प्रवले)/ Asst. Director (A&A)	मार्च/March 2020
श्री श्रीदाम चन्द्र दास/ Shri Sridam Chandra Das	एमटीएस/MTS	मार्च/March 2020

PUBLICATIONS

Research Articles

Afroz S, Singh R, Nain M S, Mishra J R, Kumar P, Iquebal M A and Khan S A, 2019. Problem Tree Analysis for delay in starting Agribusiness by trained candidates under ACABC scheme. **Indian Journal of Extension Education** [Accepted].

Afroz S, Singh R, Nain M S, Mishra J R, Kumar P, Iquebal M A and Khan S A, 2019. Content Analysis of the Training Curriculum of Agriclinics and Agribusiness Center (ACABC) scheme. **Journal of Community Mobilization and Sustainable Development** [Accepted].

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Kiran Kumar R Patil, B Chinnappa and G R Manjunatha, 2019. Economic analysis of value chain management in broiler chicken. **Indian Journal of Poultry Science**, 54 (2):169-174.

Kiran Kumar R Patil, B Chinnappa, G R Manjunatha and H S Sowmya, 2019. Eco-friendly Arecanut Leaf Sheath Products: An Economic Analysis. **Indian Journal of Ecology**, 46 (2): 431-436.

Kiran Kumar R Patil, M G Chandrakanth and G R Manjunatha, 2019. Impact of Probability of Well Success on Unit Cost of Irrigation in Karnataka. **Indian Journal of Ecology**, 46 (4):835-838.

M Kumar, L M Bhar, A Majumder, G R Manjunatha and H Das, 2019. BTIB Designs and their Efficiencies for Comparing Test versus Control Treatments with Correlated Observations. **Journal of the Indian Society of Agricultural Statistics**, 73 (3):245–251.

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Accession Number	Identified Organism/Genes	Source	Scientists Involved
LR735900	*Fusarium solani*	Mulberry root (Karjora, West Bengal)	Anil Pappachan Rahul K & V. Sivaprasad
LR735963	*F. solani*	Mulberry root (Pipulkhola, West Bengal)	
LR735964	*F. solani*	Mulberry root (Jorhat, Assam)	
LR735965	*F. solani*	Mulberry root (Sille, Arunachal Pradesh)	
LR735966	*Lasiodiplodia theobromae*	Mulberry root (Kolasib, Mizoram)	
MT221438	Pyrexia Polymorphisms (*pyx1 & pyx2*) for High Humidity	Bivoltine silkworms tolerant to high temperature & high humidity (CSRTI-Berhampore)	V.S. Raviraj N.Chandrakanth Sahadeb Roy V. Lakshamanan & V. Sivaprasad
MT221439			

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News & Views - Half Yearly R&D News Bulletin [English/Hindi; Vol.13 (1&2); 2019-2020

PAMPHLETS

সি–২০৩৮ সেচ সেবিত এবং বৃষ্টিনির্ভর অঞ্চলের জন্য নতুন তুঁত প্রজাতি
কম খরচে ফোঁটা ফোঁটা করে জল এবং সারপ্রয়োগ এর মাধ্যমে তুঁত চাষ
তাক পদ্ধতিতে পলুপালন
ভালো মানের গুটির জন্যে প্লাস্টিক কোলাপসিবল মাউন্টেজ
জৈবিক নিয়ন্ত্রণ পদ্ধতিতে তুঁত পাতাকে ক্ষতিকারক পোকা-মাকড় থেকে রক্ষার উপায় (মিলিবাগ এবং থ্রিপ্স)
সুভর্ণা (মোটর চালিত চরখা) সাথে সৌরনীর (সৌর জল গরম করার যন্ত্র)
উচ্চ রেশম উত্পাদনকারী নতুন সংকর প্রজাতি M6DPC x (SK6.7)
তুঁত গাছের শিকড় পচা রোগ নিয়ন্ত্রণে রটফিক্স' : একটি পরিবেশ বান্ধব বহুল বিস্তৃত কার্যকরী ঔষধ

C-2038 সিঁচিত এবং বর্ষাশ্রিত ক্ষেত্রাঁ কে লিএ নই শহতূত উপজাতি
শহতূত কে লিএ কম লাগত বালী ড্রিপ ফর্টিগেশন প্রণালী
শেল্ফ রেশমকীট পালন (প্ররোহ অশন)
গুণবত্তা যুক্ত কোসা উত্পাদন হেতু প্লাস্টিক কোলৈপ্সেবল চংদ্রিকা
জৈব নিযংত্রণ এর্জেট : শহতূত পীড়ক প্রবংধন (চূর্ণী মত্কুণ এবং থ্রিপ্স)
সুবর্ণা (মোটর চালিত চরখা) কে সাথ সৌরোনীর (সৌর জল তাপন ইকাই)
M6DPC x (SK6.7) নই বহুপ্রজ **x** দ্বিপ্রজ সংকর কে সাথ অধি-রেশম উত্পাদকতা

C-2038: A New Mulberry Variety for Irrigated Zone
Lowcost drip fertigation system for mulberry
Silkworm Shelf Rearing (Shoot Feeding)
Plastic Collapsible Mountages for Quality Cocoon Production
Biological Control Agents : Mulberry Pest Management (Mealybugs & Thrips)
SUVARNA (Motorized Charkha) with SOURONEER (Solar Water Heating Unit)
Training Calendar for the year 2020-21 (CSRTI-BHP)
M6DPC x (SK6.7) New Multi x Bivoltine Hybrid with High Silk Productivity

METEOROLOGICAL DATA

CSRTI-BERHAMPORE						RSRS-JORHAT					REC-MANGALDOI				
Month	Temp. (°C)		R H (%)		Rainfall (mm)	Temp. (°C)		R H (%)		Rainfall (mm)	Temp. (°C)		R H (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.		Max.	Min.	Max.	Min.		Max.	Min.	Max.	Min.	
Apr-19	40	16	85	44	192	25	21	83	60	302	38	16	91	61	418
May-19	41	23	94	51	156	26	22	82	63	270	34	20	91	62	522
Jun-19	40	23	91	56	75	31	27	85	64	297	39	23	93	63	253
Jul-19	39	25	98	61	87	34	19	89	52	273	38	24	92	63	331
Aug-19	37	25	92	56	105	36	21	92	62	154	39	26	92	63	119
Sep-19	37	22	95	69	140	28	24	87	74	228	37	22	92	68	453
Oct-19	37	19	94	57	162	27	23	85	80	469	31	19	92	69	153
Nov-19	34	15	91	44	5	26	20	83	74	5	31	16	91	65	6
Dec-19	31	8	86	63	1	18	16	82	76	12	26	9	90	65	0
Jan-20	27	9	93	52	31	20	18	79	73	60	24	9	89	60	45.5
Feb-20	32	10	89	53	0	23	19	76	67	3	28	10	90	55	8.5
Mar-20	39	14	94	53	8	27	22	63	59	0	28	10	90	51	66.5
Total/Avg	36	18	94	55	962	27	21	82	67	2073	33	17	91	62	2375
RSRS-KALIMPONG						**REC-DIMAPUR**					**REC-AIZWAL**				
Apr-19	31	13	100	32	23	26	19	74	65	49	38	15	98	74	40
May-19	32	16	100	40	12	31	22	74	66	34	37	22	98	46	25
Jun-19	34	18	100	38	11	32	24	88	68	239	31	19	98	76	41
Jul-19	34	20	100	49	226	36	25	90	74	141	31	19	98	65	55
Aug-19	35	20	100	45	23	36	24	93	75	110	33	20	100	70	46
Sep-19	34	17	100	44	0	32	30	84	76	114	31	18	97	71	29
Oct-19	32	14	100	32	0	29	24	76	66	244	33	20	100	70	46
Nov-19	29	13	98	38	0	27	16	80	65	31	30	13	95	45	48
Dec-19	27	6	98	19	0	24	20	73	62	0	24	9	95	41	5.2
Jan-20	22	4	100	37	0	24	9	75	60	18	26	7	97	38	45
Feb-20	26	7	100	16	0	23	21	86	74	26	30	7	94	34	6
Mar-20	28	11	95	36	0	31	22	74	66	34	31	5	92	58	32
Total/Avg	30	13	99	36	294	29	21	81	68	1043	26	13	81	46	418
RSRS-KORAPUT						**REC-AGARTALA**					**REC-SHILLONG**				
Apr-19	36	21	84	27	37	33	20	92	51	85	25	9	90	48	133
May-19	37	21	83	32	101	33	23	96	65	91	28	11	98	42	216
Jun-19	35	21	91	46	211	33	23	96	70	107	28	13	98	57	231
Jul-19	30	20	100	70	536	32	23	92	67	367	29	15	98	60	509
Aug-19	27	20	100	76	512	33	25	92	67	104	30	16	96	59	108
Sep-19	29	21	100	69	301	32	25	92	70	101	27	16	93	63	217
Oct-19	28	19	92	63	167	30	22	92	70	89	26	14	98	72	111
Nov-19	26	15	100	47	0.5	28	21	96	70	33	25	10	100	60	258
Dec-19	25	13	91	46	4	24	14	90	55	0	22	6	96	29	0
Jan-20	26	12	100	25	10	22	13	91	52	0	19	3	96	30	5
Feb-20	27	14	91	30	24	28	12	91	40	0	16	1	98	58	0
Mar-20	32	16	91	31	52	30	19	88	51	0	19	4	98	45	55
Total/Avg	30	18	94	47	1955	30	20	92	61	977	25	10	97	55	1844

Mulberry Acerage (ha) in East & North East India					
States	2016-17	2017-18	2018-19	2019-20 (P)	Growth Rate
Arunachal Pradesh	100	140	300	278	1.78
Assam & BTC	7898	8594	2783	2539	-0.68
Bihar	421	557	598	577	0.37
Chhattisgarh	322	261	261	242	-0.25
Jharkhand	372	472	502	606	0.63
Manipur	7548	3590	3300	3300	-0.56
Meghalaya	3209	3209	3209	3289	0.02
Mizoram	4009	4094	4094	1698	-0.58
Nagaland	290	290	394	694	1.39
Odisha	686	464	537	537	-0.22
Sikkim	198	185	185	300	0.52
Tripura	2450	2184	1935	2064	-0.16
West Bengal	15990	16480	15400	15721	-0.02
India	216810	223927	235001	239676	0.11
E & NE Share (%)	20%	18%	14%	13%	

Mulberry Raw Silk Production (MT) in East & North East India					
States	2016-17	2017-18	2018-19	2019-20 (P)	Growth Rate
Arunachal Pradesh	2	2.3	3	3	0.55
Assam & BTC	52	59	69	69	0.32
Bihar	23	17	8	2	-0.92
Chhattisgarh	8	8.3	9	8	-0.04
Jharkhand	1	3	3	3	1.86
Manipur	161	92.5	137	150	-0.07
Meghalaya	28	39	49	54	0.93
Mizoram	65	75	83	93	0.43
Nagaland	8	12	13	12	0.48
Odisha	3	3	3	2	-0.33
Sikkim	6	0.001	0.4	1	-0.83
Tripura	75	87	230	94	0.25
West Bengal	2524	2570	2365	2428	-0.04
India (Mulberry Silk)	21273	22066	25345	25384	0.19
E & NE Share	14%	13%	12%	11%	
India (Raw Silk)	30348	31906	35468	36152	0.19
Mulberry Silk Share	70%	69%	71%	70%	