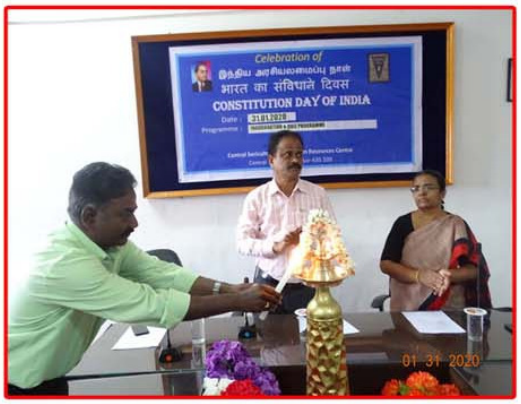

वार्षिक प्रतिवेदन
ANNUAL REPORT
2019-20
केन्द्रीय रेशम जननद्रव्य संसाधन केन्द्र
CENTRAL SERICULTURAL GERMPLASM RESOURCES CENTRE
केन्द्रीय रेशम बोर्ड , वस्त्र मंत्रालय, भारत सरकार, होसूर
Central Silk Board, Ministry of Textiles, Govt. of India, Hosur - 635 109

Visit of Sericulture Experts for the Meeting to formulate Strategy for Effective Maintenance and Utilisation of Seri-Genetic Resources

Visit of the Chairman, Central Silk Board

Visit of students from
Sher-e-Kashmir University, Kashmir



Constitution day of India

वार्षिक प्रतिवेदन

ANNUAL REPORT
2019 - 20

केन्द्रीय रेशम जननद्रव्य संसाधन केन्द्र

Central Sericultural Germplasm Resources Centre

केन्द्रीय रेशम बोर्ड, वस्त्र मंत्रालय, भारत सरकार, होसूर - 635 109

Central Silk Board, Ministry of Textiles, Govt. of India, Hosur- 635 109

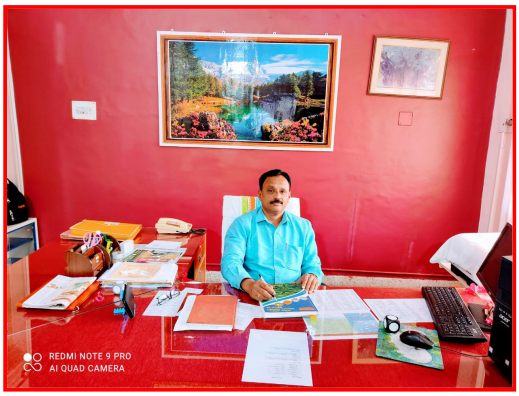
CREDIT LINE

Editor - in – Chief &	Dr. R. K. Mishra
Published by	Director (Addl. charge) Dr. B.T. Sreenivasa Director Central Sericultural Germplasm Resources Centre Central Silk Board P.B. NO. 44, Thally Road Hosur – 635 109, Tamil Nadu Phone: 04344 222013 e-mail: csgrchos.csb@nic.in website: www.csgrc.res.in
Editors	Dr. C.M. Kishor Kumar, Scientist-D Dr. Geetha N**.** Murthy, Scientist-D
Compiled by	Dr. Geetha N**.** Murthy, Scientist-D Dr. M. Maheswari, Scientist-D Dr. Jameela Khatoon, Scientist-D(R&S)
Cover Page Design & DTP	Shri S. Sekar, Assistant Director (Computer)
Photography	Dr. G. Thanavendan, Scientist-C Shri Bairwa N. Kumar M., Lib. & Info. Asst.
Hindi Translation & Editing	Smt. V. S. Sheeba, Junior Translator (Hindi) Dr. Geetha N. Murthy, Scientist-D
Printed at	Visruti Prints, Bengaluru

Disclaimer

The Annual Report of CSGRC includes the research work related to the experiments conducted during the year 2019-20 and they are not conclusive recommendations or findings of the department unless or otherwise stated in this report. The data is under the process of publication in due course. No part of this report should be reproduced in any form, or by any process without prior permission of the Director, CSGRC, Hosur except in quoting for scientific references.

प्रस्तावना



केन्द्रीय रेशम जननद्रव्य संसाधन केन्द्र, होसूर, मुख्य अनन्य केंद्र है जो भावी पीढ़ी हेतु सीरी जैव विविधता के समग्र संरक्षण के लिए प्रतिबद्ध है। केंद्र के पास 1299 से अधिक शहतूत एवं 489 रेशमकीट आनुवंशिक संसाधनों का मूल्यवान संग्रह है, जो व्यवस्थित रूप से संरक्षित हैं। इस केंद्र को शहतूत जननद्रव्य के लिए राष्ट्रीय पादप आनुवंशिक संसाधन ब्यूरो (एनबीपीजीआर), आईसीएआर, नई दिल्ली द्वारा राष्ट्रीय सक्रिय जननद्रव्य साइट (रासजस) के रूप में मान्यता प्राप्त है तथा रेशमकीट जननद्रव्य को राष्ट्रीय कृषि कीट संसाधन ब्यूरो (एनबीएआईआर), आईसीएआर, बेंगलुरु द्वारा मान्यता प्राप्त है। तदनुसार, पूर्वोक्त संस्थानों द्वारा शहतूत एवं रेशमकीट आनुवंशिक संसाधनों के संग्रह को अद्वितीय राष्ट्रीय अभिगम संख्याएँ दी गई हैं। केंद्र ने एम.फिल और पीएचडी के शोध कार्यक्रमों को करने के लिए उन्नत अनुसंधान केंद्र के रूप में पेरियार विश्वविद्यालय, सेलम, तमिलनाडु से भी मान्यता प्राप्त की हैं।

वर्ष के दौरान, मेघालय के गारो हिल्स जिले के तुरा क्षेत्र से 18 नए शहतूत जननद्रव्य तथा केरेउअएवंप्रसं, पंपोर से 01 अभिगम को एकत्र किया गया। इसी प्रकार, केरेउअएवंप्रसं, बरहामपुर से प्राप्त किए गए 14 रेशमकीट आनुवंशिक संसाधन स्टॉक को संगरोध कीटपालन के बाद संस्थान अभिगम संख्याएं दी गई। शहतूत आनुवांशिक संसाधनों के मूल्यांकन ने कई विशेषकों हेतु 10 आशाजनक अभिगमों की पहचान की। इसी प्रकार, विशिष्ट एवं कई गुणसूत्र शीर्ष दस आशाजनक रेशमकीट आनुवंशिक संसाधनों की पहचान की। शहतूत (85 विदेशी और 287 स्वदेशी अभिगम) और रेशमकीट (15 बहुप्रज अभिगम) आनुवंशिक संसाधनों को अनुसंधान उद्देश्यों हेतु जरूरतमंद मांगकर्ताओं को आपूर्ति की गई।

"जलवायु परिवर्तन में लचीलापन हेतु कार्यात्मक लक्षणों के लिए शहतूत के आनुवंशिक संसाधनों का मूल्यांकन" नामक समाप्त परियोजना के तहत पांच अभिगम अर्थात; एमआई-0437 (एफ), एमआई-0400 (एफ), एमआई-0686 (एम), एमआई-0762 (एफ) और एमआई-0251 (एफ) अत्यधिक अनुकूल होने का पता चला और शहतूत प्रजनन को लागू करने वाले संस्थानों द्वारा उठाए गए प्रजनन कार्यक्रमों में दाता माता-पिता के रूप में सहायता कर सकते हैं। जैव रासायनिक लक्षण अर्थात, ग्लूटामेट सिंथेज़ गतिविधि और एस्कॉर्बिक एसिड सामग्री जिसे सूखा सहिष्णुता के लिए सहसंबद्ध माना जाता है जो

बायोमास, शूट वजन और पत्ती वजन करने के लिए सकारात्मक संबंध के साथ उक्त कार्यात्मक विशेषता के लिए वांछित जीनोटाइप की पहचान हेतु स्क्रीनिंग टूल के रूप में कार्य कर सकता है। विभिन्न कृषि-जलवायु वाले स्थानों पर सीएसआर2 / सीएसआर4 के साथ चयनित विदेशी द्विप्रज और बहुप्रज रेशमकीट के संयोजन के मूल्यांकन ने क्षेत्र-विशिष्ट उच्च निर्वाहकों की पहचान की जो संभावित माता-पिता के रूप में कार्य कर सकते है।

मैं केन्द्रीय रेशम बोर्ड, बैंगलूरु के सदस्य सचिव, अनुसंधान सलाहकार समिति के अध्यक्ष एवं उनकी टीम के सदस्यों को सक्रिय पारस्परिक विचार-विमर्श तथा अनुसंधान गतिविधियों में सुधार एवं उपयुक्त सुझावों के लिए तहे दिल से धन्यवाद ज्ञापित करता हूँ। मैं अपने सभी सहकर्मियों को उनके द्वारा प्रदत्त योगदान एवं उपलब्धियों की सराहना कर बधाई देता हूँ । सुधार हेतु आपके बहुमूल्य सुझावों का स्वागत है।

बी.टी. श्रीनिवास

दिनांक: 29.01.2021 निदेशक

PREFACE

The Central Sericultural Germplasm Resources Centre, Hosur is the premier exclusive centre committed to overall conservation of seri-biodiversity for posterity. The Centre has a valuable collection of more than 1299 mulberry and 489 silkworm genetic resources that are systematically conserved. The centre is recognized by National Bureau of Plant Genetic Resources (NBPGR), ICAR, New Delhi as a National Active Germplasm Site (NAGS) for mulberry germplasm and by National Bureau of Agricultural Insect Resources (NBAIR), ICAR, Bengaluru for silkworm germplasm. Accordingly, the collection of mulberry and silkworm genetic resources have been assigned unique National Accession numbers by the aforesaid institutes. The centre also obtained recognition as Advanced Research Centre for conducting research in M.Phil. and Ph.D Programmes from Periyar University, Salem, Tamilnadu.

During the year, 18 new mulberry germplasm were collected from Tura region of Garo Hills District, Meghalaya and 01 accession from CSR&TI, Pampore. Similarly, the 14 silkworm genetic resource stock received from CSR&TI, Berhampore were given institute accession numbers after quarantine rearing. The evaluation of the mulberry genetic resources identified 10 promising accessions for multiple traits. Similarly, individual and multiple trait–wise top ten promising silkworm genetic resources were identified. Mulberry (85 exotic and 287 indigenous including fruiting accessions) and silkworm (15 multivoltine) genetic resources were supplied for research purposes to needy indenters.

Under the concluded project entitled "Evaluation of mulberry genetic resources for functional traits for resilience to climate change" five accessions viz., MI-0437 (F), MI-0400 (F), MI-0686 (M), MI-0762 (F) and ME-0251 (F) revealed to be highly adaptive and could serve as donor parents in breeding programs taken up by the institutes implementing mulberry breeding. The biochemical traits viz., glutamate synthase activity and ascorbic acid content known to be correlated to drought tolerance with positive correlation to biomass, shoot weight and leaf weight can function as screening tools for identifying desired genotypes for the said functional trait. Evaluation of combinations of selected multivoltine and exotic bivoltine silkworm accessions with CSR2 / CSR4 at different agro-climatic locations identified region-specific top performers that could function as potential parents.

I express my sincere thanks to the Member Secretary, Central Silk Board, Bangalore, Chairperson, RAC as well as members and other experts for their insightful guidance and suggestions for improvement of research activities. I congratulate and appreciate all my colleagues for their achievements and contributions. Any suggestions for improvement of the annual report are solicited.

Date: 29.01.2021 Director

CONTENTS

1. अनुसंधान की रूपरेखा

केंद्रीय रेशम जननद्रव्य संसाधन केन्द्र, होसूर भारत का प्रमुख अनन्य केंद्र है जो भावी पीढ़ियों के लिए शहतूत एवं रेशमकीट जैव विविधता के संरक्षण के लिए प्रतिबद्ध है। इस केंद्र को "राष्ट्रीय सक्रिय जननद्रव्य साइट" की मान्यता पर, इस केंद्र मैं अनुरक्षित शहतूत एवं रेशमकीट जननद्रव्य को राष्ट्रीय पादप आनुवंशिक संसाधन ब्यूरो (एनबीपीजीआर), आईसीएआर, नई दिल्ली तथा राष्ट्रीय कृषि कीट संसाधन ब्यूरो (एनबीएआईआर), आईसीएआर, बेंगलुरु द्वारा मान्यता प्राप्त है। वर्ष 2019-20 के लिए केंद्र के अनुसंधान विशेषताएँ निम्नलिखित हैं:

शहतूत विभाग

क्षेरेअसं, अनंतपुर (उच्च तापमान एवं कम वर्षा), केरेजसंके, होसूर एवं केरेउसंएवंप्रसं, मैसूर (अनुकूल जलवायु) में 39 चयनित शहतूत आनुवंशिक संसाधनों के मूल्यांकन ने संबंधित चेक किस्मों की तुलना में नौ अभिगमों की पहचान की अर्थात, केरेजसंके, होसूर में एमआई -0400, एमआई -0376, एमआई -0214, एमई -0007, एमआई -0762, एमआई -0686, एमआई -0763, एमई -0251 तथा एमआई -0568 सर्वोत्कृष्ट प्रदर्शन करने अभिगमों की पहचान की गई; आठ अभिगम अर्थात, एमआई **-0437**, एमआई **-0310**, एमआई **-0683**, एमई **-0173**, एमआई **-0246**, एमआई **-0685**, एमआई **-0762** और एमई **-0256** केरेउसंएवंप्रसं, मैसूर में और क्षे रे अ सं, अनंतपुर में एमई -0256।

तुरा क्षेत्र के गारो हिल्स जिला, मेघालय में एक खोजपूर्ण सर्वेक्षण किया गया और 18 नए शहतूत जननद्रव्य एकत्र किए गए जो पौधशाला में स्थापना के अधीन हैं।

रूपात्मक मापदंडों के लिए (15 वर्णनकर्ता), एनाटोमिकल (10 वर्णनकर्ता), प्रारंभिक विकास एवं उपज (24 वर्णनकर्ता) और वंश-वृद्धि (16 वर्णनकर्ता) 23 अभिगमों के एक नए सेट को विशेषित किया और डेटा को शहतूत जननद्रव्य सूचना प्रणाली (MGIS) डेटाबेस में अद्यतन किया गया।

रेशमकीट विभाग

रेशमकीट आनुवांशिक संसाधनों के संग्रह, विशेषण, मूल्यांकन और संरक्षण के निरंतर कार्यक्रम में, आगे के पंजीकरण एवं अभिगमन हेतु केरेउअएप्रसं, बरहमपोर से एकत्र किए 14 नए रेशमकीट नस्लों के लिए दूसरा संगरोध कीटपालन किया गया।

रेशमकीट आनुवंशिक संसाधनों के संरक्षण एवं रखरखाव के तहत, 475 (83 बहुप्रज, 369 द्विप्रज और 23 उत्परिवर्ती) अभिगमों को रोग मुक्त परिस्थितियों में पूर्ण रूप से लक्षण वर्णन एवं मूल्यांकन के बाद संरक्षित किया गया तथा डेटाबेस को रेशमकीट जननद्रव्य सूचना प्रणाली (रेजसूप्र) में अद्यतन किया गया।

परियोजना "एआईबी 3577: दक्षिणी एवं पूर्वी भारत के लिए उपयुक्त संकर प्रजातियों को विकसित करने हेतु संभावित वंशावली की पहचान करने के लिए बहुप्रज जननद्रव्य के मूल्यांकन" शीर्षक के तहत, 12 कीटपालन एवं 3 कोसोत्तर विशेषकों हेतु तीन विभिन्न मौसमों में केरेजसंके, होसूर, केरेउअएप्रसं, मैसूर व केरेउअएप्रसं, बरहमपोर में मूल्यांकित किए गए कुल इक्यासी बहुप्रज अभिगमों का मूल्यांकन किया गया। अध्ययन के परिणामस्वरूप, अभिगम अर्थात; बीएमआई -0025, बीएमआई -0079 व बीएमआई -0048 ने सभी परीक्षण केंद्रों में अपनी श्रेष्ठता दर्ज की और उनकी उपयोगिता को बेहतर पैतृक नस्लों के रूप में साबित किया और क्षेत्रीय विशिष्ट प्रजाति/ नस्ल सुधार कार्यक्रमों हेतु उक्त को प्रजनन कार्यक्रमों में उपयोग किया जा सकता है।

परियोजना "एआईबी 3578: पैतृक आनुवंशिक संसाधनों की पहचान करने हेतु विदेशी द्विप्रज रेशमकीट नस्लों का मूल्यांकन" शीर्षक के तहत, विभिन्न कृषि-जलवायु के स्थान अर्थात, केरेजसंके, होसूर, केरेउअएप्रसं, मैसूर, केरेउअएप्रसं, बरहमपोर व पैम्पोर में सीएसआर2 / सीएसआर4 के साथ संकरित कर चयनित किए गए 20 विदेशी द्विप्रज अभिगमों के संयोगों का मूल्यांकन किया गया । परिणामों से यह पता चला कि, अंडाकार विदेशी द्विप्रज अभिगम अर्थात; बीबीई -0201, बीबीई -0154 व बीबीई -0163 तथा डम्बल विदेशी द्विप्रज अभिगम अर्थात; बीबीई -0267, बीबीई -0197 व बीबीई -0169 ने सभी केंद्र में समान रूप से प्रादर्शित किया। इन अभिगमों का उपयोग संबंधित क्षेत्रों में वाणिज्यिक उपयोग के लिए एकल संकर तथा दोहरा संकर तैयारी हेतु किया जा सकता है।

4 प्राइमर अर्थात; एलएफएल 1123, एस 0809, एस 0329 और एस 0813 का उपयोग करते हुए ताप-सहिष्णुता से जुड़े मार्करों की उपस्थिति के लिए कुल 40 द्विप्रज अभिगमों की जांच की गई। इन अभिगमों में से, 10 द्विप्रज रेशमकीट अभिगम अर्थात; बीबीआई -0086, बीबीआई -0044, बीबीई -0184, बीबीआई -0301, बीबीआई -0334, बीबीआई -0336, बीबीआई -0338, बीबीआई -0339, बीबीआई -0343 और बीबीआई -0358 को ताप-सहिष्णुता से जुड़े मार्करों की पहचान की गई।

1. RESEARCH HIGHLIGHTS

The Central Sericultural Germplasm Resources Centre, Hosur is the premier exclusive centre in India committed to overall conservation of mulberry and silkworm biodiversity for posterity. The Centre is recognized by the National Bureau of Plant Genetic Resources (NBPGR), ICAR, New Delhi as a National Active Germplasm Site (NAGS) for mulberry germplasm and by the National Bureau of Agricultural Insect Resources (NBAIR), ICAR, Bengaluru for silkworm germplasm. The following are the research highlights of the centre for the year 2019-20:

Mulberry Division

Evaluation of 39 selected mulberry genetic resources at RSRS, Ananthapur (high temperature and low rainfall) and CSGRC, Hosur & CSR&TI, Mysuru (favorable climate) identified nine accessions Viz.,MI-0400, MI-0376, MI-0214, ME-0007, MI-0762, MI-0686, MI-0763, ME-0251 and MI-0568 as top performers at CSGRC Hosur; eight accessions Viz., MI-0437, MI-0310, MI-0683, ME-0173, MI-0246, MI-0685, MI-0762 and ME-0256 at CSR&TI Mysore and 11 accessions Viz., MI-0439, MI-0437, MI-0400, ME-0107, MI-0332, MI-0686, ME-0253, ME-0251, MI-0458, MI-0139 and ME-0256 at RSRS Ananthpur compared to respective check varieties.

Exploratory survey was conducted in Tura region of Garo Hills District, Meghalaya and 18 new mulberry germplasm were collected which are under establishment in the nursery.

A new set of 23 accessions were characterized for morphological (15 descriptors), anatomical (10 descriptors), preliminary growth and yield (24 descriptors) and propagation (16 descriptors) parameters and the data was updated in the Mulberry Germplasm Information System (MGIS) database.

Silkworm Division

In the ongoing programme of Collection, Characterization, Evaluation and Conservation of Silkworm Genetic Resources, second quarantine rearing was conducted for 14 new silkworm races collected from CSR&TI, Berhampore, for further registration and accessioning.

Under conservation and maintenance of silkworm genetic resources, 475 (83 multivoltine, 369 bivoltine and 23 mutants) accessions were conserved under disease free conditions after thorough characterization and evaluation and the database was updated in the Silkworm Germplasm Information System (SGIS).

Under the project entitled “AIB 3577: Evaluation of multivoltine germplasm to identify potential parents for developing cross breeds suitable for Southern and Eastern India” a total of 81 multivoltine accessions conserved at CSGRC, Hosur were evaluated at CSGRC, Hosur, CSRTI, Mysore and CSRTI, Berhampore in three different seasons for 12 rearing and 3 post cocoon traits. As an outcome of the study, the accessions Viz., BMI-0025, BMI-0079 and BMI-0048 recorded their superiority at all test centres proving their utility as better parental breeds and the same can be used in the breeding programmes for region specific race / breed improvement programmes.

Under the project entitled "AIB-3578: Evaluation of exotic bivoltine silkworm breeds to identify promising parental genetic resources", combinations of bivoltine accessions crossed with CSR2 / CSR4 were evaluated at different agro-climatic locations Viz., CSGRC Hosur, CSR&TI, Mysuru, Berhampore and Pampore. The results revealed that, the oval exotic bivoltine accessions Viz., BBE-0201, BBE-0154 and BBE-0163 and dumbbell exotic bivoltine accessions Viz., BBE-0267, BBE-0197 and BBE-0169 performed similarly in all the centres. These accessions can be utilized for single and double hybrid preparation for commercial utilization in the respective regions.

A total of 40 bivoltine accessions were screened for the presence of markers linked to thermotolerance using 4 primers Viz., LFL1123, S0809, S0329 and S0813. Out of these accessions, 10 bivoltine silkworm accessions Viz., BBI-0086, BBI-0044, BBE-0184, BBI-0301, BBI-0334, BBI-0336, BBI-0338, BBI-0339, BBI-0343 and BBI-0358 were identified showing markers linked to thermotolerance.

2. परिचय

केंद्रीय रेशम जननद्रव्य संसाधन केंद्र (केरेजसंके), होसुर जागरूकता निर्माण और कर्मियों के प्रशिक्षण के साथ-साथ शहतूत और रेशम के कीटाणु जननद्रव्य संसाधनों को इकट्ठा करने, परिचय देने, मूल्यांकन और संरक्षण करने वाला प्रमुख विशेष संस्थान है। केंद्रीय रेशम बोर्ड ने केंद्र को प्रजनकों के ग्रन्थकारिता अधिकारों की रक्षा के लिए जननद्रव्य पंजीकरण समिति के माध्यम से विभिन्न संस्थानों द्वारा विकसित स्वदेशी संसाधनों को पंजीकृत करने के लिए अधिकृत किया है। नेशनल ब्यूरो ऑफ प्लांट जेनेटिक रिसोर्सेज, आई सी ए आर, नई दिल्ली और नेशनल ब्यूरो ऑफ एग्रीकल्चर कीट रिसोर्सेज, आई सी ए आर, बेंगलुरु ने केंद्र को क्रमशः शहतूत और रेशम के कीटाणु जननद्रव्य के लिए "नेशनल एक्टिव जर्मप्लाज्म साइट्स" के रूप में मान्यता दी है। पूर्वोक्त संस्थानों ने इस केंद्र में संरक्षित जननद्रव्य के लिए राष्ट्रीय परिग्रहण संख्याएँ दी हैं। केरेजसंके होसुर फसल सुधार में प्रजनकों के लाभ के लिए बेहतर प्रदर्शन करने वाले पैतृक स्टॉक की पहचान के उद्देश्य से सीरगेनेटिक संसाधनों के लक्षण वर्णन और मूल्यांकन पर कई भीतरी और सहयोगी परियोजनाओं को लागू कर रहा है।

अधिदेश

- संग्रह, संरक्षण, प्रलेखन, मूल्यांकन का उपयोग करना और रेशम जननद्रव्य संसाधनों पर अनुसंधान।
- अन्य के रे बो अ व प्र संस्थानों के सहयोग से हितधारकों के लिए जननद्रव्य का सतत उपयोग।
- रेशम जननद्रव्य संसाधनों के संरक्षण और उपयोग पर हितधारकों की जागरूकता और प्रशिक्षण का सृजन।

गतिविधियाँ

- *शहतूत और रेशमकीट जननद्रव्य की खोज, संग्रह और परिचय।*
- *आनुवांशिक संसाधनों के उपयोग को बढ़ावा देने के लिए लक्षण वर्णन, वर्गीकरण, प्रारंभिक मूल्यांकन, राष्ट्रीय अभिगमन और जननद्रव्य संग्रह की सूची बनाना।*
- *रेशम उत्पादन विषयक आनुवांशिक संसाधनों के दीर्घकालिक राष्ट्रीय भंडार के रूप में सेवा करना।*
- *जननद्रव्य संसाधनों के पंजीकरण और संदर्भ केंद्र के लिए नोडल एजेंसी के रूप में कार्य करना।*
- *जननद्रव्य के परीक्षण / मूल्यांकन के लिए अंतर-संस्थागत सहयोग में प्रमुख भूमिका।*
- *आनुवंशिक संसाधनों के आयात और निर्यात का समन्वय।*
- *राष्ट्रीय डेटाबेस और हर्बेरियम / रेशम आनुवंशिक संसाधनों के प्रदर्शन के रूप में सेवा करें।*

- *जरूरतमंद संगठनों को उनकी आपूर्ति के माध्यम से जननद्रव्य के उपयोग को बढ़ावा देना।*
- *रेशम उत्पादन विषयक जननद्रव्य संसाधन प्रबंधन में प्रशिक्षण देना।*

रेसल्ट्स फ्रेमवर्क डोकुमेंट [आर एफ डी]

दृष्टिकोण

रेशम आनुवंशिक संसाधनों के पंजीकरण, मूल्यांकन, संरक्षण के लिए नोडल एजेंसी बनना।

मिशन

भारत में रेशम आनुवंशिक संसाधनों को पंजीकृत करना, फसल सुधार कार्यक्रम के लिए रेशम आनुवंशिक संसाधनों के उपयोग को सुविधाजनक बनाने के लिए अनुसंधान गतिविधियाँ, राष्ट्रीय भावी पीढ़ी को विलुप्त होने से बचाने के लिए रेशम आनुवंशिक संसाधनों का संरक्षण।

रोड मैप

लघु अवधि योजनाएं

1. विभिन्न राज्यों में अस्पष्टीकृत क्षेत्रों का सर्वेक्षण करें और आनुवंशिक स्टॉक को समृद्ध करने के लिए नए शहतूत आनुवंशिक संसाधनों के संग्रह के लिए अलग-अलग देशों से मार्ग का पता लगाएं।
2. विविधता और जीन समृद्धि के केंद्रों में शहतूत आनुवंशिक संसाधनों के सीटू संरक्षण में संवर्धन।
3. तनाव के प्रति सहिष्णु संसाधनों की पहचान के लिए हॉटस्पॉट क्षेत्रों में आनुवंशिक संसाधनों का मूल्यांकन।
4. शहतूत आनुवांशिक संसाधनों की सुरक्षा के लिए जलवायु लचीला रेशम उत्पादन को अपनाना।
5. आनुवंशिक वृद्धि के लिए पूर्व प्रजनन कार्यक्रमों का कार्यान्वयन।
6. अजैविक और जैविक तनाव के लिए रेशमकीट आनुवंशिक संसाधनों का मूल्यांकन।
7. मार्करों के माध्यम से सेरी-आनुवंशिक संसाधनों का आणविक लक्षण वर्णन।

दीर्घकालिक योजनाएं

1. एनबीपीजीआर, नई दिल्ली / आईएससी, सीएसबी कॉम्प्लेक्स, बैंगलोर के माध्यम से विदेशी शहतूत (मॉरस) प्रजातियों का परिचय।
2. इको फ्रेंडली और जैविक कृषि तकनीकों को अपनाना।
3. शहतूत प्रजनकों द्वारा नवीन जीनों / एलील्स के उपयोग और बेस चौड़ीकरण के साथ-साथ हेटेरोसिस के दोहन के लिए जंगली जीनों के अंतःक्षेपण के लिए प्रीब्रीडिंग कार्यक्रमों का कार्यान्वयन।

4. संरचित और टिकाऊ ऑन-फार्म का कार्यान्वयन और अपने मूल कृषि-पारिस्थितिक वातावरण में भूमि के संरक्षण का इन सीटू संरक्षण।
5. शहतूत और रेशमकीट जीन बैंकों के लिए एक्स सीटू संरक्षण रणनीतियों का उन्नयन, लागत प्रभावी संरक्षण के लिए उन्नत जैव प्रौद्योगिकी के साधनों को अपनाना।
6. आनुवंशिक वृद्धि के लिए पूर्व प्रजनन कार्यक्रम में उपयोग हेतु आणविक उपकरणों का उपयोग करके जंगली और भूमि जाति में होनहार जीन की पहचान।
7. केंद्र के एक आवश्यक अधिदेश के रूप में जीनोमिक्स को शामिल करके विभिन्न अजैविक तनावों / कार्यात्मक लक्षणों के प्रति सहिष्णुता के लिए आणविक साधनों की जांच हेतु आणविक उपकरणों का उपयोग।
8. कठिन श्रम कमी के लिए मेजबान संयंत्र की खेती और रेशम कीट पालन में मशीनीकरण।
9. जलवायु परिवर्तन के लिए लचीलापन हेतु विशिष्ट कार्यात्मक लक्षणों के साथ शहतूत जननद्रव्य की पहचान।
10. लक्षण और मूल्यांकन डेटा के साथ-साथ आणविक आईडी के साथ सेरी-आनुवंशिक संसाधनों के राष्ट्रीय डेटा बेस का विकास।

2. INTRODUCTION

The Central Sericultural Germplasm Resources Centre (CSGRC), Hosur is the premier exclusive institute mandated to collect, introduce, characterize, evaluate and conserve mulberry and silkworm germplasm resources alongwith creation of awareness and training personnel on the same. The Central Silk Board has authorized the Centre to register seri-genetic resources developed by various institutes through the Germplasm Registration Committee to protect authorship rights of breeders. The National Bureau of Plant Genetic Resources (NBPGR), ICAR, New Delhi and the National Bureau of Agricultural Insect Resources (NBAIR), ICAR, Bengaluru have recognized the centre as "National Active Germplasm Sites" for mulberry and silkworm germplasm, respectively. The aforesaid institutes have assigned national accession numbers for the germplasm conserved at this centre. CSGRC Hosur is implementing several in-house and collaborative projects on characterization and evaluation of seri-genetic resources aiming at identification of better performing parental stock for the benefit of breeders in crop improvement.

Mandate

1. *Collection, conservation, documentation, evaluation, utilization of sericultural germplasm resources for research.*
2. *Sustainable utilization of germplasm for stakeholders in collaboration with other CSB R&D Institutes.*
3. *Creation of awareness and training of stakeholders on conservation and utilization of sericultural germplasm resources.*

Activities

- *Exploration, collection and introduction of mulberry and silkworm germplasm.*
- *Characterisation, classification, preliminary evaluation, national accessioning and cataloguing of germplasm collection for promoting utilization of genetic resources.*
- *Serve as long-term national repository of sericultural genetic resources.*
- *Act as nodal agency for registration and reference centre for germplasm resources.*
- *Play lead role in inter-institutional collaboration for testing / evaluation of germplasm.*
- *Co-ordinate import and export of genetic resources.*
- *Serve as the national database and herbarium / display of sericultural genetic resources.*
- *Promote utilization of germplasm through their supply to needy organizations.*
- *Impart training in sericultural germplasm resource management.*

Results framework document [RFD]

Vision: To become the nodal agency for registration, evaluation and conservation of seri-genetic resources.

Mission: Register the seri-genetic resources in India, Research activity facilitating utilisation of seri-genetic resources for crop improvement programme, Conservation of seri-genetic resources, National posterity and prevention of extinction.

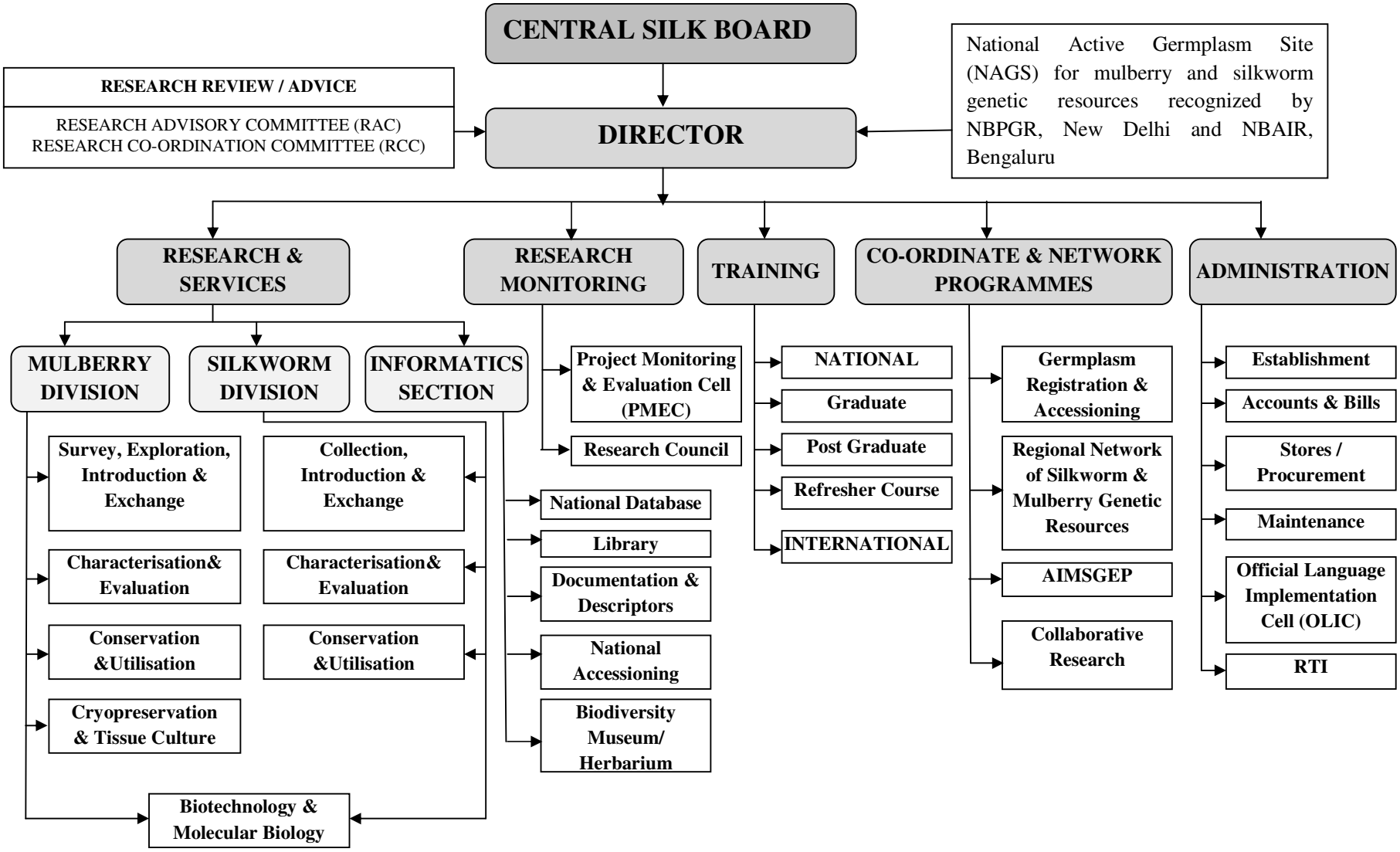
Short term plans

1. Survey unexplored areas in different states and explore avenues from different countries for collection of new mulberry genetic resources to enrich the genetic stock.
2. Promotion of *in situ* conservation of mulberry genetic resources at the centers of diversity and gene richness.
3. Evaluation of genetic resources in hotspot areas to identify resources tolerant to stress.
4. Adoption of climate resilient sericulture to protect mulberry genetic resources.
5. Implementation of pre-breeding programmes for genetic enhancement.
6. Evaluation of silkworm genetic resources for abiotic and biotic stress.
7. Molecular characterization of seri-genetic resources through markers.

Long term plans

1. Introduction of exotic mulberry (*Morus*) species through NBPGR, New Delhi / ISC, CSB Complex, Bengaluru.
2. Adoption of eco-friendly and organic farming techniques.
3. Implementation of pre-breeding programs for introgression of genes into the agronomic varieties to facilitate use of novel genes/alleles by mulberry breeders and for base broadening as well as exploitation of heterosis.
4. Implementation of structured and sustainable on-farm and *in situ* conservation of landraces in their native agro-ecological environments.
5. Upgradation of *ex situ* conservation strategies for mulberry and silkworm gene banks adopting advanced biotechnological tools with back up for cost-effective conservation.
6. Identification of promising genes in wild and land races using molecular tools for utilization in pre-breeding programme for genetic enhancement.
7. Utilization of molecular tools for screening seri-genetic resources for tolerance to different abiotic stresses / functional traits by including Genomics as an essential mandate of the centre.
8. Mechanization in host plant cultivation and silkworm rearing for drudgery reduction.
9. Identification of mulberry germplasm with specific functional traits for resilience to climate change.
10. Development of National Data Base of Seri-genetic Resources with molecular IDs along with characterization and evaluation data.

3. ORGANISATION CHART OF CSGRC, HOSUR



4. LIST OF RESEARCH PROJECTS

PROJECT CODE	TITLE OF PROJECT	DURATION
MULBERRY DIVISION		
Continued during 2019-20		
PIE-06001 SI	Collection, Characterization, Evaluation, Conservation and Supply of Mulberry Genetic Resources	Nov.18 to Nov.21
PIC 01003 CN: NW4B	Sugar-Mimic Alkaloids in Mulberry and their Role in Modulating Host Plant-Insect Interactions) *(CSB-DBT funded Multi-Component Network Project: Genetic Enhancement of Mulberry through Genomic Approaches)*	Jun.18 to Jun. 21
PIB – 3586	Development of superior mulberry varieties through controlled hybridization for North-West Indian states *(CSR&TI Pampore with CSGRC Hosur)*	Mar.17 to Feb.22
PIB - 3629	Development of Mulberry Genotypes Suitable for Rainfed Hill Farming in North - West India *(RSRS, Jammu with CSGRC, Hosur)*	Jan.18 to Dec. 21
Continued through and concluded during 2019-20		
PIE – 3575	Evaluation of mulberry genetic resources for functional traits for resilience to climate change *(CSGRC Hosur with RSRS Ananthpur & CSR&TI Mysuru)*	May.16 to May.19
PIB – 3505	Development of drought tolerant mulberry varieties for rainfed sericulture *(CSR&TI Berhampore with CSGRC Hosur)*	Feb.14 to Dec.19
New initiated during 2019-20		
PIG - 06004S1	Studies on the cytological status of mulberry genetic resources	Mar.20 To Feb.23
PIG - 06005S1	Molecular characterization of mulberry genetic resources for the identification of duplicates and effective utilization.	Mar.20 To Feb.23
PIT – 08004MI	Studies on epigenetic and autophagy modifiers on induction of haploid microspore embryogenesis in mulberry. *(SBRL Kodathi with CSGRC Hosur)*	Mar.20 To Feb.23

SILKWORM DIVISION		
Continued through and concluded during 2019-20		
AIB – 3577	Evaluation of multivoltine germplasm to identify potential parents for developing cross breeds for Southern and Eastern India *(CSGRC Hosur with CSR&TI Mysuru & CSR&TI Berhampore)*	Jun.16 to May'19
AIB – 3578	Evaluation of exotic bivoltine silkworm breeds to identify promising parental genetic resources *(CSGRC Hosur with CSR&TI Mysuru, CSR&TI Berhampore & CSR&TI Pampore).*	Jun.16 to Sep.19
New initiated during 2019-20		
AIE - 06002 MI	Evaluation of bivoltine silkworm genetic resources for tolerance to abiotic stress in selected hotspots *(CSGRC Hosur with CSR&TI Mysuru, CSR&TI Berhampore & CSR&TI Pampore)*	Apr.19 to Mar. 22
AIE - 06003 SI	Evaluation of silkworm genetic resources of *Bombyx mori*. L, with reference to inbreeding depression and their conservation.	Dec.19 to Nov. 22

5. PROGRESS OF RESEARCH PROJECTS

MULBERRY DIVISION

Projects continued through and concluded during 2019-20

1. PIE-3575: Evaluation of mulberry genetic resources for functional traits for resilience to climate change *(CSGRC Hosur with RSRS Ananthpur, REC-SU Koppal and CSR&TI Mysuru)* (May 2016 - May 2019)

CSGRC, Hosur: *K. Jhansilakshmi (till Jun.18), S. Masilamani (from Jul.18 till May'19), G. Thanavendan (from Jul.18), Raju Mondal (from Jan.19),*
CSRTI, Mysore: *S. Gandhi Doss and T. Gayathri,* ***RSRS, Anantapur:*** *P. Sudhakar,* ***REC-SU, Koppal:*** *A. Umesh*

Background

CSGRC, Hosur which is a National Active Germplasm Site for mulberry is maintaining more than 1200 mulberry genetic resources in its field gene bank collected from different agro-climatic regions. In order to evaluate them for their utility as potential parents in crop improvement, a project was taken up to evaluate 39 short-listed mulberry genetic resources at RSRS, Ananthapur (high temperature and low rainfall), CSGRC, Hosur and CSR&TI, Mysuru (favorable climate) and identify top performers with adaptive traits that make them resilient to climate change. The identified top performing accessions can function as potential parental material for developing climate resilient mulberry varieties.

Objectives

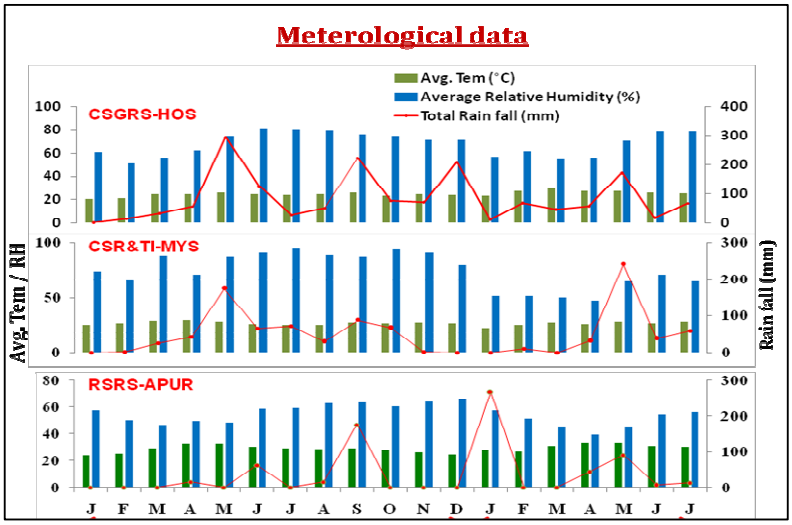
1. To estimate variability in different functional traits associated with drought tolerance in mulberry germplasm
2. To identify donor parents for specific traits having adaptive significance
3. To standardize the assessment method for different functional traits to identify desired mulberry genotypes

Methodology

Meteorological and soil parameter data

The meteorological data (average temperature, relative humidity, rainfall) was downloaded from meteorology units of all research locations and is presented in below (Fig.1).

After establishment of experimental plots (2016-2017) data was recorded for two crops during 2018 and 2019. The crop data recording was carried out during minimum rainfall period in February and July for successive years.



Primary axis: average min temperature (green bar), average relative humidity (blue bar),
Secondary axis: average rain fall (red line)

Fig.1: Meterological data (January 2018 to July 2019)

Experimental Design

39 accessions along with four high yielding varieties as checks *viz.,*. S-13, Vishala, V1 and Anantha were planted as per Randomization Block Design (RBD) layout in paired row system (5'+3') x 2 (Table-1). The experimental plots were divided into three main blocks and each block was again divided into two sub blocks.

Table 1. Details of germplasm utilized for the study

Sl.No.	Acc. No.	Accession Name	National Acc. No.	Scientific Name
1.	ME-0007	Shrim-2	EC493764	*M.alba*
2.	ME-0016	Lazuraso	EC493773	*M.latifolia*
3.	ME-0065	S-1	EC493822	*M.alba*
4.	ME-0107	M. Lhou seringe	EC493985	*M.latifolia*
5.	ME-0125	Thailand lobed	EC493852	*M.alba*
6.	ME-0137	Zimbabwe-12	EC493864	*M.alba*
7.	ME-0170	Tonkin	EC493897	*M.latifolia*
8.	ME-0188	China-8	EC493915	*M.latifolia*
9.	ME-0244	Morus f6	NA	*M.latifolia*
10.	ME-0251	Br-4	NA	*M.alba*
11.	ME-0253	Br-3	NA	*M.latifolia*
12.	MI-0139	Gajapathipur-3	IC313761	*M.indica*
13.	MI-0214	T-15	IC313864	*M.alba*
14.	MI-0226	T-36	IC313876	*M.alba*
15.	MI-0246	C-1748	IC313896	*M.indica*

Sl.No.	Acc. No.	Accession Name	National Acc. No.	Scientific Name
16.	MI-0256	Up-23	IC313800	*M.indica*
17.	MI-0286	Mother graft	IC313667	*M.indica*
18.	MI-0310	Chekmajra	IC314155	*M.indica*
19.	MI-0314	Up-27	IC313812	*M.alba*
20.	MI-0332	Nagalur estste	IC314028	*M.indica*
21.	MI-0376	Kunjagao-2	IC314166	*M.indica*
22.	MI-0400	Krishnaswamy-2	IC314233	*M.indica*
23.	MI-0437	Baragarh-2	IC314185	*M.indica*
24.	MI-0439	Rsrs, sahaspur	IC314187	*M.latifolia*
25.	MI-0458	C-1	IC314239	*M.indica*
26.	MI-0470	K2 x bc	IC313998	*M.indica*
27.	MI-0568	C-1657	NA	*M.alba*
28.	MI-0622	Karanjtoli-2	IC405770	*M.laevigata*
29.	MI-0657	Dhandore	IC405805	*M.indica*
30.	MI-0670	Madhopur-4	IC405818	*M.indica*
31.	MI-0682	Kota-4	IC405830	*M.indica*
32.	MI-0683	Alsigad	IC405831	*M.indica*
33.	MI-0685	Khakad-2	IC405833	*M.alba*
34.	MI-0686	Mount abu-1	IC405834	*M.indica*
35.	MI-0762	Chirayinkizh	IC572983	*M.latifolia*
36.	MI-0763	Saranath-2	IC572984	*M.indica*
37.	MI-0768	Mangari	IC572989	*M.indica*
38.	MI-0827	Jalalgarah-3	IC573048	*M.indica*
39.	MI-0835	Hosur-C15	IC573056	*M.indica*

The following parameters were evaluated during the course of the project:

Morphological / Physiological/ Biochemical

- No. of branches, length of the longest shoot, shoot weight, leaf biomass, intermodal distance, single leaf weight and leaf size were recorded along with leaf yield as per standard methods.
- The percentage of senescent leaves was estimated as per following formula:

$$\text{Leaf senescence } (\%) = \frac{L_y + L_a}{L_p + L_a + L_y} \times 100$$

Where,

L_y = Number of yellow leaves (Yellowing of the leaf area > 25% has been considered as senescent leaf);

L_a = number of leaves absent (fallen) due to senescence (This was obtained by counting the number of nodes without leaves from the bottom of the stem in the experimental plants);

L_p = number of green leaves present on the stem.

- Chlorophyll content was estimated by Dimethyl sulphoxide (DMSO) as per Hiscox & Israelstam (1979).
- Leaf protein as per Lowry assay 1951.
- Glutamine synthetase activity was measured by estimating the g-glutamylhydroxamate formed in the reaction mixture (Rowe *et al*., 1970).
- Ascorbic acid, and proline contents estimated as per Robertson *et al*. (1959).

Results:

To make use of mulberry genetic resources available at CSGRC, the present investigation has been undertaken to study the 10 morphological, 5 physiological and 7 biochemical traits. Shortlisted 39 mulberry accessions were selected and planted as per Randomization Block Design (RBD) layout in paired row system (5'+3') x 2' at three different agro-climatic regions viz., CSGRC, Hosur, CSR&TI, Mysuru (favorable climate) and RSRS, Anantapur (high temperature and low rainfall). The data on variability of functional traits were subjected to analysis across the seasons under all three trial locations. In the mixed culture system the heterogeneous environment of the three trial locations across the different seasons revealed high divergence in functional morphological traits as indicated in Table-2. Biomass revealed maximum variability, while internodal distance revealed the least.

Table 2. Variability statistics for morphological traits of mulberry accessions evaluated in three test centres

Traits	Min.	Max.	Average	SD
Biomass (g)	322.17	1145.33	774.85	197.61
Shoot wt (g)	165.50	711.00	444.87	121.40
Leaf wt (g)	97.50	503.50	329.98	91.78
Height (cm)	113.33	224.33	170.19	28.10
Leaf Length (cm)	12.60	26.00	19.46	3.12
Leaf width (cm)	9.27	19.00	13.15	2.43
Internodal distance(cm)	3.84	7.21	5.31	0.80
Senescence (%)	0.22	13.12	3.09	2.12
Single leaf weight (g)	0.32	3.70	1.72	1.14

High divergence was also observed in biochemical traits at the three trial locations across the different seasons as indicated in Table-3. GS activity revealed maximum variability, while, Chlorophyll-a content revealed the least.

Table 3. Variability statistics for biochemical traits of mulberry accessions evaluated in three test centres

Traits	Min.	Max.	Average	SD
Chlorophyll-a (mg/g fr.wt.)	1.27	3.12	2.19	0.47
Chlorophyll-b (mg/g fr.wt.)	0.20	4.50	0.54	0.64
Total Chlorophyll (mg/g fr.wt.)	1.46	3.76	2.66	0.55
Protein soluble (fresh weight %)	1.23	6.36	2.98	1.39
GS activity (unit mg^{-1} protein h^{-1})	11.29	27.39	18.75	4.44
Proline content (µmolg^{-1} fr. wt.)	1.55	5.48	3.67	0.95

In CSGRC Hosur, 09 accessions viz. MI-0400, MI-0376, MI-0214, ME-0007, MI-0762, MI-0686, MI-0763, ME-0251 and MI-0568 were the top performers compared to the check varieties S-13 and Anantha. In CSR&TI Mysore, 08 accessions viz. MI-0437, MI-0310, MI-0683, ME-0173, MI-0246, MI-0685, MI-0762 and ME-0256 were the top performers compared to the check varieties S-13 and Anantha. In RSRS Ananthpur, 11 accessions viz. MI-0439, MI-0437, MI-0400, ME-0107, MI-0332, MI-0686, ME-0253, ME-0251, MI-0458, MI-0139 and ME-0256 were the top performers compared to the check varieties S-13 with MI-0458. Considering all morphological parameters, MI-0568, MI-0762, and Anantha performed better in CSGRC, Hosur, CSR&TI, Mysuru and RSRS, Anantapur respectively. Comparative results revealed that 05 accessions viz. MI-0437 (F), MI-0400 (F), MI-0686 (M), MI-0762 (F) and ME-0251 (F) to be highly adaptive in all the three experimental locations proving their utility as donor parents by institutes implementing breeding programs (Table-4).

Table 4. Comparative performance of mulberry accessions evaluated in three test centres

	CSGRC, Hosur	CSRTI, Mysore	RSRS-Anunthapur
PCA analysis OUTPUT			
Check-1	S-13	S-13	S-13
Check-2	Anantha	Anantha	Anantha
Accn. 1	MI-0762	MI-0762	--
Accn .2	MI-0400	--	MI-0400
Accn. 3	MI-0686	--	MI-0686
Accn. 3	ME-0251	--	ME-0251
Overall OUTPUT			
Highest performer	MI-0568	MI-0768	MI-0458
Leaf weight	MI-0568	MI-0437	Anantha
Green Biomass	ME-0253	ME-0125	MI-0763
Shoot weight	ME-0253	ME-0125	Anantha

Recommendations

The five accessions viz., MI-0437 (F), MI-0400 (F), MI-0686 (M), MI-0762 (F) and ME-0251 (F) that revealed to be highly adaptive could serve as donor parents in breeding programs taken up by the institutes implementing mulberry breeding. The biochemical traits viz., Glutamate synthase activity and ascorbic acid content known to be correlated to drought tolerance with positive correlation to biomass, shoot weight and leaf weight can function as screening tools for identifying desired genotypes for the said functional traits. The morphological and biochemical data generated in this study can be utilized for identifying additional mulberry genotypes tolerant or sensitive to drought with resilience to climate change. The result of this study provides a foundation for further investigation of molecular mechanism underlying response to drought stress.

2. PIB-3505: **Development of drought tolerant mulberry variety for rainfed sericulture**
(Jan.14 – Dec.19) *(CSGRC, Hosur as collaborator with CSR&TI, Berhampore)*

CSR&TI Berhampore: *Suresh, K (PI), D. Chakravarty, Anil Pappachan, Maloy Lasker, JRF*
CSGRC Hosur: *K. Jhansilakshmi (till Jun.18), G. Thanavendan (from Jul.18)*

Background

The project was implemented by CSR&TI, Berhampore with an aim to develop drought tolerant mulberry variety for rainfed conditions. CSGRC, Hosur was a collaborater involved in selection of donor parents from the field gene bank at CSGRC Hosur, hybridization of selected donor parents, supply of seeds generated to CSR&TI, Berhampore for further evaluation and selection of progenies for primary yield trial (PYT) at CSR&TI, Berhampore.

Objective

Development of drought tolerant mulberry variety

Results

Ten crosses were prepared using selected donor mulberry genetic resources at CSGRC, Hosur and the resultant seeds were supplied to CSR&TI, Berhampore. Thirty selected progenies from the ten crosses established in ARBD along with three check varieties S1635, C1730 and C2038 were assessed at CSR&TI Berhampore based on drought tolerant indices and leaf yield per plant. Leaf yield per plant recorded significant positive association with mean productivity (MP), geometric mean productivity (GMP), harmonic mean (HM), yield index (YI), stress tolerance index (STI) and modified stress tolerance indices (K_1STI and K_2STI) and hence would be effective in identifying high yielding drought tolerant mulberry genotypes. Among the seventeen traits studied, specific leaf area, fresh leaf moisture, relative water content, primary shoots per plant and total shoot length recorded significant positive association with leaf yield indicating their importance in yield-based selection. The results of principal components analysis (PCA) and biplot indicated six genotypes as drought tolerant and high yielding. The genotypes (PYD 01, 08, 09, 21, 04 and 07) were identified as high yielding with 1.72-1.96 kg / yr (~ >6% over C-2038) and drought tolerant (compared to C1730). Genotypes PYD-10, 20, 08, 24, 06 and 22 recorded > 5% higher yield over C-2038 under PYT. Among the 30 genotypes evaluated, 10 recorded significantly high annual leaf yield over check C-2038 under rainfed conditions.

Recommendations

The five genotypes (PYD 01, 04, 07, 08 and 21) identified as drought tolerant as well as high yielding and the 10 accessions that recorded significantly high annual leaf yield over check C-2038 under rainfed conditions can be utilized for crop improvement.

Projects continued during 2019-20

1. PIE-06001SI: Collection, Characterization, Evaluation, Conservation and Supply of Mulberry Genetic Resources (Nov. 18 to Nov.21)

G. Thanavendan (PI) (from Jun.19), M.C. Thriveni, (from Jan. 19), Raju Mondal, (from Jan. 19) and Geetha N. Murthy

Background

The project aims to collect mulberry genetic resources to enrich the gene bank of the centre, characterize, evaluate and conserve available genetic resources and supply them to needy indentors for utilization.

S-01: Survey and collection of new Mulberry Genetic Resources

Eighteen new mulberry germplasm were collected from Tura region of Garo Hills, Meghalaya (Fig. 2) and one accession from CSR&TI, Pampore and the details are as indicated below (Table 5). All the Ninteen newly collected mulberry germplasm were planted in nursery beds under the shade net conditions for better growth and development. Among the collections, two from Tura region failed to germinate and the rest recorded >75% of germination.

Table 5. New collections of mulberry genetic resources collected from different regions

Sl. No.	Collection Code	Accession Name	Place of collection	Altitude (MSL)	Scientific Name
1	GTv_2019 Gurez_J&K-01	Gurez -1	CSR&TI, Pampore	2,400 m	*Morus* spp.
2	GTv_2020 (GH_ML) 01	Okkapara_1	West Garo Hills district of the Meghalaya	349 m	*Morus* spp.
3	GTv_2020 (GH_ML) 02	Okkapara_2		349 m	*Morus* spp.
4	GTv_2020 (GH_ML) 03	Okkapara_3		349 m	*Morus* spp.
5	GTv_2020 (GH_ML) 04	Okkapara_4		349 m	*Morus* spp.
6	GTv_2020 (GH_ML) 05	Ampati_1	South West Garo Hills district of the Meghalaya	32 m	*Morus* spp.
7	GTv_2020 (GH_ML) 06	Ampati_2		32 m	*Morus* spp.
8	GTv_2020 (GH_ML) 07	Ampati_3		32 m	*Morus* spp.
9	GTv_2020 (GH_ML) 08	Garobadha_1		29 m	*Morus* spp.
10	GTv_2020 (GH_ML) 09	Garobadha_2		29 m	*Morus* spp.
11	GTv_2020 (GH_ML) 10	New TURA_1	West Garo Hills district of the Meghalaya	349 m	*Morus* spp.
12	GTv_2020 (GH_ML) 11	New TURA_ 2		349 m	*Morus* spp.
13	GTv_2020 (GH_ML) 12	New TURA_ 3		349 m	*Morus* spp.
14	GTv_2020 (GH_ML) 13	New TURA_ 4		349 m	*Morus* spp.
15	GTv_2020 (GH_ML) 14	New TURA_ 5		349 m	*Morus* spp.
16	GTv_2020 (GH_ML) 15	New TURA_ 6		349 m	*Morus* spp.

Sl. No.	Collection Code	Accession Name	Place of collection	Altitude (MSL)	Scientific Name
17	GTv_2020 (GH_ML) 16	New TURA_ 7		349 m	*Morus* spp.
18	GTv_2020 (GH_ML) 17	Nokrek_Wild_1		1412 m	*Morus* spp.
19	GTv_2020 (GH_ML) 18	Nokrek_Wild_2		1412 m	*Morus* spp.

Fig. 2: Survey, exploration & collection of mulberry germplasm from Nokrek Park (Tura) Garo Hills, Meghalaya.

S-02: Characterization of Mulberry Genetic Resources

E-01: Morphological characterization of mulberry genetic resources

During the period under report, seven newly inducted genetic resources are under establishment in the *ex situ* Field Gene Bank (FGB) with recommended cultural practices. A set of 23 accessions were characterized as per prescribed descriptors Viz., morphological (15 descriptors), anatomical (10 descriptors), preliminary growth and yield (24 descriptors) and propagation (16 descriptors) parameters. The data documented was updated in the Mulberry Germplasm Information System (MGIS) database. Details of morphological characterization of the 23 mulberry accessions (16 descriptors) are as indicated in Table 6 & 7 below:

Table 6: Details of mulberry genetic resources under characterization

Sl. No.	Institute Acc-No.	Accession Name	Region	Date of Collection	State
1	MI-0985	Thalaghattapura-38	South India	03/08/2011	Karnataka
2	MI-0986	Thalaghattapura-39	South India	03/08/2011	Karnataka
3	MI-0987	Thalaghattapura-40	South India	03/08/2011	Karnataka
4	MI-0988	Thalaghattapura-41	South India	03/08/2011	Karnataka
5	MI-0989	Thalaghattapura-42	South India	03/08/2011	Karnataka
6	MI-0990	Thalaghattapura-43	South India	03/08/2011	Karnataka
7	MI-0991	Thalaghattapura-44	South India	03/08/2011	Karnataka
8	MI-0992	Thalaghattapura-45	South India	03/08/2011	Karnataka
9	MI-0993	Thalaghattapura-46	South India	03/08/2011	Karnataka
10	MI-0994	Thalaghattapura-47	South India	03/08/2011	Karnataka
11	MI-0995	Thalaghattapura-48	South India	03/08/2011	Karnataka
12	MI-0996	Thalaghattapura-49	South India	09/09/2011	Karnataka
13	MI-0997	Thalaghattapura-50	South India	09/09/2011	Karnataka
14	MI-0999	Thalaghattapura-52	South India	09/09/2011	Karnataka
15	MI-1000	Suvarna-1	South India	28/12/2015	Karnataka
16	MI-1001	Suvarna-2	South India	28/12/2015	Karnataka
17	MI-1002	Suvarna-3	South India	28/12/2015	Karnataka
18	MI-1003	S 41 (4x)	South India	28/12/2015	Karnataka
19	MI-1004	K 2 (3x)	South India	28/12/2015	Karnataka
20	MI-1005	RFS 135 (4x)	South India	28/12/2015	Karnataka
21	MI-1006	S 35 (4x)	South India	28/12/2015	Karnataka
22	MI-0980	Madathanthope	West India	13/03/2013	Pondicherry
23	MI-0837	Hunder-2	North India	31/03/2005	J & K
24	MI-0838	Beema	North India	03/11/2005	J & K
25	MI-0839	Hunder-3	North India	31/03/2005	J & K
26	MI-0841	Biagdong	North India	31/03/2005	J & K

Sl. No.	Institute Acc-No.	Accession Name	Region	Date of Collection	State
27	MI-0857	Delhi-1	North India	24/11/2008	New Delhi
28	MI-0859	Batwa	North India	24/11/2008	Punjab
29	MI-0860	Naloh	North India	24/11/2008	Punjab
30	MI-1007	Ziro valley-1	NE India	03/08/2016	Arunachal Pradesh

Table 7. Morphological characterization of mulberry accessions in Field Gene Bank

Parameter	Frequency	Percentage
Branching Nature		
Erect	8	34.78
Spreading	11	47.83
Straight	4	17.39
Total	**23**	**100.00**
Curve or Straightness of the branch		
Erect	8	34.78
Slightly curved	2	8.70
Straight	13	56.52
Total	23	100.00
Colour of young shoot		
Green	12	52.17
Greenish purple	2	8.70
Grey brown	4	17.39
Grey green	1	4.35
Light Green	4	17.39
Total	**23**	**100.00**
Colour of mature shoot		
Brown	1	4.35
Brownish green	1	4.35
Dark green	1	4.35
Green	1	4.35
Greenish brown	13	56.52
Grey green	6	26.09
Total	**23**	**100.00**
Stipule nature		
Foliaceous	2	8.70
Free lateral	21	91.30
Total	**23**	**100.00**
Stipule duration		
Caducous	21	91.30
Persistant	2	8.70
Total	**23**	**100.00**

Leaf lobation type		
Deeply lobed	2	8.70
Medium lobed	12	52.17
Unlobed	9	39.13
Total	**23**	**100.00**
Leaf nature		
Heterophyllous	13	56.52
Homophyllous	10	43.48
Total	**23**	**100.00**
Leaf colour		
Dark Green	1	4.35
Green	22	95.65
Total	**23**	**100.00**
Leaf surface		
Rough	21	91.30
Smooth	2	8.70
Total	**23**	**100.00**
Leaf texture		
Chartaceous	1	4.35
Coriaceous	22	95.65
Total	**23**	**100.00**
Leaf apex		
Acute	22	95.65
Caudate	1	4.35
Total	**23**	**100.00**
Leaf margin		
Crenate	21	91.30
Dentate	1	4.35
Serrate	1	4.35
Total	**23**	**100.00**
Leaf base		
Cordate	23	100.00
Total	**23**	**100.00**
Leaf shape		
Ovate	23	100.00
Total	23	100.00

Among the accessions characterized, 47.8% had spreading branching nature followed by erect branches (34.8%), heterophyllous leaf (52.2%) with medium lobation (52.2%), chartaceous (95.7%) in leaf texture, acute leaf apex (95.7%), crenate leaf margin (91.3%), and cordate leaf shape (100%).

E02: Leaf anatomical characterization of mulberry genetic resources

The highest coefficient of variability (32.58%) was recorded for lower cuticle thickness among different anatomical parameters (Table-8). The lower cuticle thickness varied from 1.73µm to 6.03µm. The maximum leaf thickness was 187.98 µm and minimum was 137.23 µm. The number of chloroplasts / stomata an indicator for ploidy level, varied from 8.77 to 14.07. Better performing accessions for different anatomical traits and the range of variation for these accessions are presented in Table-9.

Table 8. Variability statistics for different anatomical traits of mulberry accessions

Parameters	Mean	Min	Max	SD	SE	CV%
Stomatal size (sq.µm)	269.88	226.07	399.35	40.46	8.43	14.99
Stomatal frequency/no./sq.mm)	714.42	563.24	952.67	117.82	24.56	16.49
Upper cuticular thickness (µm)	5.54	3.59	9.25	1.34	0.27	24.20
Lower cuticular thickness (µm)	2.88	1.73	6.034	0.93	0.19	32.58
Upper epidermal thickness (µm)	23.66	18.77	32.24	3.08	0.64	13.03
Lower epidermal thickness (µm)	8.30	6.28	12.13	1.20	0.25	14.49
Leaf thickness (µm)	160.75	137.23	187.98	12.61	2.63	7.84
No. of chloroplast/stomata	10.54	8.77	14.07	1.02	0.21	9.63
Palisade thick (µm)	55.02	45.88	67.74	5.43	1.13	9.88
Spongy thick (µm)	65.21	46.40	83.39	7.57	1.58	11.62

Table 9. Top performing accessions for anatomical traits of mulberry accessions

Parameters	Range	Top performing Accessions
Stomatal size (sq.µm)	272.19-399.35	MI-0857, MI-0878, MI-0980, MI-0837, MI-0970, MI-0839, MI-0838, MI-0869, MI-0860, MI-0858
Stomatal frequency/no./ sq.mm)	734.98-952.67	MI-0869, MI-0815, MI-0814, MI-0975, MI-0859, MI-0813, MI-0840, MI-0900, MI-0962, MI-0837
Upper cuticle thickness (µm)	4.80-3.60	MI-0962, MI-0859, MI-0966, MI-0900, MI-0814, MI-0869, MI-0816, MI-0838, MI-0815, MI-0813
Lower cuticle thickness (µm)	1.74-2.40	MI-0900, MI-0859, MI-0837, MI-0814, MI-0815, MI-0962, MI-0839, MI-0966, MI-0877, MI-0816
Upper epidermal thick (µm)	18.77-22.74	MI-0839, MI-0814, MI-0815, MI-0869, MI-0962, MI-0966, MI-0840, MI-0975, MI-0970, MI-0900

Lower epidermal thick (µm)	6.29-8.26	MI-0859, MI-0815, MI-0869, MI-0839, MI-0814, MI-0813, MI-0857, MI-0900, MI-0858, MI-0837
Leaf thickness (µm)	161.05-187.99	MI-0857, MI-0878, MI-0841, MI-0816, MI-0839, MI-0860, MI-0975, MI-0980, MI-0837, MI-0858
No. of chloroplast/stomata	10.44-14.07	MI-0857, MI-0878, MI-0974, MI-0816, MI-0970, MI-0877, MI-0966, MI-0973, MI-0837, MI-0839
Palisade thick (µm)	55.70-67.75	MI-0839, MI-0878, MI-0857, MI-0869, MI-0841, MI-0816, MI-0814, MI-0975, MI-0813, MI-0859
Spongy thick (µm)	68.31-83.40	MI-0857, MI-0816, MI-0815, MI-0860, MI-0858, MI-0838, MI-0878, MI-0841, MI-0973, MI-0970

S03: Evaluation of Mulberry Genetic Resources

Evaluation was carried out for preliminary growth and yield (24 descriptors) as well as propagation (16 descriptors) parameters recorded after 90 days of pruning. The data on characterization and evaluation was documented in Mulberry Germplasm Information System (MGIS).

E01: Evaluation of mulberry genetic resources for propagation traits

Wide variations were observed among the 30 accessions tested for propagation traits (Table-10). The highest coefficient of variation was recorded for dry shoot weight (69.43%) followed by fresh shoot weight/ sapling (68.02%). Total fresh biomass/ sapling varied from 9.74 g to 55.26 g. The highest shoot length varied from 13.23 cm to 57.62 cm. Better performing accessions for different propagation traits are presented in Table-11.

Table 10. General Statistics for Propagation traits of mulberry accessions

Parameters	Mean	Min.	Max.	SD	SE	CV%
No. of leaves/saplings	10.96	6.80	15.85	3.14	0.69	28.70
Leaf length (cm)	10.41	7.38	15.88	1.75	0.38	16.84
Leaf width (cm)	8.04	5.44	11.99	1.29	0.28	16.07
Fresh leaf wt/sapling (g)	14.51	8.05	33.09	5.67	1.24	39.06
Dry leaf wt/sapling (g)	4.43	2.13	11.56	2.03	0.44	45.86
Shoot length (cm)	28.07	13.23	57.62	9.94	2.17	35.42
Fresh shoot wt/sapling (g)	6.69	1.36	22.17	4.55	0.99	68.02
Dry shoot wt/sapling (g)	2.36	0.37	7.44	1.64	0.36	69.43
Shoot diameter (cm)	0.57	0.32	1.05	0.18	0.04	32.35
Total fresh biomass/sapling (g)	21.00	9.74	55.26	10.02	2.19	47.70
Total dry biomass/sapling (g)	6.79	2.50	19.00	3.64	0.79	53.56
No. of roots/sapling	6.36	2.93	10.59	2.16	0.47	33.98

Fresh root wt/sapling (g)	3.38	1.17	8.32	1.88	0.41	55.54
Dry root wt/sapling (g)	1.08	0.35	2.74	0.65	0.14	60.81
Longest root length/sapling (cm)	19.45	14.49	27.17	3.47	0.76	17.82
Root volume/sapling (ml)	2.14	0.61	5.56	1.42	0.31	66.27

Table 11. Top performing mulberry accessions for Propagation traits

Parameters	Range	Top performing Accessions
No. of leaves/saplings	12.37-15.85	MI-0857, MI-0962, MI-0838, MI-0966, MI-0837, MI-0980, MI-0858, MI-0860, MI-0970, MI-0973
Leaf length(cm)	10.37-15.88	MI-0962, MI-0878, MI-0860, MI-0970, MI-0869, MI-0900, MI-0966, MI-0838, MI-0857, MI-0837
Leaf width(cm)	8.12-11.99	MI-0962, MI-0878, MI-0900, MI-0869, MI-0860, MI-0970, MI-0816, MI-0877, MI-0966, MI-0838
Fresh leaf wt/sapling(g)	14.52-33.09	MI-0962, MI-0860, MI-0970, MI-0869, MI-0878, MI-0966, MI-0857, MI-0838, MI-0900, MI-0837
Dry leaf wt/sapling(g)	4.09-11.56	MI-0962, MI-0860, MI-0970, MI-0869, MI-0878, MI-0815, MI-0966, MI-0857, MI-0900, MI-0837
Shoot length (cm)	30.03-57.62	MI-0962, MI-0966, MI-0869, MI-0838, MI-0857, MI-0860, MI-0970, MI-0837, MI-0878, MI-0973
Fresh shoot wt/sapling(g)	7.08-22.17	MI-0962, MI-0869, MI-0815, MI-0966, MI-0860, MI-0970, MI-0857, MI-0837, MI-0838, MI-0859
Dry shoot wt/sapling(g)	2.31-7.44	MI-0962, MI-0869, MI-0815, MI-0860, MI-0970, MI-0966, MI-0859, MI-0878, MI-0857, MI-0837
Shoot diameter (cm)	0.32-0.48	MI-0816, MI-0813, MI-0859, MI-0839, MI-0815, MI-0974, MI-0858, MI-0980, MI-0973, MI-0877
Total fresh biomass/sapling(g)	9.74-55.26	MI-0975, MI-0813, MI-0816, MI-0877, MI-0839, MI-0974, MI-0814, MI-0815, MI-0973, MI-0858
Total dry biomass/sapling(g)	2.5-5.67	MI-0975, MI-0813, MI-0877, MI-0974, MI-0839, MI-0816, MI-0814, MI-0973, MI-0858, MI-0980
No. of roots/sapling	10.59-6.58	MI-0839, MI-0838, MI-0837, MI-0857, MI-0858, MI-0974, MI-0980, MI-0966, MI-0973, MI-0878
Fresh root wt/sapling(g)	1.17-2.48	MI-0975, MI-0813, MI-0877, MI-0839, MI-0974, MI-0816, MI-0814, MI-0973, MI-0980, MI-0858
Dry root wt/sapling(g)	0.35-0.68	MI-0813, MI-0975, MI-0974, MI-0877, MI-0839, MI-0858, MI-0973, MI-0980, MI-0816, MI-0814
Longest root length/sapling cm)	14.49-18.35	MI-0839, MI-0813, MI-0974, MI-0877, MI-0859, MI-0975, MI-0815, MI-0980, MI-0858, MI-0900
Root volume/sapling (ml)	1.93-5.56	MI-0860, MI-0970, MI-0815, MI-0869, MI-0838, MI-0857, MI-0858, MI-0837, MI-0859, MI-0980

E-02: Evaluation of mulberry genetic resources for growth and yield parameters

Under the study, high variability was observed for growth and yield parameters among the mulberry accessions (Table-12). The coefficient of variation was highest for lenticel density (27.17%) followed by total shoot weight (23.1%) and total leaf yield (91.53%). The highest value for total shoot length is 5038 cm recorded in MI-0970. The better performing accessions for different growth and yield parameters are presented in Table-13.

Table 12. General statistics for growth and yield characters of mulberry accessions

Parameters	Mean	Min.	Max.	SD	SE	CV%
No. of shoots	31.14	6.33	89	17.51	3.73	56.22
Length of longest shoot (cm)	132.51	44.33	226.33	49.93	10.64	37.68
Lamina length (cm)	15.36	10.50	23	4.10	0.87	26.69
Lamina width (cm)	12.61	8.33	18.66	2.97	0.63	23.55
Petiole length (cm)	4.31	2.86	6.16	1.06	0.22	24.71
Petiole width (cm)	0.34	0.20	1.53	0.29	0.062	85.12
Weight of single leaf (g)	3.38	0.93	8.50	2.01	0.43	59.51
Weight of lamina (g)	3.05	0.73	7.66	1.72	0.36	56.42
Lenticel density (no/cm^2)	13.92	3.66	187.33	37.82	8.06	27.17
Total shoot length (cm)	2377.35	66.66	5038	14.80	315.70	62.28
Total shoot weight (cm)	2.19	0.17	25.01	5.09	1.086	23.17
Total leaf yield (kg)	0.99	0.09	3.158	0.91	0.19	91.53
Wt. of 100 leaves (g)	349.84	162.65	867.25	17.47	36.43	49.94
Leaf yield/plant (g)	1.72	0.89	2.73	0.52	0.10	30.62
Internodal distance (cm)	5.41	3.17	7.97	0.90	0.18	16.75
Moisture content (%)	68.47	66.22	71.23	1.49	0.31	2.18
Moisture retention capacity (%)	64.48	52.74	76.93	5.41	1.12	8.39
Survival (%)	49.11	12.47	70.61	18.37	3.83	37.41

Table 13. Top performing mulberry accessions for growth and yield characters

Parameters	Range	Top performing accessions
No. of shoots	32.66-89.0	MI-0838, MI-0970, MI-0837, MI-0858, MI-0857, MI-0860, MI-0859, MI-0966, MI-0839, MI-0980
Length of longest shoot (cm)	14-226.33	MI-0981, MI-0966, MI-0974, MI-0980, MI-0975, MI-0857, MI-0877, MI-0858, MI-0970, MI-0973
Lamina length (cm)	15.33-23.0	MI-0966, MI-0878, MI-0975, MI-0973, MI-0857, MI-0974, MI-0970, MI-0816, MI-0980, MI-0814
Lamina width (cm)	13.16-18.67	MI-0857, MI-0878, MI-0973, MI-0966, MI-0970, MI-0816, MI-0814, MI-0975, MI-0980, MI-0962
Petiole length (cm)	2.87-4.16	MI-0869, MI-0815, MI-0877, MI-0981, MI-0878, MI-0970, MI-0860, MI-0980, MI-0900, MI-0839
Petiole width (cm)	0.2-0.23	MI-0877, MI-0815, MI-0839, MI-0869, MI-0970, MI-0860, MI-0859, MI-0900, MI-0838, MI-0975
Weight of single leaf (g)	3.36-8.5	MI-0966, MI-0857, MI-0816, MI-0973, MI-0878, MI-0814, MI-0975, MI-0813, MI-0974, MI-0962
Weight of lamina (g)	0.73-2.36	MI-0869, MI-0860, MI-0859, MI-0900, MI-0877, MI-0815, MI-0980, MI-0981, MI-0858, MI-0970
Lenticel density (no/cm^2)	6.66-187.33	MI-0900, MI-0857, MI-0859, MI-0837, MI-0839, MI-0877, MI-0966, MI-0838, MI-0860, MI-0878
Total shoot length (cm)	2349.66-5038	MI-0970, MI-0857, MI-0966, MI-0838, MI-0980, MI-0858, MI-0837, MI-0981, MI-0859, MI-0974
Total shoot weight (kg)	0.69-25.02	MI-0813, MI-0857, MI-0980, MI-0838, MI-0858, MI-0981, MI-0966, MI-0974, MI-0970, MI-0973
Total leaf yield (g)	0.77-3.16	MI-0857, MI-0966, MI-0858, MI-0838, MI-0981, MI-0837, MI-0970, MI-0974, MI-0980, MI-0962

S-04: Conservation, plant protection and supply of mulberry genetic resources

The diverse collections of mulberry genetic resources from different geographical regions were maintained in *ex-situ* field gene bank as dwarf trees (four plants per accession) with spacing of 2.4m x 2.4m. The plants in the *ex situ* conservation were trained at 1.5 m crown height following one pruning after the onset of monsoon (June-July). Immediately after pruning, manure application and intercultural operations for weed and insect pest management was carried out. Irrigation was provided through drip irrigation (4lph) system during non-rainy days as per plants requirement. Special attention was given to poor accessions doing grafting for better maintenance. Basal branches from the root stock were regularly removed and plant protection measures were taken up as per the pest and disease infestation and time bound requirement. Seven new mulberry accessions were inducted into the *ex-situ* field gene bank and a total of 1299 accessions were conserved of which 285 were exotic and 1014 indigenous (Table-14).

Table 14. Details of mulberry genetic resources maintained in Field Gene Bank

Sl.No.	National	No. of accns.
1	Andaman & Nicobar	15
2	Arunachal Pradesh	10
3	Andhra Pradesh	4
4	Assam	11
5	Bihar	9
6	Chattisgarh	4
7	Goa	11
8	Gujarat	16
10	Himachal Pradesh	36
11	Jammu & Kashmir	41
12	Jharkhand	17
13	Karnataka	161
14	Kerala	71
15	Madhya Pradesh	12
16	Maharashtra	32
17	Manipur	12
18	Meghalaya	23
19	Mizoram	8
20	Nagaland	9
21	New Delhi	3
22	Orissa	1
23	Pondicherry	4
24	Punjab	18
25	Rajasthan	63

Sl.No.	International	No. of accns.
1	Afghanistan	3
2	Australia	2
3	Bangladesh	5
4	China	55
5	Cyprus	1
6	Egypt	3
7	France	32
8	Hungary	1
9	Indonesia	8
10	Italy	7
11	Japan	72
12	Myanmar	7
13	Nepal	1
14	Pakistan	8
15	Papua New Guinea	1
16	Paraguay	4
17	Philippines	1
18	Portugal	1
19	Russia	1
20	South Korea	6
21	Spain	2
22	Sri Lanka	2
23	Thailand	11
24	Turkey	1

26	Sikkim	15
27	Tamil Nadu	86
28	Tripura	2
29	Uttar Pradesh	146
30	Uttaranchal	8
31	West Bengal	153
	TOTAL	**1014**

25	USA	4
26	Venezuela	1
27	Venosa	1
28	Vietnam	5
29	Zimbabwe	11
	Unidentified	28
	TOTAL	**285**

Indigenous (1014) + Exotic (285) = 1299

E01: Evaluation of mulberry genetic resources for natural incidence of insect pests

A] Chewing insect pest complex:

Minor incidence of stem borer, leaf roller, bihar hairy caterpillar and termites were observed in the Field Gene Bank. Among the 30 accessions evaluated, 10 accessions revealed least infestation viz., MI-0857, MI-0837, MI-0980, MI-0838, MI-0858, MI-0962, MI-0966, MI-0973, MI-0974 and MI-0841 which has been recorded based on preliminary observation for all seasons.

The following management practices were adopted:

- Clipping off of infested apical shoots manually.
- Application of DDVP (76% EC) during rainy season to manage young caterpillar stage.
- Application of agave crude extract (10%) for repellency and antifeedant effect to reduce the infestation and poured into the hole followed by closing with wet earth.
- Prepared a solution of Chlorpyriphos (20% EC) @ 3ml/litre of water for termite managaement.
- In established *ex situ* plantation, soil drenching with 0.1% Chlorpyriphos 20% EC was carried out to reduce infestation of termite.
- Imidacloprid @ 3ml per litre of water was applied with needle injection in galleries of infested trees at three month interval to control termite.

B] Sucking insect pest complex:

Among the sucking insects minor incidence of tukra mealybug, papaya mealybug, thrips, white fly and *Clovia* spp. were observed. Among the 30 accessions evaluated, 10 accessions revealed least infestation viz., MI-0857, MI-0837, MI-0980, MI-0838, MI-0858, MI-0962, MI-0966, MI-0973, MI-0974 and MI-0841 were recorded based on the preliminary observation in all the seasons.

The following management practices were adopted:

- Clipping off of infested apical shoots.
- Removal of infested portions with secature and buried.
- Spraying Dimethoate (36%EC) 2.0 ml / litre of water at one month interval for thrips management during summer season.
- Application of 2nd dose of 0.2% DDVP (76% EC) one month after first spray during summer.
- Release of lady bird beetles, *Scymnus coccivora* @ 500 beetles or *Cryptolaemus montrouzieri* @250 beetles/ac/year in two splits at an interval of 6 months for management of sucking pests.
- Inoculative release of exotic nymphal parasitoid, *Acerophagus papayae* @ 100 adults (one vial)/acre/ year in papaya mealybug infested gardens.

E02: Evaluation of mulberry genetic resources for natural incidence of major foliar fungal diseases

The natural incidence of diseases were observed with major fungal diseases viz., powdery mildew, leaf spot and leaf rust were monitored and necessary measures were taken to control the disease. Among the 23 accessions, following 10 were promising with least disease incidence viz., MI-0857, MI-0837, MI-0980, MI-0838, MI-0858, MI-0962, MI-0966, MI-0973, MI-0974 and MI-0841 were recorded based on the preliminary observation in all the seasons (Table-15).

Table 15. Incidence of foliar fungal diseases in mulberry genetic resources

Disease Grade	Summer			Rainy			Winter		
	No. of accessions								
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
No incidence	10	23	17	10	19	16	10	8	16
Less incidence	9	-	4	9	2	4	7	11	3
Moderate incidence	2	-	2	2	1	3	6	2	2
Higher incidence	2	-	-	2	1	-	-	2	2
Total no. of accessions	**23**	**23**	**23**	**23**	**23**	**23**	**23**	**23**	**23**

Note: A*-Leaf spot* ***B****-Powdery mildew* ***C****-Leaf rust.*

E03: Supply of mulberry genetic resources

During the period, a total of 372 mulberry accessions (includes repeat supply) comprising of 85 exotic and 287 indigenous accessions were supplied to 9 indenters (Table 16) for different purposes viz., DUS project, screening for root rot resistance, identification of QTLs, Sheep and Goat fodder purpose, evaluation of arid fruit, UG, PG education and Ph.D project works of universities and other R & D institutes. The details of supply is given in Table-16.

Table 16. Details of mulberry germplasm supply under CSGRC, Hosur

Sl. No.	Name of indentor	No. of Accessions			Purpose
		Indigenous	**Exotic**	**Total**	
1	The Director CSR&TI, CSB, Mysuru	8	2	10	For World environment Day Celebrations at CSR&TI, Mysuru
2	The Associate Dean College of Agriculture MPKV, Raguri, Pune- 411005	20	0	20	For UG and PG Education Purpose
3	The Director CSR&TI, CSB, Mysuru	102	61	163	PIC01003 CN: NW 2d DBT-CSB Network Project

4	Dr. S.V. Krishnamoorthy Professor and Head Dept. Of Sericulture FC&RI, TNAU, Mettupalayam.	20	10	30	PG -Education and Ph.D. Research purpose
5	The Director CSR&TI, CSB, Mysuru	115	0	115	PIC01003 CN: NW 2d DBT-CSB Project
6	The Director CSR&TI, CSB, Mysuru	5	3	8	PIE-3511(DUS Project)
7	The Director SBRL, Kodathi, Bengaluru.	3	7	10	Project purpose PRP08002MI
8	The Farm Manager Sheep and Goat Farm Ranjani, Sangli Dist. Maharashtra.	8	2	10	Sheep and Goat fodder purpose
9	Dr. Mukesh Kumar Asst. Horticulturist CCS Haryana Agricultural University, RRS, Bawal.	6	0	6	For evaluation of Arid Fruit project
	TOTAL	**287**	**85**	**372**	

Inter-institutional (Other institute projects with CSGRC Hosur as collaborator)

1. **PIB-3586**: **Development of superior mulberry varieties through controlled hybridization for North-West Indian states** (Mar.17 – Feb.22) (CSR&TI Pampore with CSGRC, Hosur)

CSR&TI, Pampore: *Rajesh Kumar (PI), Pawan Saini, Aftab A. Shabnam,*
CSGRC, Hosur: *G. Thanavendan,* ***RCS-CO, Bangalore:*** *K. Vijayan*

Background

Project implemented by CSR&TI, Pampore with CSGRC, Hosur as one of the collaborators aiming to develop high yielding mulberry variety with early sprouting and cold tolerance for North West India.

Progress

During the year, CSGRC Hosur received seeds of three crosses from CSR&TI, Pampore and the same F1 seeds were sown in the nursery pots. The saplings establishment is in progress at CSGRC, Hosur under shade net conditions.

Fig.3 Mud pot method under shade net conditions

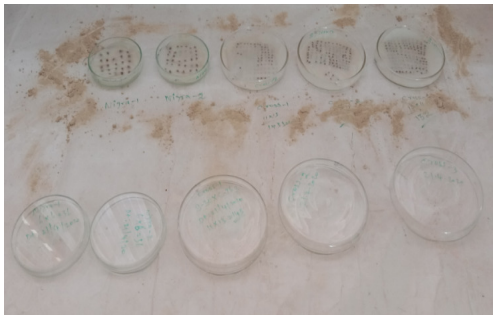


Fig.4 Petriplate method under room conditions

2. PIB-3629: Development of drought tolerant mulberry genotype suitable for rainfed hill farming in North-west India (Jan.18 to Dec.21) (CSGRC, Hosur with RSRS, Jammu)

RSRS Jammu: *Chhattar Pal (PI), Jadhav Ashok Limbaji (till Nov.18), Murali S.*
CSGRC, Hosur: *G.Thanavendan*

Background

The project aims to develop drought tolerant mulberry genotypes for rainfed hill farming in North West India.

Progress

Parental selection

Eleven female and five male parents were selected based on pre-breeding data for drought tolerance, leaf structure, root and shoot characteristics and flower synchrony (Table 17). During parental selection preference was given to select dioecious female parents. These parents are being maintained at *ex-situ* field gene bank at CSGRC, Hosur.

Table 17. List of selected parents and their cross combinations

Sl. No.	CROSS	Sl. No.	CROSS
1	MI-0877 × MI-0836	**7**	MI-0324× MI-0313
2	ME-0256 × MI-0836	**8**	MI-0310 × MI-0012
3	MI-0827 × MI-0836	**9**	MI-0439 × MI-0012
4	MI-0868× MI-0836	**10**	MI-0675 × MI-0440
5	MI-0853 × MI-0836	**11**	MI-0853 × MI-0125
6	MI-0835 × MI-0313	**12**	MI-0486 × MI-0012

Hybridization of Parents

Hybridization programme was carried out during Jan-Feb 2019 at *ex-situ* field gene bank of Central Sericultural Germplasm Resource Centre, Hosur. To pollinate young receptive females, fresh pollen grains were collected from identified male parents. Pollen grains were collected in the late morning hours when anthesis occurred. The collected pollen grains were dusted on receptive female catkins, and repeated twice.

Fig.5 Hybridization of the female plants

Fruit collection and seed extraction

Fruit collection and hybrid seed extraction from twelve selected crosses were completed during the month of April, 2019 at CSGRC, Hosur and these seeds were supplied to PI, RSRS Jammu for raising hybrid progenies and further evaluation.

Fig.6 Fruit collection from female parents in FGB and seed extraction in plastic trays

Fig.7 Seed samples of MI 0835 x MI 0313 and packed with proper labelling

3. PIC-01003CN – NW 4b: Sugar-mimic alkaloids in mulberry and their role in modulating host plant-insect interactions (Jun.18 – May' 21) (CSGRC, Hosur, UAS-GKVK, Bengaluru, CSRI-NCL-Pune, CSR&TI, Mysuru)

UAS, GKVK Bengaluru: *R. Uma Shanker, N. Nataraja Karaba*
CSIR-NCL-Pune: *H.V. Thulasiram,* ***CSGRC, Hosur:*** *G. Thanavendan*

Background

A multi-institutional project funded by DBT and CSB, Govt. of India was taken up to explore the diversity of sugar-mimic alkaloids in the mulberry germplasm including a range of *Morus* species, geographical provenances, examine their insecticidal activity, study the biochemical and molecular basis of the insecticidal activity caused by the sugar-mimic alkaloids and understand the molecular basis of resistance in those pests that are able to overcome mulberry plant's defenses.

Progress

CSGRC, Hosur is one of the collaborators in the project with a work plan that involves maintenance of mulberry genetic resources shortlisted for the study and supply of samples of leaf as well as latex for further biochemical and other studies to the other collaborating institutes. As a collaborator of the project, the concerned scientist of this centre participated in the project related meetings. During the period supplied the leaf and latex samples of 13 different mulberry species (approx. 100ml) maintained in the field gene bank to CSIR-NCL, Pune for further experimental work.

Fig.8 Latex collection of different mulberry genotypes from FGB

Fig.9 Project discussions during March 2020 at GKVK, Bengaluru

Fig.10 Latex samples of mulberry genotypes

Projects initiated during 2019-20

During the period under report, three new projects [two in-house and one collaborative] as indicated below were approved during March 2020.

1. PIG - 06004S1: **Studies on the cytological status of mulberry core-set accessions** (Mar.20 - Feb.23)

Raju Mondal and M.C. Thriveni

Background

Ploidy breeding warrants information on cytological status to achieve desired crop improvement. In this context, a project has been initiated during March 2020 to investigate the cytological status in

selected mulberry genotypes to find out the ploidy level. This will help to identify chromosome duplicates with similar genotypes in a particular species which could be demarcated to prioritize management of unique profiles in the mulberry field bank.

Progress

The morphological data (passport data) collection in the database is being analyzed for selection of mulberry genotypes followed by cluster analysis to identify similar genotypes.

2. PIG - 06005 S1: Molecular characterization of mulberry genetic resources for the identification of duplicates and effective utilization (Mar.20 - Feb.23)

M.C. Thriveni and Raju Mondal

Background

Developing new mulberry variety by conventional methods of breeding and selection takes a minimum of 15-20 years without any guarantee of release of new variety. Thus, in order to curtail the breeding period, expenditure and also to enhance efficiency of selection process, dependable marker systems are essential. In this context, a project has been initiated during March 2020 to characterize selected mulberry genotypes through molecular markers for the identification of duplicates and their demarcation that can help easy selection for quantitative traits.

Progress

The morphological and passport data was verified for 100 accessions. Each morphological descriptor was coded using 0-9 scale. The coded accessions were verified for accuracy and subjected to cluster analysis. The 100 accessions with coded morphological descriptors were subjected to cluster analysis using PAST software and UPGMA tree was generated for all the accessions. Those accessions which are in single cluster will be considered as suspected duplicates to be subjected to DNA isolation.

3. PIT–08004MI: **Studies on epigenetic and autophagy modifiers on induction of haploid microspore embryogenesis in mulberry.** ***(SBRL Kodathi with CSGRC Hosur)*** (Mar.20 - Feb.23)

SBRL, Kodathi: *A. Ramesha (PI) and Himanshu Dubey (CI)*
RCS, CO: *Prashanth Sangannavar (CI),* ***CSGRC, Hosur****: Raju Mondal (CI)*

Background

Homozygous/inbred lines are used for trait heritability studies and trait discovery applications such as mapping, gene functional analysis and for development of superior hybrids from the parents lacking undesirable alleles. In mulberry there is a lack of homozygous / inbred lines, deterring crop improvement through trait discovery analysis and breeding. Therefore, a project was initiated during March 2020 by SBRL Kodathi with CSGRC as collaborator to study the effect of chemicals in inhibiting pollen cell death and modifying the epigenetic status in mulberry as reported in few other crop plants so as to enhance haploid microspore embryogenesis and regeneration of haploid plants.

Progress

CSGRC, Hosur has initiated activities for selection and planting of mulberry accession for the aforesaid study.

SILKWORM DIVISION

Projects continued through and concluded during 2019-20

1. AIB-3577: Evaluation of multivoltine germplasm to identify potential parents for developing cross breeds suitable for Southern and Eastern India (June 2016 – May 2019)
(CSGRC, Hosur with CSR&TI, Mysuru & Berhampore)

CSGRC, Hosur: *G. Punithavathy (from July 2018), N.Balachandran (till June 2018), Nivedita S (till June 2018), D S Somaprakash & Jameela Khatoon (from July 2018),* ***CSRTI, Mysuru:*** *K.B. Chandrashekar & P.V.Soudaminy,****CSR&TI Berhampore:*** *G.C. Das & N.Chandrakanth*

Introduction:

India, a country of tropical climatic conditions is mainly dependent on the crossbreed and multivoltine type of silk production. Most of the sericultural areas are under tropical regions and 77% of the raw silk production comes from crossbreeds (Multivoltine x bivoltine) and the rest is bivoltine silk (CSB Annual Report, 2015-16). Therefore, it becomes a priority to improve the quality and quantity of multivoltine silk. In this context, evolving superior multivoltine parental breeds for tropical conditions in the crossbreed dfls production is very much essential.

Silkworm germplasm constitute the potential raw material and having wide variation in their genotypic expressions, there is always under-utilization of silkworm germplasm resources for breeding programmes. Therefore, the silkworm breeding strategy is oriented towards involving multivoltine silkworm genetic resources at CSGRC, Hosur in preparation of Improved cross breeds with specific qualitative and quantitative traits. Multivoltine silkworm genetic resources available at CSGRC, Hosur were not explored by the breeders so far and also studies related to pre-breeding involving multivoltine silkworm genetic resources from CSGRC gene bank is not yet attempted. Therefore, it is proposed to conduct pre-breeding involving promising multivoltine silkworm genotypes from silkworm gene bank of CSGRC, Hosur crossed with popular bivoltine breed (CSR_2) and assessed the performance of these cross breeds in different agro-climatic regions for further utilization by the breeders, for improvement of quality silk production.

Objective

The project aims to evaluate multivoltine germplasm accessions for the identification of crossbreeds suitable for Southern and Eastern Zones.

Methodology

A. Identification and short listing of better performing multivoltine accessions

Eighty-one multivoltine accessions conserved at CSGRC, Hosur from different geographical locations were crossed with CSR-2 and evaluated at CSGRC,Hosur in three different seasons for 12 rearing and 3 post cocoon traits for assessing their superiority using the multiple trait Evaluation Index method (Mano, 1993). The values of the combinations pertaining to PM x CSR2 and Nistari x CSR2

were set as the cut off values and those combinations which performed better than these two ruling popular cross breed races were short listed for further evaluation in different geographical areas. Table 18.

Table 18. Short listed Better Performing Multi x Bi combinations

Sl. No.	Multi X Bi combinations	Performance
1	BMI-0001 x BBI-0290 (PM X CSR2)	Control
2	BMI-0007 x BBI-0290 (Mysore Princess X CSR2)	Top ranking
3	BMI-0017 x BBI-0290 (Nistari X CSR2)	Control
4	BMI-0022 x BBI-0290 (KW X CSR2)	Top ranking
5	BMI-0025 x BBI-0290 (A25 X CSR2)	Top ranking
6	BMI-0026 x BBI-0290 (Oval X CSR2)	Top ranking
7	BMI-0030 x BBI-0290 (GNM X CSR2)	Top ranking
8	BME-0048 x BBI-0290 (Nistid W X CSR2)	Top ranking
9	BMI-0054 x BBI-0290 (DMR X CSR2)	Top ranking
10	BMI-0055 x BBI-0290 (LMO X CSR2)	Top ranking
11	BMI-0068 x BBI-0290 (M12W X CSR2)	Top ranking
12	BMI-0069 x BBI-0290 (M15 X CSR2)	Top ranking
13	BMI-0074 x BBI-0290 (MH1 X CSR2)	Top ranking
14	BMI-0076 x BBI-0290 (APM2 X CSR2)	Top ranking
15	BMI-0077 x BBI-0290 (APM3 X CSR2)	Top ranking
16	BMI-0078 x BBI-0290 (APDR15 X CSR2)	Top ranking
17	BMI-0079 x BBI-0290 (Mcon1 X CSR2)	Top ranking
18	BMI-0080 x BBI-0290 (Mcon4 X CSR2)	Top ranking
19	BMI-0081 x BBI-0290 (L14 X CSR20)	Top ranking
20	BMI-0082 x BBI-0290 (L15 X CSR2)	Top ranking

B. Evaluation of Short-listed Multi X Bi combinations

The above shortlisted hybrid combinations were evaluated for two years in six rearing trials at two test centres *viz.,* CSGRC,Hosur & CSRTI, Mysore (southern zone) along with control PM x CSR2 (BMI-0001 x BBI-0290) and at CSRTI, Berhampore (Eastern zone) along with control Nistari x CSR2 (BMI-0017 x BBI-0290). Three replications each of 300 larvae were retained after third-moult to assess the performance of these cross breed combinations. The post-cocoon parameters were analysed at Post Cocoon Evaluation Unit, of the respective test centre adopting standard reeling procedure. Nine rearing and six reeling parameters were considered for evaluation during the study. The data were recorded for Fecundity (No,), Hatching (%), Larval weight (g), Yield /10,000 larvae by weight (kg.), Pupation rate (%), Single cocoon weight (g), Single shell weight (g), Shell ratio (%) and Average Filament length (m.), Non-breakable filament length (m), Denier, Reelability (%), Renditta (kg) and Raw silk (%). The rearing and reeling performance data recorded was pooled and statistically analysed. The Multiple Trait Evaluation Index was computed for all the traits studied, except for Denier and Renditta.

Statistical Analysis

Collection, compilation of data of all the centres was carried out and analyzed statistically. Calculated multi-trait evaluation index value and percentage of improvement over the control to identify the location wise potential Multi x Bi combinations.

Results and Discussion

CSGRC, Hosur: The mean rearing performance pertaining to economic traits of the 20 shortlisted Multi x Bi hybrid combinations are presented in Table 19. The top performing M x B hybrid combinations recorded the pupation (96-97%), cocoon weight (1.5 -1.606g), shell weight (0.283 - 0.306g), shell percentage (18.58-20.16%) and average filament length (692- 850 m). Based on nine rearing and six reeling parameters, five combinations *viz*., BMI-0025 x BBI-0290, followed by BME-0048 x BBI-0290, BMI-0074 x BBI-0290, BMI-0079 x BBI-0290 & BMI-0076 x BBI-0290 performed better and expressed the EI values of 58.58, 56.41, 55.97, 55.79 & 55.11 respectively have been selected as top performers. The percentage of improvement over control ranged from 6.0 to 7.2% (Table-20).

CSR&TI Mysuru: The rearing and reeling performance and mean evaluation index of the pooled data of all the six rearing trials and one reeling trial is given in Table-21. Among the twenty hybrid combinations, BMI-0079 x BBI-0290 recorded the highest cocoon weight of 1.553 g and BMI-0081 x BBI-0290 recorded highest shell weight and shell ratio of 0.303 g and 19.69% respectively and recorded the highest mean EI value of 55.72. Based on nine rearing and three reeling parameters, five combinations *viz*., BMI-0081 x BBI-0290 showed significant percent of improvement (3.18%) over control, and BMI-0079 x BBI-0290, BME-0048 x BBI-0290, BMI-0025 x BBI-0290 & BMI-0074 x BBI-0290 recorded EI values above 50 (Table-22).

CSR&TI Berhampore: The rearing and reeling performance of twenty shortlisted crossbreeds along with mean evaluation index (EI) values for fifteen economic traits are shown in Table 23. The maximum cocoon yield per 10000 larvae by weight (12.42kg) was recorded in BMI-0080 x BBI-0290 followed by BMI-0079 x BBI-0290 (12.09kg). Higher cocoon weight (1.561g) and shell weight (0.290g) was recorded in BME-0048 x BBI-0290. The maximum shell percentage of 19.95 was recorded in BMI-0080 x BBI-0290 followed by 19.33 in BMI-0076 x BBI-0290. Among the twenty combinations tested, BMI-0025 x BBI-0290 exhibited maximum average EI value of 54.45 followed by 53.12 in BME-0048 x BBI-0290.

The mean evaluation index and percentage of improvement over control of the pooled data of all the six rearing trials and three reeling trials is given in Table-24 and revealed that the BMI-080 x BBI-0290, followed by BMI-0079 x BBI-0290, BMI-0025 x BBI-0290, BME-0048 x BBI-0290 & BMI-0068 x BBI-0290 were the top performing accessions with EI values of 59.19, 55.62, 54.45, 53.12 & 52.42 respectively and 6.83, 5.63, 4.18, 2.85 & 2.69 % of improvement over control.

Table 19. Rearing performance of Multi x Bi combinations at CSGRC, HOSUR (Mean of six trials)

Sl. No	Multi x bi combinations	Rearing parameters									Reeling parameters*						Average EI
		Fecundity (no.)	Hatching %	Wt. of 10 grown larvae (g)	ERR		Pupation rate (%)	Single cocoon wt.(g)	Single shell wt. (g)	Shell Ratio (%)	AFL (m)	NBFL (m)	Denier	Reelability (%)	Renditta	Raw silk recovery (%)	
					by no	by wt(Kg)											
1	BMI-0007 X BBI-0290	467	97.71	34.76	9719	14.55	96.48	1.488	0.269	18.21	724.07	629.86	2.51	87.12	7.31	77.31	47.64
2	BMI-0017 X BBI-0290	451	96.91	34.62	9735	14.21	96.60	1.48	0.263	17.91	628.94	582.97	2.69	93.04	8.36	69.00	42.40
3	BMI-0022 X BBI-0290	431	96.73	35.86	9675	13.88	95.76	1.484	0.272	18.39	718.62	653.72	2.58	91.03	7.48	75.05	43.45
4	BMI-0025 X BBI-0290	451	96.69	41.01	9770	15.92	96.95	1.606	0.301	18.83	784.25	708.56	2.68	90.75	6.96	79.04	58.58
5	BMI-0026 X BBI-0290	462	97.41	37.96	9565	13.97	94.64	1.535	0.287	18.77	733.03	668.86	2.79	91.29	7.34	74.80	46.80
6	BME-0030 X BBI-0290	455	96.07	36.48	9715	15.20	96.58	1.507	0.29	19.40	698.42	639.24	2.92	91.74	6.96	76.49	49.94
7	BME-0048 X BBI-0290	472	97.12	40.69	9749	16.04	96.37	1.604	0.296	18.58	692.54	638.46	2.95	92.43	7.01	76.78	56.41
8	BMI-0054 X BBI-0290	473	96.59	37.95	9741	15.89	96.7	1.484	0.279	18.92	735.98	655.27	2.63	89.09	7.33	75.69	51.61
9	BMI-0055 X BBI-0290	482	96.58	38.55	9772	15.53	96.89	1.535	0.28	18.29	726.05	642.40	2.63	88.69	7.73	72.87	51.82
10	BMI-0068 X BBI-0290	466	97.59	34.06	9704	13.91	96.54	1.461	0.277	19.06	702.02	659.45	2.53	94.1	7.50	73.06	48.50
11	BMI-0069 X BBI-0290	454	96.66	34.98	9724	14.68	96.39	1.452	0.27	18.69	713.00	659.37	2.56	92.66	7.04	77.81	47.40
12	BMI-0074 X BBI-0290	461	97.87	37.51	9680	15.99	96.21	1.500	0.283	18.87	819.14	758.56	2.53	92.95	6.78	78.43	55.97
13	BMI-0076 X BBI-0290	440	96.91	37.60	9696	14.42	95.99	1.528	0.306	20.09	849.80	768.18	2.56	90.61	6.49	78.13	55.11
14	BMI-0077 X BBI-0290	466	97.26	36.50	9722	14.02	96.55	1.499	0.278	18.68	663.09	580.10	2.82	87.76	7.35	73.74	45.39
15	BMI-0078 X BBI-0290	474	96.69	37.29	9725	14.55	96.68	1.471	0.281	19.19	686.21	625.13	2.64	91.26	7.58	68.76	48.13
16	BMI-0079 X BBI-0290	490	97.61	38.33	9662	15.71	95.56	1.518	0.304	20.16	759.70	674.29	2.81	88.68	6.89	76.27	55.79
17	BMI-0080 X BBI-0290	457	97.50	37.92	9744	15.52	96.68	1.524	0.29	19.04	778.28	636.72	2.7	81.87	7.13	73.68	50.38
18	BMI-0081 X BBI-0290	463	96.61	40.58	9738	15.37	96.46	1.552	0.293	19.01	719.72	644.7	2.78	89.79	7.26	72.38	51.52
19	BMI-0082 X BBI-0290	452	96.38	37.15	9816	14.28	97.58	1.476	0.270	18.60	674.19	600.47	2.86	89.4	7.35	77.38	48.20
20	BMI-0001 X BBI-0290 (control)	463	96.91	35.42	9688	14.88	96.37	1.50	0.271	17.86	621.77	536.1	2.75	86.61	8.21	66.85	41.95
	Mean	461	96.99	37.26	9717	14.92	96.39	1.51	0.28	18.82	721.44	648.12	2.69	90.04	7.30	74.67	
	SD	13.62	0.49	2.00	51.08	0.77	0.59	0.04	0.01	0.59	57.22	54.58	0.13	2.82	0.44	3.41	
	CV	2.95	0.50	5.38	0.52	5.16	0.61	2.76	4.38	3.17	7.93	8.42	4.97	3.13	6.11	4.57	

* *Mean of three trials*

Table 20. Ranking of the Top performing Multi x Bi combinations against control hybrids at CSGRC, Hosur

Sl.No.	Multi x bi combination	Fecundity (no.)	Hatching (%)	Wt. of 10 grown larvae (g)	ERR by no.	ERR by wt.(Kg)	Pupation rate (%)	Single cocoon wt.(g)	Single shell wt. (g)	Shell ratio (%)	Filament length (m)	NBFL (m)	Denier	Reelability (%)	Renditta	Raw silk recovery (%)	Mean
1	BMI-0025 x BBI-0290	451 *42.30* *-2.6*	96.69 *43.49* *-0.2*	41.00 *68.65* *15.8*	9770 *60.37* *0.8*	15.92 *62.90* *7.0*	96.95 *59.26* *0.6*	1.606 *72.86* *6.4*	0.301 *64.36* *11.5*	18.83 *50.05* *5.4*	784 *60.97* *26.1*	709 *61.07* *32.2*	2.68 - *-2.5*	90.75 *52.50* *4.8*	6.96 - *-15.1*	79.04 *62.77* *18.2*	- *58.58* *7.2*
2	BME-0048 x BBI-0290	472 *57.70* *1.9*	97.12 *51.96* *0.2*	40.69 *67.11* *14.9*	9749 *56.26* *0.6*	16.04 *64.45* *7.8*	96.37 *49.51* *0.0*	1.604 *72.38* *6.2*	0.296 *60.34* *9.6*	18.58 *45.87* *4.0*	693 *44.95* *11.4*	638 *48.23* *19.1*	2.95 - *7.3*	92.43 *58.45* *6.7*	7.00 - *-14.6*	76.78 *56.15* *14.9*	- *56.41* *6.0*
3	BMI-0074 x BBI-0290	461 *49.63* *-0.4*	97.87 *66.73* *1.0*	37.51 *51.24* *5.9*	9680 *42.76* *-0.1*	15.99 *63.80* *7.5*	96.21 *46.82* *-0.2*	1.500 *47.45* *-0.7*	0.283 *49.88* *4.8*	18.87 *50.72* *5.7*	819 *67.07* *31.7*	759 *70.23* *41.5*	2.53 - *-8.0*	92.95 *60.29* *7.3*	6.78 - *-17.3*	78.43 *60.98* *17.3*	- *55.97* *6.4*
4	BMI-0079 x BBI-0290	490 *70.91* *5.8*	97.61 *61.61* *0.7*	38.33 *55.33* *8.2*	9662 *39.23* *-0.3*	15.71 *60.17* *5.6*	95.56 *35.90* *-0.8*	1.518 *51.76* *0.5*	0.304 *66.77* *12.6*	20.16 *72.30* *12.9*	760 *56.69* *22.2*	674 *54.79* *25.8*	2.81 - *2.2*	88.68 *45.17* *2.4*	6.89 - *-16.0*	76.27 *54.66* *14.1*	- *55.79* *6.4*
5	BMI-0076 x BBI-0290	440 *34.22* *-5.0*	96.91 *47.82* *0.0*	37.60 *51.69* *6.2*	9696 *45.89* *0.1*	14.42 *43.44* *-3.1*	95.99 *43.13* *-0.4*	1.528 *54.16* *1.2*	0.306 *68.38* *13.3*	20.09 *71.13* *12.5*	850 *72.43* *36.7*	768 *71.99* *43.3*	2.56 - *-6.9*	90.61 *52.01* *4.6*	6.49 - *-20.9*	78.13 *60.10* *16.9*	- *55.11* *6.6*
6	BMI-0001 x BBI-0290 (control)	*463* *51.10*	96.91 *60.03*	35.42 *40.82*	9688 *44.32*	14.88 *49.40*	96.37 *49.51*	1.510 *49.84*	0.270 *39.42*	17.86 *33.82*	622 *32.58*	536 *29.48*	2.75 -	86.61 *37.84*	8.20 -	66.85 *27.11*	- *41.95* -

(Value in italics depicts evaluation index and the percentage improvement over control)

Table 21. Rearing performance of multi x bi combinations at CSR&TI, Mysuru

Sl. No.	Multi x bi combinations	Rearing parameters									Reeling parameters*			Average Evaluation Index
		Fecundity (no.)	Hatching %	Wt. of 10 grown larvae (g)	ERR by no.	ERR by wt (kg)	Pupation rate (%)	Single cocoon wt.(g)	Single shell wt. (g)	SR %	Filament length (m)	NBFL (m)	Denier (d)	
1	BMI-0007 x BBI-0290	446	96.82	32.14	9677	11.71	95.51	1.343	0.245	18.06	642.84	611.27	2.59	45.72
2	BMI-0017 x BBI-0290	439	96.59	30.90	9806	13.44	97.00	1.455	0.249	17.18	596.36	552.02	2.63	49.88
3	BMI-0022 x BBI-0290	452	97.01	29.70	9660	13.28	94.94	1.505	0.239	16.03	631.89	590.23	2.55	47.78
4	BMI-0025 x BBI-0290	449	96.42	34.88	9769	13.92	96.40	1.490	0.261	17.53	664.48	584.98	2.66	52.36
5	BMI-0026 x BBI-0290	439	96.97	31.38	9695	12.67	95.64	1.500	0.261	17.51	624.10	615.78	2.55	49.26
6	BME-0030 x BBI-0290	467	95.96	32.58	9762	13.22	96.64	1.460	0.244	16.73	640.49	596.02	2.76	48.72
7	BME-0048 x BBI-0290	454	96.84	35.52	9743	14.09	96.00	1.549	0.284	18.32	642.84	611.27	2.88	52.70
8	BMI-0054 X BBI-0290	454	96.48	33.89	9789	13.22	96.48	1.439	0.257	17.93	688.21	692.00	2.54	50.88
9	BMI-0055 X BBI-0290	456	96.34	35.85	9685	12.93	95.79	1.384	0.246	17.76	736.67	722.54	2.61	49.99
10	BMI-0068 X BBI-0290	422	95.63	28.34	9749	13.79	96.06	1.509	0.281	18.55	721.59	688.52	2.66	48.44
11	BMI-0069 X BBI-0290	454	96.98	30.00	9674	13.43	95.06	1.465	0.270	18.38	643.61	636.74	2.79	48.02
12	BMI-0074 X BBI-0290	448	96.69	33.39	9669	13.16	95.08	1.535	0.266	17.42	693.17	650.15	2.62	52.33
13	BMI-0076 X BBI-0290	458	96.66	31.38	9432	12.30	92.79	1.498	0.288	19.28	786.16	742.68	2.59	48.98
14	BMI-0077 X BBI-0290	452	96.26	30.55	9669	12.96	95.71	1.447	0.283	19.48	664.45	599.18	2.75	52.04
15	BMI-0078 X BBI-0290	444	95.88	31.75	9641	12.13	95.05	1.450	0.283	19.32	616.02	494.05	2.60	45.12
16	BMI-0079 X BBI-0290	466	96.76	30.68	9575	13.36	94.40	1.553	0.301	19.23	705.99	644.63	2.75	53.59
17	BMI-0080 X BBI-0290	454	95.83	34.73	9712	13.18	95.34	1.390	0.252	18.16	657.43	646.76	2.58	48.00
18	BMI-0081 X BBI-0290	450	96.12	33.41	9704	13.92	95.56	1.534	0.303	19.69	661.94	657.34	2.82	55.72
19	BMI-0082 X BBI-0290	450	96.32	33.30	9737	12.24	96.35	1.430	0.260	18.15	671.45	621.48	2.73	48.20
20	BMI-0001 X BBI-0290 (control)	478	96.81	30.33	9703	14.23	96.10	1.498	0.269	18.06	652.84	642.12	2.69	54.01
	Mean	451.00	96.47	32.24	9692.00	13.16	95.60	1.47	0.27	18.14	667.13	629.99	2.72	50.00
	SD	11.55	0.42	2.09	82.19	0.68	0.93	0.06	0.02	0.95	69.05	75.61	0.17	
	CV	2.56	0.43	6.47	0.85	5.19	0.97	3.84	7.12	5.24	8.88	10.08	6.24	

* *one reeling trial*

Table 22. Ranking of the Top performing Multi x Bi combinations against control hybrids at CSR&TI, Mysuru

Sl. No.	Multi x bi combinations	Fecundity (no.)	Hatching %	Wt. of 10 grown larvae (g)	ERR by no.	ERR by wt. (kg)	Pupation rate (%)	Single cocoon wt.(g)	Single shell wt. (g)	SR %	Filament length (m)	NBFL (m)	Denier	Mean
1	BMI-0081 x BBI-0290	450 *48.61* *-5.86*	96.12 *41.62* *-0.71*	33.41 *55.63* *10.15*	9704 *51.39* *0.01*	13.92 *61.14* *-2.18*	95.56 *49.62* *-0.56*	1.534 *61.01* *2.40*	0.303 *68.85* *12.64*	19.69 *66.31* *9.03*	796.27 *52.69* *6.64*	796.27 *56.09* *6.64*	2.78 - *0.00*	-- *55.72* *3.18*
2	BMI-0079 x BBI-0290	466 *62.47* *-2.51*	96.76 *57.00* *-0.05*	30.68 *42.54* *1.15*	9575 *35.69* *-1.32*	13.36 *52.94* *-6.11*	94.40 *37.13* *-1.77*	1.553 *64.37* *3.67*	0.301 *67.80* *11.90*	19.23 *61.47* *6.48*	793.91 *52.35* *6.33*	793.91 *55.77* *6.33*	2.71 - *-2.52*	- *53.59* *-1.80*
3	BME-0048 x BBI-0290	454 *52.07* *-5.02*	96.84 *58.92* *0.03*	35.52 *65.74* *17.11*	9743 *56.13* *0.41*	14.09 *63.63* *-0.98*	96.00 *54.35* *-0.10*	1.549 *63.66* *3.40*	0.284 *58.86* *5.58*	18.32 *51.90* *1.44*	627.3 *28.22* *-15.99*	570.27 *26.20* *-23.62*	3.21 -- *15.47*	- *52.70* *-0.19*
4	BMI-0025 x BBI-0290	449 *47.74* *-6.07*	96.42 *48.83* *-0.40*	34.88 *62.67* *15.00*	9769 *59.30* *0.68*	13.92 *61.14* *-2.18*	96.40 *58.66* *0.31*	1.490 *53.23* *-0.53*	0.261 *46.76* *-2.97*	17.53 *43.60* *-2.93*	807.08 *54.25* *8.09*	672.56 *39.73* *-9.92*	2.66 -- *-4.32*	- *52.36* *-0.44*
5	BMI-0074 x BBI-0290	448 *46.88* *-6.28*	96.69 *55.32* *-0.12*	33.39 *55.53* *10.09*	9669 *47.13* *-0.35*	13.16 *50.01* *-7.52*	95.08 *44.47* *-1.06*	1.535 *61.19* *2.47*	0.266 *49.39* *-1.12*	17.42 *42.44* *-3.54*	848.81 *60.30* *13.68*	848.81 *63.04* *13.68*	2.62 - *-5.76*	- *52.33* *-1.18*
6	BMI-0001 x BBI-0290 (control)	478 *72.86*	96.81 *58.20*	30.33 *40.87*	9703 *51.27*	14.23 *65.68*	96.10 *55.43*	1.498 *54.65*	0.269 *50.97*	18.06 *49.17*	746.66 *45.50*	746.66 *49.53*	2.78 -	- *54.01*

(Value in italics depicts evaluation index and the percentage improvement over control)

Table 23. Rearing performance of multi x bi combinations at CSR&TI, Berhampore (Mean of six trials)

Sl. No.	Multi x bi combinations	Rearing parameters									Reeling parameters*						Average EI
		Fecundity (no.)	Hatching (%)	Wt. of 10 grown larvae(g)	ERR by no.	ERR by wt (kg)	Pupation rate (%)	Single cocoon wt.(g)	Single shell wt. (g)	SR %	Filament length (m)	NBFL (m)	Denier	Reelability (%)	Renditta	Raw silk recovery (%)	
1	BMI-0001 x BBI-0290	433	95.01	34.49	8547	12.21	84.28	1.422	0.248	17.41	605.50	444.11	2.46	72.00	8.93	73.72	46.43
2	BMI-0007 x BBI-0290	478	97.17	34.62	7493	9.86	72.79	1.364	0.252	18.52	694.00	465.50	2.40	74.33	8.66	71.61	4784
3	BMI-0022 x BBI-0290	448	97.68	35.23	7376	9.45	70.88	1.399	0.261	18.92	650.06	458.33	2.38	68.44	9.87	69.67	45.89
4	BMI-0025 x BBI-0290	437	95.54	38.15	7866	10.65	77.52	1.460	0.268	18.51	749.83	691.33	2.43	75.61	8.89	72.94	54.45
5	BMI-0026 x BBI-0290	445	94.57	35.54	8165	11.08	81.06	1.404	0.239	17.12	704.28	653.61	2.33	74.67	9.21	73.00	48.11
6	BME-0030 x BBI-0290	428	94.82	36.30	6422	8.77	62.30	1.449	0.268	18.79	682.22	626.22	2.55	70.17	8.34	71.33	45.81
7	BME-0048 x BBI-0290	488	96.04	38.80	7133	10.03	69.71	1.561	0.290	18.71	678.00	586.39	2.37	79.17	8.90	71.67	53.12
8	BMI-0054 x BBI-0290	431	93.82	38.31	7636	10.60	73.94	1.456	0.268	18.46	675.89	483.11	2.41	66.78	9.68	70.50	47.36
9	BMI-0055 x BBI-0290	433	95.11	37.16	7600	10.32	73.30	1.447	0.264	18.24	669.33	613.33	2.34	74.83	8.60	73.33	49.90
10	BMI-0068 x BBI-0290	420	91.26	37.77	8050	11.26	78.76	1.471	0.277	18.77	670.94	596.28	2.35	79.22	8.44	75.17	52.42
11	BMI-0069 x BBI-0290	421	94.33	35.75	8853	12.30	87.25	1.392	0.257	18.30	708.00	499.39	2.40	73.94	8.37	73.39	50.87
12	BMI-0074 x BBI-0290	510	94.54	36.02	8126	11.33	79.37	1.394	0.255	18.31	704.33	634.83	2.44	72.56	9.22	70.61	50.70
13	BMI-0076 x BBI-0290	450	93.88	36.53	7266	9.89	71.13	1.408	0.272	19.33	716.72	521.00	2.33	71.33	9.04	66.83	47.37
14	BMI-0077 x BBI-0290	445	95.42	37.89	7659	10.47	74.89	1.477	0.278	18.97	635.78	438.78	2.40	73.94	8.72	68.94	51.91
15	BMI-0078 x BBI-0290	495	95.25	38.47	6336	8.94	60.89	1.443	0.276	19.23	592.83	532.82	2.54	71.61	9.93	65.72	51.28
16	BMI-0079 x BBI-0290	498	95.60	35.62	8472	12.09	83.27	1.459	0.273	18.73	668.89	613.06	2.47	77.44	9.09	73.67	55.62
17	BMI-0080 x BBI-0290	479	94.40	38.77	8544	12.42	84.56	1.488	0.294	19.95	713.72	542.95	2.42	73.56	9.56	73.44	59.19
18	BMI-0081 x BBI-0290	492	96.13	38.42	5420	7.57	52.30	1.515	0.286	19.04	660.89	453.00	2.53	68.50	8.95	72.00	47.35
19	BMI-0082 x BBI-0290	426	96.69	35.60	7767	10.82	75.13	1.466	0.272	18.70	669.67	434.50	2.47	78.58	10.19	73.25	51.56
20	BMI-0017 x BBI-0290 (control)	388	94.87	34.53	8182	10.22	80.62	1.371	0.252	18.53	656.17	585.17	2.58	73.11	9.47	68.94	44.84
	Mean	452	95.11	36.69	7645	10.51	74.69	1.442	0.268	18.63	675.00	544.00	2.43	73.49	9.10	71.49	
	SD	33	1.37	1.52	841	1.26	8.73	0.049	0.014	0.62	37.33	138.00	0.08	3.50	0.54	2.46	
	CV	7	1.44	4.13	11	12.02	11.68	3.408	5.348	3.31	5.53	24.27	3.09	4.77	5.89	3.44	

* *Mean of three trials*

Table 24: Ranking of the Top performing Multi x Bi combinations against control hybrids at CSR&TI, Berhampore

Sl. No.	Multi x bi combination	Fecundity (no.)	Hatching (%)	Wt. of 10 grown larvae (g)	ERR by no.	ERR by wt.(Kg)	Pupation rate (%)	Single cocoon wt.(g)	Single shell wt. (g)	Shell ratio (%)	Filament length (m)	NBFL (m)	Denier	Reelability (%)	Renditta	Raw silk recovery (%)	Mean
1	BMI-0080 x BBI-0290	479 *58.15* *23.45*	94.40 *44.84* *-0.50*	38.77 *63.67* *12.28*	8544 *60.68* *4.42*	12.42 *65.08* *21.53*	84.56 *61.30* *4.89*	1.488 *59.30* *8.53*	0.294 *68.52* *16.67*	19.95 *71.46* *7.66*	713.72 *60.28* *8.77*	542.95 *48.10* *-7.21*	2.42 - *-6.20*	73.56 *50.20* *0.62*	9.56 - *0.95*	73.44 *57.94* *6.53*	- *59.19* *6.83*
2	BMI-0079 x BBI-0290	498 *63.94* *28.35*	95.60 *53.60* *0.77*	35.62 *42.88* *3.16*	8472 *59.82* *3.54*	12.09 *62.47* *18.30*	83.27 *59.82* *3.29*	1.459 *53.40* *6.42*	0.273 *53.84* *8.33*	18.73 *51.67* *1.08*	668.89 *48.27* *1.94*	613.06 *53.17* *4.77*	2.47 - *-4.26*	77.44 *61.27* *5.92*	9.09 - *-4.01*	73.67 *58.88* *6.86*	- *55.62* *5.63*
3	BMI-0025 x BBI-0290	437 *45.35* *12.63*	95.54 *53.16* *0.71*	38.15 *59.58* *10.48*	7866 *52.62* *-3.86*	10.65 *51.08* *4.21*	77.52 *53.23* *-3.85*	1.460 *53.60* *6.49*	0.268 *50.35* *6.35*	18.51 *48.10* *-0.11*	749.83 *69.95* *14.27*	691.33 *58.84* *18.14*	2.43 - *-5.81*	75.61 *56.05* *3.42*	8.89 - *-6.12*	72.94 *55.91* *5.80*	- *54.45* *4.18*
4	BME-0048 x BBI-0290	488 *60.89* *25.77*	96.04 *56.81* *1.23*	38.80 *63.87* *12.37*	7133 *43.91* - *12.82*	10.03 *46.17* *-1.86*	69.71 *44.28* *-13.53*	1.561 *74.15* *13.86*	0.290 *65.73* *15.08*	18.71 *51.35* *0.97*	678.00 *27.89* *3.33*	586.39 *84.35* *0.21*	2.37 - *-8.14*	79.17 *44.64* *8.29*	8.90 - *-6.02*	71.67 *26.56* *3.96*	- *53.12* *2.85*
5	BMI-0068 x BBI-0290	420 *40.17* *8.25*	91.26 *21.93* *-3.81*	37.77 *57.07* *9.38*	8050 *54.81* *-1.61*	11.26 *55.90* *10.18*	78.76 *54.66* *-2.31*	1.471 *55.84* *7.29*	0.277 *56.64* *9.92*	18.77 *52.32* *1.30*	670.94 *48.82* *2.25*	596.28 *51.96* *1.90*	2.35 - *-8.91*	79.22 *66.35* *8.36*	*8.44* *-10.88*	75.17 *64.97* *9.04*	- *52.42* *2.69*
6	BMI-0017 x BBI-0290 (control)	388 *30.42*	94.87 *48.27*	34.53 *35.69*	8182 *56.38*	10.22 *47.67*	80.62 *56.79*	1.371 *35.49*	0.252 *39.17*	18.53 *48.43*	670.94 *44.86*	596.28 *51.15*	2.35 -	79.22 *48.92*	*8.44* -	75.17 *39.65*	- *44.84*

(Value in italics depicts evaluation index and the percentage improvement over control)

Outcome of the Project

India, being a tropical country, is more suitable for raw silk production from crossbreeds, which can perform well in varying environmental conditions. In order to assess the quality and productivity of the crossbreeds, it is necessary to test the hybrid combinations in different locations to identify superior cross breed combinations. Keeping the above in view, in the present study, five multi x bi hybrid combinations were identified based on their overall performance and evaluation index values / percentage of improvement over control at each test location. At CSGRC, Hosur, the top performing accessions were BMI-0025 x BBI-0290, BME-0048 x BBI-0290, BMI-0074 x BBI-0290, BMI-0079 x BBI-0290 & BMI-0076 x BBI-0290. At CSR&TI, Mysore, BMI-0081 x BBI-0290, BMI-0079 x BBI-0290, BME-0048 x BBI-0290, BMI-0025 x BBI-0290 & BMI-0074 x BBI-0290 performed well. At CSR&TI, Berhampore, BMI-080 x BBI-0290, followed by BMI-0079 x BBI-0290, BMI-0025 x BBI-0290, BME-0048 x BBI-0290 & BMI-0068 x BBI-0290 were the top performing accessions. Further, in all the three test locations, three hybrid combinations that consistently performed better were BMI-0025 x BBI-0290, BMI-0079 x BBI-0290 and BME-0048 x BBI-0290 (Table-25).

Table 25. Top performing multi x bi combinations in different test centres

CSGRC, Hosur	CSR&TI, Mysore	CSR&TI, Berhampore
BMI-0025 x BBI-0290	BME-0081 x BBI-0290	BMI-0080 x BBI-0290
BMI-0076 x BBI-0290	**BMI-0079 x BBI-0290**	**BMI-0025 x BBI-0290**
BMI-0074 x BBI-0290	**BMI-0048 x BBI-0290**	**BMI-0079 x BBI-0290**
BMI-0079 x BBI-0290	**BMI-0025 x BBI-0290**	BMI-0068 x BBI-0290
BME-0048 x BBI-0290	BMI-0079 x BBI-0290	**BME-0048 x BBI-0290**

Recommendations

- The results clearly indicate that the multivoltine accessions identified as better combiners for multiple traits under each centre are economically viable as they have recorded >50 mean evaluation index values.

- The centre-wise top performing accessions are recommended for further large scale trials and to select a best one for commercial exploitation in the respective region.

Among the top performing multivoltine accessions, the accessions *viz*., **BMI-0025, BMI-0079 and BMI-0048** recorded their superiority at all test centres proving their utility as better parental breeds and they can be used in the breeding programmes for regional specific race / breed improvement programmes.

2. AIB-3578: Evaluation of exotic bivoltine silkworm breeds to identify promising parental genetic resources (Jun.16 – Sept.19) (CSGRC Hosur with **CSR&TI** Mysuru, Berhampore and Pampore)

CSGRC, Hosur: *M. Maheswari (from July 2018) M. Muthulakshmi (till June 2018), G. Lokesh, D.S.Somaprakash & Jameela Khatoon (from July 2018),*
CSR&TI, Mysuru: *C.M. Kishor Kumar & M.S. Ranjini*
CSR&TI, Berhampore: *G.C. Das & N. Chandrakant,*
CSR&TI, Pampore: *Babulal, Shivakumar & Bharat Kumar*

Introduction

In India, most of the sericultural areas are under tropical regions and 90% of the raw silk production comes from crossbreeds (Multi x Bi). Since bivoltine races were also one of the counterparts to produce crossbreed, emphasis was given towards development of high yielding bivoltine breeds. Selection of parents as resource material is a prerequisite contributing to the success of breeding potential breeds / hybrids. Thorough and proper evaluation of the genetic resources and utilization of the native breeds of potential nature will help the breeder to select most effective genotypes before choosing the materials for breeding. Among the Research Institutes, Central Sericultural Research and Training Institute, Berhampore, Mysuru and Pampore and Regional stations working under those institutes were the pioneers in silkworm breeding. CSR&TI, Berhampore initiated silkworm breeding by working an elaborate way between 1960s to 1980s and came out with many new high yielding bivoltine breeds like SK3, SK4, SK5, SK6, SK7, YB and BHR series.

The success of silkworm breeds developed with great caution by the silkworm breeders mainly depends on its combining ability. Quite a good number of bivoltine breeds with high silk content and raw silk recovery developed at CSR&TI, Mysore are being maintained systematically and the single hybrid CSR2xCSR4 and the double hybrid (CSR2xCSR27) x (CSR6xCSR26) are being extensively reared in India (Basavaraja *et al.,* 2005 and Nirmal Kumar *et al*., 1998) which have played a key role in boosting bivoltine silk production in India.

Presently, India is producing mainly non-gradable silk from Multivoltine x Bivoltine. (cross breeds) which is mostly suitable for handlooms. In the recent years, power looms are emerging as major consumers of raw silk to produce fine silk fabrics of high quality, for which international grade silk is essential. Therefore, the silkworm breeding strategy should be oriented towards preparation of bivoltine hybrids with high silk productivity. Hence, the study has been planned to utilize the promising exotic bivoltine breeds shortlisted from bivoltine germplasm resources for preparing hybrid combinations by crossing with CSR2/CSR4 to evaluate their performance. The identified potential exotic bivoltine parental breeds can be utilized in breeding and hybrid seed production for commercial exploitation.

Objective

To identify bivoltine silkworm germplasm for specific qualitative and quantitative traits.

Methodology

- Evaluation, Characterisation and conservation rearing of 369 accessions of bivoltine silkworm germplasm resources was conducted and short listed 20 exotic bivoltine silkworm accessions

available at CSGRC, Hosur based on available Silkworm Germplasm Information system (SGIS) database (Table-26).

- Evaluation rearing of twenty short listed top ranking exotic bivoltine breeds (oval-10) and dumb-bell-10) conducted at CSGRC, Hosur. These promising top ten, each of oval and dumb-bell breeds used for conducting line x tester (Oval accns. X CSR2 & Dumbbell accns. X CSR4) analysis to identify the promising exotic bivoltine breeds as parents.
- Dfls of hybrid combinations of 20 exotic bivoltine accessions was assessed along with control CSR2 x CSR4 (BBI-0290 x BBI-0291) / SK6 x SK7 by taking up 4 rearing trials in favourable season at each test centres v*iz.,* CSRTI, Mysuru (Southern zone), CSRTI, Berhampore (Eastern zone) and 3 rearing trials at CSR&TI, Pampore (Northern zone) in favorable seasons.
- Collection, compilation of data of all centres was carried out and subjected for general statistics and multi traits evaluation index analysis to identify the centre/season wise potential exotic bivoltine accessions.

Table 26. Shortlisted promising Exotic bivoltine Accessions

Sl. No.	Acc. No.	Name	Cocoon shape	Performance
1	BBE-0005	MEIGITSU	oval	Top ranking
2	BBE-0163	THAICHOAN	oval	Top ranking
3	BBE-0232	NB1	oval	Top ranking
4	BBE-0329	MIR-4	oval	**AIMSGEP**
5	BBE-0013	CHAUNG NAUNG	oval	Top ranking
6	BBE-0154	J-MARKED	oval	Top ranking
7	BBE-0201	C124	oval	Top ranking
8	BBE-0225	JZH (PO)	oval	Top ranking
9	BBE-0043	BELKOKONA-II	oval	Top ranking
10	BBE-0266	J2P	oval	**AIMSGEP/Hot spot**
11	BBE-0143	KY-1	Dumb-bell	Top ranking
12	BBE-0155	J-DEEP MARKED	Dumb-bell	Top ranking
13	BBE-0164	SHOGETSU HOSHO	Dumb-bell	Top ranking
14	BBE-0268	J1M	Dumb-bell	**AIMSGEP**
15	BBE-0169	SHINKI RAYAKU (M)	Dumb-bell	Top ranking
16	BBE-0267	14M	Dumb-bell	Top ranking
17	BBE-0177	JPN5 x B25	Dumb-bell	Top ranking
18	BBE-0197	A	Dumb-bell	**AIMSGEP**
19	BBE-0050	UKR-2	Dumb-bell	Top ranking
20	BBE-0035	SANISH-18(M)	Dumb-bell	Top ranking

Results:

CSGRC, Hosur

During the period, 4 rearing trials were taken up with the hybrid combinations of 20 exotic bivoltine accessions along with control (CSR2 x CSR4) [June-July 2017 (monsoon), Sept-Oct 2017 (monsoon), Sept-Oct 2018 (monsoon) and Mar-Apr 2019 (spring)] to evaluate the parameters *Viz.,* Fecundity (FEC), Hatching (HATCH), Larval weight (LW), Yield/10000 larvae by weight (ERR), Pupation rate (PR), Single cocoon weight (SCW), Single shell weight (SSW), Shell ratio (SR) and Average Filament length (AFL).

The mean evaluation index (EI) of the pooled data of oval foundation crosses of all the 4 trials indicated in Table-27 revealed the better performance with BBE-0163, followed by BBE-0154 and BBE-0201. In case of dumbbell foundation crosses, the accessions *viz*., BBE-0197 followed by BBE-0267 and BBE-0164 performed better (Table-28).

Table 27. Performance of Oval Foundation Crosses (Mean of 4 trials)

Accn. x CSR2 (BBI-0290)	FEC (No.)	HATCH (%)	LW (g)	ERR (kg)	PR (%)	SCW (g)	SSW (g)	SR (%)	AFL (m)	Mean EI
BBE-0005	403	98.24	38.38	13.59	87.40	1.621	0.300	18.59	860	**45.53**
BBE-0163	**428**	**97.91**	**41.59**	**14.55**	**92.05**	**1.650**	**0.313**	**19.06**	**849**	**54.45**
BBE-0232	400	98.20	43.44	12.36	83.52	1.642	0.321	19.60	828	**49.67**
BBE-0329	440	96.28	40.92	13.21	85.70	1.669	0.319	19.18	940	**52.26**
BBE-0013	434	96.33	39.98	13.94	91.58	1.606	0.310	19.52	798	**49.66**
BBE-0154	**402**	**94.69**	**44.05**	**14.44**	**90.79**	**1.568**	**0.316**	**20.31**	**899**	**51.88**
BBE-0201	**428**	**97.54**	**41.69**	**13.48**	**90.76**	**1.570**	**0.303**	**19.27**	**970**	**51.57**
BBE-0225	378	97.14	42.31	12.59	83.52	1.628	0.329	20.29	826	**48.57**
BBE-0043	430	95.44	41.15	14.60	91.21	1.641	0.304	18.69	816	**49.34**
BBE-0266	424	97.18	40.69	11.21	77.92	1.629	0.318	19.64	869	**44.81**
CSR2 x CSR4 (control)	*425*	*96.28*	*41.18*	*13.47*	*90.83*	*1.600*	*0.325*	*20.32*	*821*	***52.27***
Average	***417***	***96.83***	***41.40***	***13.40***	***87.75***	***1.620***	***0.314***	***19.50***	***862***	**-**
SD	***18.90***	***1.150***	***1.557***	***1.037***	***4.579***	***0.032***	***0.009***	***0.618***	***54.48***	**-**
CV%	***4.527***	***1.183***	***3.751***	***7.736***	***5.218***	***1.968***	***2.971***	***3.168***	***6.32***	**-**

Table 28. Performance of Dumbbell Foundation Crosses (Mean of 4 trials)

Accn. x CSR4 (BBI-0291)	FEC (No.)	HATCH (%)	LW (g)	ERR (kg)	PR (%)	SCW (g)	SSW (g)	SR (%)	AFL (m)	Mean EI
BBE-0143	432	96.26	38.59	12.21	80.88	1.616	0.301	18.79	856	**38.79**
BBE-0155	433	96.25	38.51	13.68	92.34	1.534	0.296	19.45	877	**48.32**
BBE-0164	**470**	**97.40**	**41.41**	**13.72**	**86.39**	**1.650**	**0.312**	**19.01**	**852**	**52.16**
BBE-0268	454	97.26	38.94	13.74	90.17	1.535	0.290	18.98	922	**49.64**
BBE-0169	457	95.57	41.42	13.54	89.10	1.584	0.296	18.67	927	**49.71**
BBE-0267	**456**	**98.29**	**40.98**	**13.76**	**87.67**	**1.630**	**0.309**	**19.08**	**921**	**54.20**
BBE-0177	462	96.28	41.04	13.98	91.21	1.539	0.297	19.32	882	**51.79**
BBE-0197	468	97.00	42.05	14.71	89.18	1.642	0.332	20.27	879	**59.65**
BBE-0050	424	98.07	39.13	13.14	88.53	1.544	0.291	18.91	851	**45.22**
BBE-0035	438	95.95	41.33	13.96	87.08	1.683	0.312	18.69	812	**48.49**
CSR2 x CSR4 (control)	425	96.28	41.18	13.47	90.83	1.600	0.325	20.32	821	**52.01**
Average	***447***	***96.78***	***40.42***	***13.63***	***88.49***	***1.596***	***0.306***	***19.23***	***872***	**-**
SD	***17.15***	***0.884***	***1.326***	***0.611***	***3.104***	***0.053***	***0.014***	***0.580***	***39.2***	**-**
CV%	***3.830***	***0.913***	***3.282***	***3.508***	***4.480***	***3.508***	***3.306***	***4.515***	***3.01***	**-**

CSRTI Mysore

Under this centre, the rearing trials were taken up on the hybrid combinations of 20 exotic bivoltine accessions during Aug-Sept'17 (Monsoon), Oct-Nov'17 (Winter), Aug-Sept'18 (Monsoon) and Mar-April'19 (Summer) respectively to evaluate the rearing and reeling traits. The analysed data of the oval foundation crosses of exotic bivoltine accessions recorded the better performance with BBE-0201, BBE-0266 and BBE-0154 (Table-29). Whereas with regard to dumbbell FCs, BBE-0197, BBE-0169 and BBE-0267 revealed better performance (Table-30).

Table 29. Performance of Oval Foundation Crosses (Mean of 4 trials)

Accn. x CSR2 (BBI-0290)	FEC (No.)	HATCH (%)	LW (g)	ERR (kg)	PR (%)	SCW (g)	SSW (g)	SR (%)	AFL (m)	Mean EI
BBE-0005	380	94.32	40.70	13.75	90.92	1.518	0.274	18.22	842	44.94
BBE-0163	484	95.06	41.85	13.34	88.41	1.553	0.282	18.26	845	49.47
BBE-0232	361	93.81	40.68	13.72	88.01	1.578	0.292	18.56	863	47.53
BBE-0329	435	92.69	42.29	12.87	85.23	1.553	0.291	18.66	855	46.46
BBE-0013	445	93.01	42.93	12.68	82.32	1.585	0.292	18.61	817	45.71
BBE-0154	**437**	**88.40**	**43.33**	**14.45**	**93.64**	**1.544**	**0.286**	**18.44**	**875**	**53.10**
BBE-0201	**448**	**94.43**	**42.12**	**13.82**	**91.29**	**1.560**	**0.300**	**19.35**	**907**	**56.38**
BBE-0225	405	93.73	41.98	12.64	87.92	1.543	0.300	19.54	839	47.94
BBE-0043	470	90.47	41.26	13.05	85.58	1.588	0.287	18.15	795	44.06

BBE-0266	**456**	**92.74**	**42.01**	**13.92**	**87.74**	**1.573**	**0.305**	**19.54**	**859**	**53.29**
CSR2 x CSR4 (control)	*469*	*95.70*	*42.06*	*13.73*	*92.07*	*1.591*	*0.325*	*20.35*	*869*	***61.11***
Average	***435***	***93.12***	***41.93***	***13.45***	***88.46***	***1.562***	***0.294***	***18.88***	***851***	**-**
SD	***38.50***	***2.099***	***0.817***	***0.579***	***3.337***	***0.023***	***0.014***	***0.709***	***29.64***	**-**
CV %	***8.86***	***2.254***	***1.950***	***4.307***	***3.772***	***1.461***	***4.599***	***3.754***	***3.48***	**-**

Table 30. Performance of Dumbbell Foundation Crosses (Mean of 4 trials)

Accn. x CSR4 (BBI-0291)	FEC (No.)	HATCH (%)	LW (g)	ERR (kg)	PR (%)	SCW (g)	SSW (g)	SR (%)	AFL (m)	Mean EI
BBE-0143	420	93.58	41.38	13.21	89.03	1.576	0.284	18.10	879	47.80
BBE-0155	515	94.20	39.65	12.21	84.41	1.522	0.283	18.65	863	43.26
BBE-0164	499	96.17	40.66	13.12	86.00	1.575	0.289	18.45	907	50.02
BBE-0268	422	94.25	41.57	12.50	83.00	1.534	0.285	18.63	796	41.33
BBE-0169	**487**	**92.77**	**41.67**	**13.97**	**90.76**	**1.640**	**0.311**	**19.00**	**933**	**57.18**
BBE-0267	**444**	**92.15**	**41.93**	**13.76**	**89.70**	**1.578**	**0.304**	**19.37**	**945**	**53.64**
BBE-0177	397	94.10	40.46	13.18	88.23	1.537	0.286	18.64	841	45.01
BBE-0197	**444**	**93.49**	**43.22**	**14.12**	**89.73**	**1.635**	**0.324**	**19.80**	**906**	**58.78**
BBE-0050	428	93.00	41.09	13.74	92.51	1.526	0.279	18.29	828	48.17
BBE-0035	455	90.69	41.52	13.85	87.59	1.591	0.279	17.62	818	45.32
CSR2 x CSR4 (control)	***469***	***95.70***	***42.06***	***13.73***	***92.07***	***1.591***	***0.325***	***20.35***	***869***	***59.49***
Average	***452***	***93.6***	***41.38***	***13.39***	***88.45***	***1.573***	***0.295***	***18.80***	***871***	**-**
SD	***36.5***	***1.538***	***0.934***	***0.616***	***3.021***	***0.041***	***0.018***	***0.782***	***48.10***	**-**
CV %	***8.07***	***1.642***	***2.258***	***4.594***	***3.415***	***2.593***	***5.933***	***4.155***	***5.52***	**-**

CSR&TI Berhampore

Under this test centre, four rearing trials were taken up with 20 exotic bivoltine silkworm accessions along with SK6 x SK7 (control) during Oct-Nov'17 (Autumn), Feb-Mar'18 (Spring), Oct-Nov'18 (Autumn) and Feb-Mar'19 (Spring) to assess the performance of parental breeds. The analyzed data of the oval FCs of all the 4 trials indicated in Table-31 recorded the better performance with BBE-0232, BBE-0163 and BBE-0201. In case of dumbbell FCs, BBE-0267, BBE-0169 and BBE-0177 performed better (Table-32).

Table 31. Performance of oval Foundation Crosses (Mean of 4 trials)

Accn. x CSR2 (BBI-0290)	FEC (No.)	HATCH (%)	LW (g)	ERR (kg)	PR (%)	SCW (g)	SSW (g)	SR (%)	AFL (m)	Mean EI
BBE-0005	482	93.72	37.66	7.45	54.27	1.386	0.262	18.91	734	43.24
BBE-0163	**513**	**96.52**	**39.09**	**8.33**	**55.55**	**1.484**	**0.292**	**19.71**	**773**	**53.90**
BBE-0232	**468**	**97.12**	**39.57**	**8.63**	**59.43**	**1.475**	**0.299**	**20.26**	**822**	**55.01**
BBE-0329	506	95.12	40.22	4.28	27.00	1.436	0.264	18.22	857	44.11
BBE-0013	483	96.75	40.06	5.88	37.80	1.414	0.282	20.09	739	46.35
BBE-0154	468	96.15	40.38	6.58	40.80	1.466	0.304	20.52	799	51.14

BBE-0201	**516**	**96.30**	**37.23**	**8.67**	**59.38**	**1.418**	**0.290**	**20.42**	**810**	**53.15**
BBE-0225	472	90.63	37.23	9.72	68.64	1.393	0.286	20.69	771	49.15
BBE-0043	523	94.88	36.34	8.37	53.21	1.458	0.272	18.81	747	47.97
BBE-0266	479	97.04	38.20	7.86	51.76	1.470	0.290	19.86	874	52.96
SK6 X SK7	**463**	**90.96**	**41.38**	**10.98**	**74.16**	**1.490**	**0.271**	**18.14**	**832**	**53.04**
Average	***488***	***95.01***	***38.85***	***7.886***	***52.90***	***1.445***	***0.283***	***19.60***	***796***	**-**
SD	***21.86***	***2.326***	***1.614***	***1.829***	***13.56***	***0.037***	***0.014***	***0.927***	***47.57***	**-**
CV %	***4.475***	***2.448***	***4.154***	***23.194***	***25.63***	***2.556***	***4.940***	***4.730***	***5.975***	**-**

Table 32. Performance of Dumbbell Foundation Crosses (Mean of 4 trials)

Accn. x CSR4 (BBI-0291)	FEC (No.)	HATCH (%)	LW (g)	ERR (kg)	PR (%)	SCW (g)	SSW (g)	SR (%)	AFL (m)	Mean EI
BBE-0143	504	97.01	37.30	5.57	38.85	1.407	0.262	18.61	686	38.96
BBE-0155	503	95.07	39.02	8.90	64.09	1.384	0.275	19.72	733	48.42
BBE-0164	505	97.12	38.15	8.57	56.44	1.485	0.292	19.63	766	50.99
BBE-0268	488	97.47	37.78	7.97	54.17	1.457	0.272	18.90	842	47.92
BBE-0169	**544**	**94.98**	**38.95**	**7.94**	**54.81**	**1.443**	**0.295**	**20.53**	**881**	**53.00**
BBE-0267	**539**	**97.32**	**39.81**	**8.51**	**58.93**	**1.420**	**0.286**	**20.25**	**845**	**54.05**
BBE-0177	**485**	**97.35**	**38.65**	**8.87**	**60.53**	**1.433**	**0.291**	**20.42**	**855**	**52.61**
BBE-0197	513	95.13	39.17	6.00	38.04	1.481	0.320	21.69	847	50.81
BBE-0050	452	95.69	39.65	9.24	65.74	1.458	0.286	19.55	879	52.44
BBE-0035	485	96.42	37.86	8.62	53.30	1.538	0.288	18.50	731	48.47
SK6 X SK7	***463***	***90.96***	***41.38***	***10.98***	***74.16***	***1.490***	***0.271***	***18.14***	***832***	***52.34***
Average	***498***	***95.86***	***38.88***	***8.288***	***56.27***	***1.454***	***0.285***	***19.63***	***808***	**-**
SD	***28.13***	***1.901***	***1.147***	***1.482***	***10.71***	***0.043***	***0.016***	***1.056***	***67.37***	**-**
CV %	***5.645***	***1.983***	***2.949***	***17.87***	***19.03***	***2.989***	***5.447***	***5.378***	***8.330***	**-**

CSR&TI Pampore

Under pampore, three rearing trials were taken up with the hybrid combinations of 20 exotic bivoltine accessions along with a control (CSR2 × CSR4) during Sept-Oct'17 (Autumn season), Sept-Oct'18 (Autumn season) and May-June'19 (Spring season) as hybrids to assess their performance of parental breeds at temperate region by recording the traits *Viz.,* Fecundity (No,), Hatching %, Larval weight (g), Yield /10,000 larvae by weight (kg.), Single cocoon weight (g), Single shell weight (g), Shell ratio (%), Pupation rate (%), Avg. Filament length (m.).

The analyzed pooled data of oval FCs of all the 3 trials revealed that, out of 10 accns. BBE-0201, BBE-0329 and BBE-0043 performed top (Table-33) and in case of dumbbell FCs, BBE-0197, BBE-0267 and BBE-0268 recorded higher evaluation index values (Table-34).

Table 33. Performance of Oval Foundation Crosses (Mean of 3 trials)

Accn. x CSR2 (BBI-0290)	FEC (No.)	HATCH (%)	LW (g)	ERR (kg)	PR (%)	SCW (g)	SSW (g)	SR (%)	AFL (m)	Mean EI
BBE-0005	409	93.22	39.97	13.17	94.73	1.616	0.335	20.77	810	49.67
BBE-0163	393	91.38	39.47	14.41	97.73	1.592	0.325	20.37	766	48.44
BBE-0232	406	94.26	40.78	13.79	93.80	1.595	0.314	19.72	821	44.10
BBE-0329	**403**	**93.05**	**39.86**	**14.36**	**93.76**	**1.662**	**0.338**	**20.40**	**807**	**50.92**
BBE-0013	382	92.31	39.31	13.70	93.38	1.594	0.328	20.55	795	43.31
BBE-0154	415	90.91	39.58	14.27	94.49	1.635	0.332	20.28	819	49.10
BBE-0201	**400**	**92.84**	**41.36**	**14.57**	**96.64**	**1.628**	**0.336**	**20.58**	**783**	**54.01**
BBE-0225	398	91.97	41.34	14.24	94.13	1.644	0.332	20.21	822	49.53
BBE-0043	**398**	**90.37**	**39.39**	**14.56**	**94.47**	**1.667**	**0.339**	**20.39**	**801**	**49.83**
BBE-0266	408	91.51	39.89	14.35	92.66	1.657	0.334	20.17	791	46.41
CSR2 x CSR4 ©	***450***	***94.91***	***45.20***	***14.69***	***95.71***	***1.665***	***0.342***	***20.57***	***853***	***64.68***
Average	***405***	***92.43***	***40.55***	***14.19***	***94.68***	***1.632***	***0.332***	***20.36***	***806***	**-**
SD	***17.1***	***1.393***	***1.709***	***0.456***	***1.483***	***0.029***	***0.008***	***0.278***	***23.18***	**-**
CV %	***4.23***	***1.507***	***4.213***	***3.216***	***1.566***	***1.805***	***2.335***	***1.366***	***2.876***	**-**

Table 34. Performance of Dumbbell Foundation Crosses (Mean of 3 trials)

Accn. x CSR4 (BBI-0291)	FEC (No.)	HATCH (%)	LW (g)	ERR (kg)	PR (%)	SCW (g)	SSW (g)	SR (%)	AFL (m)	Mean EI
BBE-0143	412	93.52	40.61	14.02	95.89	1.587	0.316	19.92	800	47.78
BBE-0155	422	92.21	39.94	14.31	95.16	1.625	0.326	20.12	788	48.24
BBE-0164	436	92.21	39.55	13.90	95.56	1.587	0.316	19.97	754	44.95
BBE-0268	**426**	**93.08**	**40.53**	**14.41**	**94.52**	**1.649**	**0.334**	**20.24**	**819**	**51.33**
BBE-0169	422	92.34	40.56	14.31	95.90	1.614	0.320	19.85	767	47.94
BBE-0267	**383**	**92.60**	**41.67**	**14.72**	**96.29**	**1.639**	**0.344**	**20.99**	**828**	**55.51**
BBE-0177	414	93.87	39.94	13.76	96.82	1.540	0.307	19.93	797	46.51
BBE-0197	**407**	**93.25**	**40.36**	**14.77**	**96.53**	**1.654**	**0.348**	**21.03**	**780**	**56.13**
BBE-0050	401	90.46	40.77	14.47	95.16	1.643	0.330	20.11	809	48.19
BBE-0035	402	91.03	40.10	14.32	92.36	1.664	0.322	19.39	779	40.64
CSR2 x CSR4 ©	***450***	***94.91***	***45.20***	***14.69***	***95.71***	***1.665***	***0.342***	***20.57***	***853***	***62.79***
Average	***415***	***92.68***	***40.83***	***14.33***	***95.44***	***1.624***	***0.328***	***20.19***	***797***	**-**
SD	***18.2***	***1.257***	***1.549***	***0.333***	***1.217***	***0.039***	***0.013***	***0.495***	***28.58***	**-**
CV %	***4.39***	***1.356***	***3.793***	***2.322***	***1.275***	***2.407***	***4.007***	***2.450***	***3.584***	**-**

Discussion

Although, India ranks second in global silk production, there exists a wide gap in the overall qualitative and quantitative silk output. This is attributed to the bulk production of Polyvoltine x Bivoltine (cross breed) (Datta, 1984) necessitating the adoption of bivoltine sericulture under tropical conditions to improve silk quality and productivity. In this direction, a few bivoltine breeds which were evolved could

not adjust to the fluctuating tropical conditions (Thiagarajan *et al*., 1993; Naseema Begum *et al*., 2001; Chandrasekaraiah and Ramesh Babu M., 2003)). During the last decade with the re-orientation of breeding approaches in line to develop bivoltine breeds adaptable to tropical conditions quite a good number of bivoltine breeds were developed (Datta *et al*., 2000). In the present study, different combinations of shortlisted 20 exotic bivoltine accessions with CSR2 (BBI-0290) / CSR4 (BBI-0291) were evaluated at four test centres. The results clearly revealed the better combiners and their seasonal performance trends for the economic traits under various agroclimatic locations.

The centre wise better performing exotic oval and dumbbell bivoltine accessions were highlighted in Table-35 and 36.

Table 35. Centre-wise best performing Oval Bivoltine accessions

CSGRC, Hosur	CSR&TI, Mysore	CSR&TI, Berhampore	CSR&TI, Pampore
BBE-0197	**BBE-0197**	**BBE-0267**	**BBE-0197**
BBE-0267	**BBE-0169**	**BBE-0169**	**BBE-0267**
BBE-0164	**BBE-0267**	**BBE-0177**	**BBE-0268**

Table 36. Centre-wise best performing Dumbbell Bivoltine accessions

CSGRC, Hosur	CSR&TI, Mysore	CSR&TI, Berhampore	CSR&TI, Pampore
BBE-0163	**BBE-0201**	**BBE-0232**	**BBE-0201**
BBE-0154	**BBE-0266**	**BBE-0163**	**BBE-0329**
BBE-0201	**BBE-0154**	**BBE-0201**	**BBE-0043**

Performances of accessions are largely dependent on the combined action of heredity of its population and its environment to which it is exposed. Studies on the interaction of genotype x environment with respect to the seasonal variation has been reported by several investigators (Kalpana and Sreerama Reddy, 1998 and Rao *et al*., 2003). Multiple trait evaluation index method of Mano *et al.* (1993) has become a very useful tool for evaluation and identification of promising silkworm breeds / hybrids and is widely applied by the many silkworm breeders (Ramesh Babu *et al*., 2001; Sudhakara Rao *et al*., 2001). In the present study, analysis has been carried out based on Mano index. This observation corroborates the earlier work of Khan *et al*., (2001) where a profound role of genotype x environmental interaction on yield attributes was reported and with the findings of Khan *et al*. (2003) as well as Suresh Kumar *et al.,* (2006) reported that most of the economically important traits of the silkworm are polygenic in nature and are greatly influenced by environment.

The present study is also in accordance to the view of Murakami (1999) who reported that racial differences in various biological characters are due to adaptation in the particular place. This also coincides Rapussas and Gabriel (1976) reported that environmental factors especially temperature and humidity play a very important role in the lifecycle of silkworm in determining the cocoon characters and its existence in a particular zone. Hot climatic conditions prevailing particularly in summer are not conducive to rear these

high yielding bivoltine hybrids throughout the year. Apart from temperature, humidity also influences the productivity pattern in the silkworm as observed by Krishnaswami (1986) and Sudhakara Rao (2003). The variations observed for different economic traits among the exotic bivoltine accessions in different seasons with diverse temperature and humidity conditions could be due to the inherent genetic potentiality of the breeds to perform during environmental variations especially in temperature and humidity. This observation corroborates the earlier work of Benchamin and Jolly (1986) where they have reported that environment is dynamic which brings about profound changes in the physical and biotic factors governing the expression of commercial characters in the organism.

Positive correlation has been reported between cocoon weight, shell weight, shell ratio % and filament length. Particularly the accessions which are showing >50 index value expressed the effects for qualitative characters like cocoon weight and cocoon shell weight indicate the additive gene action is important for these characters (Satenahalli *et al.,* 1990; Subba Rao and Sahai, 1989 and Rajalakshmi *et al.,* 1997. In the present study also, the exotic bivoltine accessions identified as better combiners for multi-traits recorded >50 index values. Studies have clearly revealed maximum expression of economic traits during favourable seasons like monsoon and post monsoon compared to unfavourable seasons (Das *et al*., 1995, Rao *et al*., 2003). In China, high silk yielding silkworm breeds have been developed for rearing in spring season (Hourong *et al*., 1996; Wang 1997) and during summer-autumn season at a temperature of 28-30˚C and humidity 85-90% (He *et al*., 1989; Sohn *et al*., 1987; Yang, 1998). In Japan also, silkworm breeds suitable for spring, summer and autumn seasons were evolved and are also commercially exploited (Eguchi *et al*., 1995).

Inference / Recommendations

a. It is clear from the results of the study that, the exotic bivoltine accessions identified as better combiners for multiple traits under each centre are economically viable as they have recorded > 50 index values.

b. Following oval and dumbbell exotic bivoltine accessions showed average evaluation index > 50 identified common in all the centres can be utilized for single hybrid and double hybrid preparation for commercial utilization at field level in the respective regions.

Oval exotic bivoltine accns - BBE-0201, BBE-0154 and BBE-0163

Dumbbell exotic bivoltine accns - BBE-0267, BBE-0197 and BBE-0169

Progress of ongoing research projects

1. AIE-06002MI: Evaluation of bivoltine silkworm genetic resources for tolerance to abiotic stress in selected hotspots (Mar.19 – Mar.22).

CSGRC, Hosur: *M. Maheswari (PI), G. Lokesh, Geetha N Murthy & Jameela Khatoon*
SBRL, Kodathi: *K.S.Tulsi Naik*
REC, Chitradurga-CSRTI, Mysuru: *Y. Srinivasulu*
CSRTI, Berhampore: *N. Chandrakanth & G. C Das*
RSRS, Jammu-CSRTI, Pampore: *Sardar Singh & S. Murali*

Objectives

- To screen and select bivoltine germplasm resources with presence of markers linked to thermo-tolerance.
- To evaluate selected bivoltine germplasm resources against abiotic stress and identify suitable bivoltine breeds to target selected hot spots.

Progress

Under the project, a total of 40 bivoltine accessions were shortlisted out of 369 bivoltine accessions based on the economic parameters. These selected breeds were screened for the presence of markers linked to thermo-tolerance using 4 primers Viz.,LFL1123, S0809, S0329 and S0813. The PCR analysis of the genomic DNA of the accessions using thermo-tolerant markers revealed 8 accessions with 100% thermo-tolerance and 2 accessions with 87% thermo-tolerance. These Identified bivoltine silkworm accessions Viz.,BBI-0086, BBI-0044, BBE-0184, BBI-0301, BBI-0334, BBI-0336, BBI-0338, BBI-0339, BBI-0343 and BBI-0358 will be utilized for field trials during summer and autumn seasons at REC, Chitradurga and RSRS, Jammu.

New Projects initiated during 2019-20

AIE-06003SI: Evaluation of silkworm genetic resources of *Bombyx mori* L. with reference to inbreeding depression and their conservation (Dec, 19 - Nov, 22)

D. S. Somaprakash (PI), M. Maheswari, G. Punithavathy, G. Lokesh, Jameela Khatoon, and Ritwika Sur Chaudhuri

Objectives

- To evaluate silkworm genetic resources and estimate the level of inbreeding depression
- To promote utilization of sericultural germplasm for crop improvement programmes.
- To maintain national database on silkworm accessions and catalogue the data generated

Progress

The project was initiated during December 2019, During the period under report, rearing and grainage operations of 113 bivoltine, 83 multivoltine and 23 mutants silkworm accessions was conducted following standard operating procedures. Data on rearing performance was recorded for further analysis and updating the national silkworm database.

***Continuous Programme:* Collection, characterization, evaluation, conservation and supply of silkworm genetic resources (SWGRs)** (Apr.2018 – Nov.2019)

D.S. Somaprakash, M. Maheswari, G. Punithavathy, G. Lokesh, Jameela Khatoon, Ritwika Sur Chaudhuri and Geetha N Murthy

CSGRC Hosur is the exclusive centre for conserving mulberry silkworm genetic resources for utilization by various CSB and other research institutes / universities. As per mandate, the centre is conserving 475 seri-genetic resources [83 multivoltine, 369 bivoltine and 23 mutants] with due characterization, evaluation, updation of database and promotion of utilization.

S-01: Collection of Silkworm Genetic Resources

New Bivoltine silkworm genetic resources (D5, D6 (M), BHR-2, MJ-1, MJ-2, MC4 (E), MC4 (O), MC2, BG (W), SK3C, SK4N, NBO-2, NBO-3 and NBP4) which were collected from CSR&TI, Berhampore during 2018-19, were subjected to quarantine rearing (second trial) to ensure disease freeness. Evaluation studies revealed that the breeds exhibited variability in terms of origin, qualitative and quantitative traits.

The gene bank currently holds a total of 475 indigenous and exotic silkworm genetic resources collected from 9 States of the country and 14 countries across the world. It includes 83 multivoltine (indigenous-73 & exotic-10), 369 bivoltine (indigenous-209 & exotic-160) and 23 mutant genetic stocks (exotic) (Table-37).

Table 37. Phase wise silkworm germplasm resources collection

Year	Phase	Bivoltine	Multivoltine	Mutant	TOTAL
1993-1997	I	169	57	-	**226**
1997-2000	II	103	-	-	**103**
2000-2003	III	40	8	19	**67**
2003-2006	IV	25	7	1	**33**
2006-2009	V	2	1	-	**3**
2009-2012	VI	11	1	-	**12**
2012-2015	VII	15	7	-	**22**
2015-2018	VIII	4	2	3	**9**
Grand Total		**369**	**83**	**23**	**475**

S-02: Characterization and Evaluation of Silkworm Genetic Resources

Morphological characterization was carried out for 475 silkworm genetic resources using 27 descriptors on various growth stages Viz., egg, larva, cocoon, pupa and moth, to confirm its maintenance true to catalogue data. The data generated were updated in the Silkworm Germplasm Information System [SGIS] database. The 14 newly collected silkworm genetic resources were characterized for different descriptors as per standard protocol and evaluated for 11 important economic parameters that paves a way to manage the gene bank efficiently with authentic database. The database will aid in ascertaining the variability or similarity of newly introduced accessions with existing accessions in the gene bank during registration.

E-01: Morphological characterization of SWGRs

Morphological characterization was carried out using 27 descriptors for 475 silkworm accessions (83 multivoltine, 369 bivoltine and 23 mutants) on various growth stages *viz.,* egg, larva, cocoon, pupa and moth stages to confirm its maintenance true to catalogue data. The variability in the morphological features of all the silkworm accessions for each descriptor was found true to catalogue data.

The data on the important morphological parameters of the 83 multivoltine silkworm accessions are presented in Table-38. Multivoltine silkworm accessions revealed three types of larval patterns *Viz.,*. plain, marked and mixed. The analysed data on morphological characters of multivoltine accessions indicated, maximum accessions with plain larval pattern (46 accns, 55.4%) followed by marked (33 accns; 39.8%) and mixed (4 accns; 4.8%). In case of cocoon colour, maximum accessions revealed greenish yellow colour (35 accns; 42.2 %) followed by white (22 accns; 26.5%), chrome yellow (20 accns; 24.1%), yellow cocoons (4 accns; 4.8%) and creamy white (2 accns; 2.4%). Similarly the cocoon shape revealed maximum oval shaped cocoons (31 accns; 37.3%) followed by elongated with narrow constriction (24 accns; 28.9%), spindle shape (19 accns; 22.9%), spatulate (4 accns; 4.8%), dumbbell (3 accns; 3.6%) and elongated (2 accns; 2.4%).

Table 38. Morphological trait variations in multivoltine SWGRs

Parameters	Frequency	Percentage
Larval Pattern		
Plain	46	55.4
Marked	33	39.8
Mixed	4	4.8
Cocoon colour		
Greenish yellow	35	42.2
White	22	26.5
Chrome yellow	20	24.1
Yellow	4	4.8
Creamy white	2	2.4
Cocoon shape		
Oval	31	37.3
ENC	24	28.9
Spindle	19	22.9
Spatulate	4	4.8
Dumb-bell	3	3.6
Elongated	2	2.4

Morphological characterisation of the 369 bivoltine silkworm accessions recorded variability for important morphological descriptors and is presented in Table-39 . There are four types of larval patterns with majority accessions revealing plain pattern (221 accns; 59.9%) followed by marked (128 accns; 34.7%), mixed (18 accns; 4.9%) and sex limited (2 accns; 0.5%). The cocoon colour revealed maximum accessions with white cocoons (343 accns; 93%) followed by chrome yellow (9 accns; 2.4%), flesh

cocoons (6 accns; 1.6%), greenish yellow (4 accns; 1.1%) and mixed (2 accns; 0.5%). In the same way, cocoon shape revealed maximum accessions with elongated constricted cocoons (164 accns; 44.4%) followed by oval (126 accns; 34.1%), elongated non-constricted (37 accns; 10%), elongated faint constriction (9 accns; 2.4%), spindle cocoons (6 accns; 1.6%) and elliptical (1 accn; 0.3 %).

Table 39. Morphological trait variations in bivoltine SWGRs

Traits	Frequency	Percentage
Larval pattern		
Plain	221	59.9
Marked	128	34.7
Mixed	18	4.9
Sex limited	2	0.5
Cocoon colour		
White	343	93.0
Chrome yellow	9	2.4
Flesh	6	1.6
Creamish white	5	1.4
Greenish yellow	4	1.1
Mixed	2	0.5
Cocoon shape		
Elongated constricted	164	44.4
Oval	126	34.1
Elongated non-constricted	37	10.0
Dumb-bell	26	7.0
Elongated faint constricted	9	2.4
Spindle	6	1.6
Elliptical	1	0.3

E-02: Evaluation of multivoltine SWGRs for growth and reproductive traits

Since inclusion to the end of current year, a total of 118 conservation crops of multivoltine SWGRs are completed. During the year, evaluation and data analysis of 4 conservation crops of multivoltine SWGRs were carried out for 12 important rearing and reeling traits. The variability in economic traits and the individual trait-wise performance of the accessions along with mean and CV % is presented in Table-40. The analysed data depicts that maximum fecundity was recorded as 456(BMI-0078), and minimum as 348 (BMI-0026), maximum weight of 10 larvae was 35.05g (BMI-0083) and minimum was 17.82g (BMI-0017), ERR by no. was minimum in accession BMI-0064 (9260) and maximum in BMI-0081 (9763), whereas, accession BMI-0031 recorded minimum ERR by wt. (7.30 kg) and BMI-0083 maximum ERR by wt. (12.88 kg). Minimum single cocoon weight, single shell weight and SR%, respectively were recorded in accessions BMI-0047(0.72 g), BMI-0047(0.09 g) and BMI-0064 (11.41%), whereas accession BMI-0083 recorded maximum single cocoon weight (1.41 g), single shell weight (0.26 g) and BMI-0076 SR% (18.67 %). The details of individual trait-wise top performing ten accessions for 10 rearing and reeling parameters along with the range values are presented in Table 41.

Table 40. Economic trait-wise range of variability in multivoltine SWGRs

Traits	Mean	Min	Max	SD	SE	CV%
Fecundity (No.)	399	348(BMI-0026)	456 (BMI-0078)	19.40	2.143	4.86
Hatching (%)	96.82	95.16(BMI-0025)	97.86 (BME-0007)	0.537	0.059	0.55
Wt. of 10 Larvae (g)	21.87	17.82(BME-0017)	35.05 (BMI-0083)	3.252	0.359	14.87
Total larval duration (h)	509	498(BMI-0019)	594 (BMI-0001)	16.105	1.778	3.16
V^{th} Larval duration (h)	111	100(BMI-0017)	158(BMI-0001)	10.152	1.121	9.13
ERR (No.) (10000 larvae)	9607	9260(BMI-0064)	9763 (BMI-0081)	76.67	8.467	0.79
ERR (wt. in kg)	8.95	7.30(BMI-0031)	12.88 (BMI-0083)	1.148	0.127	12.82
Pupation rate (%)	96.07	92.6(BMI-0064)	97.63 (BMI-0081)	0.767	0.085	0.79
Single Cocoon Wt (g)	0.899	0.720(BMI-0047)	1.41 (BMI-0083)	0.126	0.014	14.06
Single Shell Wt (g)	0.121	0.09(BMI-0047)	0.26 (BMI-0083)	0.033	0.004	26.99
Shell Ratio (%)	13.47	11.41(BMI-0064)	18.67 (BMI-0076)	1.686	0.186	12.52
Average filament length (m)	414	273 (BMI-0020)	749 (BMI-0076)	80.06	8.84	19.33

Table 41. Trait-wise top performing multivoltine SWGRs

Traits	Range	Accession No.
Fecundity (No.)	456-418	BMI-0078, BMI-0080, BMI-0084, BMI-0079, BMI-0083, BMI-0077, BMI-0081, BMI-0082, BMI-0047, BMI-0021
Hatching (%)	97.86-97.40	BMI-0007, BMI-0037, BMI-0039, BMI-0032, BME-0015, BMI-0079, BMI-0043, BMI-0046, BMI-0038, BMI-0064
Wt. of 10 Larvae (g)	35.05-24.63	BMI-0083, BMI-0084, BMI-0081, BMI-0080, BMI-0078, BMI-0076, BMI-0074, , BME-0048, BMI-0067, BMI-0079
ERR (By No.)	9763-9687	BMI-0081, BMI-0082, BMI-0079, BMI-0047, BMI-0026, BMI-0001, BMI-0063, BME-0005, BMI-0022, BMI-0058
ERR (By Wt.) Kg.	12.88-10.15	BMI-0083, BMI-0084, BMI-0080, BMI-0074, BMI-0078, BMI-0081, BMI-0067, BMI-0082, BME-0048, BMI-0079
Pupation rate (%)	97.63-96.87	BMI-0081, BMI-0082, BMI-0079, BME-0047, BMI-0026, BMI-0001, BMI-0063, BME-0005, BMI-0022, BMI-0058
Single Cocoon Wt. (g)	1.41-0.999	BMI-0083, BMI-0084, BMI-0080, BMI-0081, BMI-0076, BMI-0078, BME-0048, BMI-0074, BMI-0067 BMI-0066
Single Shell Wt. (g)	0.26 - 0.151	BMI-0083, BMI-0084, BMI-0076, BMI-0080, BMI-0081, BMI-0074, BMI-0078, BMI-0067, BMI-0073, BMI-0066
Shell Ratio (%)	18.67-15.97	BMI-0076,BMI-0083, BMI-0084, BMI-0080, BMI-0081, BMI-0074, BME-0012, BMI-0073, BMI-0079, BME-0052
Average Filament Length (m)	273-749	BMI-0076, BMI-0080, BMI-0074, BMI-0083, BMI-0084, BMI-0081, BMI-0067, BMI-0046, BMI-0078, BMI-0063

The multiple trait evaluation for the rearing and reeling traits (Table-42) revealed that, accession BMI-0081 ranked first with best performance for 9 traits followed by BMI-0079, BMI-0083, BMI-0080 and BMI-0084 ranked for 7 traits and BMI-0078 and BMI-0074 for 6 traits.

Table 42. Top performing multivoltine SWGRs for multiple traits

Accession No.	No. of traits	Trait No. and Values
BMI-0081	9	1(435), 3(31.06),4(9763), 5(11.12), 6(97.63), 7(1.216), 8(0.2), 9(16.63), 10 (516)
BMI-0079	7	1(447), 2(97.55), 3(24.63), 4(9722), 5(10.15), 6(97.22), 9(16.15)
BMI-0083	7	1(442), 3(35.05), 5(12.88), 7(1.411), 8(0.258), 9(18.35), 10 (578)
BMI-0080	7	1(452), 3(29.89), 5(11.82), 7(1.237), 8(0.207), 9(16.91), 10 (601)
BMI-0084	7	1(451), 3(33.26), 5(12.62), 7(1.379), 8(0.244), 9(17.75), 10 (523)
BMI-0078	6	1(456), 3(29.79), 5(11.18), 7(1.126), 8(0.176), 10 (507)
BMI-0074	6	3(28.92), 5(11.78), 7(1.104), 8(0.18), 9(16.58), 10 (599)

Figures in parenthesis indicate the actual value of the traits.

1.Fecundity (No.), 2.Hatching (%), 3.Wt of 10 larvae (g), 4.ERR (No.), 5.ERR (Wt.), 6.Pupation Rate (%), 7.Single Cocoon Wt (g), 8.Single Shell Wt (g), 9.Shell Ratio (%),10. Average filament length (m)

E-03: Preliminary evaluation of bivoltine silkworm genetic resources for growth and reproductive traits

The 369 bivoltine silkworm genetic resources were evaluated for 12 important growth, reproductive traits and reeling parameter in three conservation crops. Variability statistics analysis of the data generated for important quantitative traits is presented in Table-43**.** The fecundity ranged from 172(BBE-0236) to 497(BBI-0286), hatching percentage from 82.67% (BBI-0079) to 98.4% (BBI-0246), the larval weight for 10 larvae ranged from 23.27g (BBI-0209) to 47.53g (BBI-0363). In case of total larval duration it ranged from 528h (BBE-0002) to 600h (BBE-0170). Accession BBE-0002 recorded minimum fifth age larval duration (149 h), while, maximum was in BBE-0170 (196 h). The ERR by no. was minimum in BBE-0250 (4640) and maximum in BBI-0124 (9920). Accession BBI-0250 recorded minimum ERR by wt. (6.45kgs), whereas BBI-0095 recorded maximum (15.50 kgs). Similarly, the pupation rate ranged from a minimum of 46.4% (BBE-0250) to a maximum of 98.6% (BBE-0340). Accession BBI-0209 recorded minimum single cocoon weight (0.930 g) and maximum in BBE-0336 (1.938 g). In case of accession BBI-0093 recorded minimum single shell weight (0.132 g) and BBI-0092 recorded minimum shell ratio (11.06%). Maximum single shell weight was recorded in BBE-0386 (0.418) and shell ratio % in BBE-0368 (23.63 %). The accession BBI-0093 recorded minimum filament length of 264 m and BBI-0362 maximum of 1275 m. The coefficient of variation was highest for V^{th} instar larval duration (21.86%) followed by shell weight (18.29), average filament length (16.41) and fecundity (15.05%) which reflects the high variability for the traits among the accessions.

Table 43. Economic trait-wise range of variability in bivoltine SWGRs

Traits	Mean	Min	Max	SD	CV%
Fecundity(No.)	345	172 (BBE-0236)	497 (BBI-0286)	51.89	15.05
Hatching (%)	94.71	82.67 (BBI-0079)	98.37 (BBE-0246)	2.631	2.78
Wt. of 10 larvae (g)	37.06	23.27 (BBE-0209)	47.53 (BBI-0363)	5.218	14.08
Total larval duration (h)	553	528 (BBE-0002)	600 (BBE-0170)	32.415	5.86
V^{th} instar larval duration (h)	149	114 (BBE-0002)	196 (BBE-0170)	32.485	21.86
ERR by no. (10000 larvae)	9238	4640 (BBE-0250)	9920 (BBI-0124)	738.593	7.99
ERR by wt.(kg)	12.79	6.45 (BBE-0250)	15.5 (BBI-0095)	1.460	11.42
Pupation rate (%)	91.35	46.4 (BBE-0250)	98.6 (BBI-0340)	7.372	8.07
Single cocoon wt. (g)	1.459	0.93 (BBE-0209)	1.938 (BBI-0336)	0.189	12.94
Single shell wt. (g)	0.269	0.132 (BBI-0093)	0.418 (BBI-0386)	0.049	18.29
Shell ratio (%)	18.48	11.06 (BBI-0092)	23.63 (BBI-0368)	1.561	8.44
Average Filament Length (m)	840	264 (BBI-0093)	1275 (BBI-0362)	137.833	16.41

The better performing bivoltine accessions shortlisted based on ANOVA as well as multiple trait analysis for individual and multiple important economic traits are presented along with the range values in Tables 44 and 45, respectively.

Table 44. Top performing bivoltine germplasm accessions for individual traits

Trait	Range	Accession No.
Fecundity (No.)	497-402	BBI-0286, BBI-0055, BBI-0357, BBI-0105, BBI-0079, BBI-0115, BBI-0044, BBI-0060, BBE-0028, BBI-0237, BBI-0340, BBI-0119, BBI-0383, BBE-0023, BBI-0305, BBI-0282, BBI-0388, BBE-0014, BBE-0159, BBE-0006, BBE-0181, BBE-0004, BBE-0024, BBE-0013, BBE-0051, BBI-0100, BBI-0045, BBI-0138, BBI-0071, BBI-0108, BBI-0058, BBI-0290, BBE-0035, BBI-0303, BBE-0157, BBE-0015, BBE-0038, BBI-0350, BBI-0059, BBE-0019, BBE-0187, BBI-0381, BBI-0369, BBI-0281, BBI-0072, BBI-0121, BBI-0297, BBE-0011, BBI-0338, BBI-0354
Hatching (%)	98.37-97.15	BBE-0246, BBE-0201, BBI-0348, BBE-0162, BBI-0107, BBI-0284, BBI-0239, BBI-0378, BBE-0230, BBE-0220, BBE-0187, BBI-0381, BBI-0053, BBE-0186, BBE-0001, BBE-0175, BBE-0171, BBI-0052, BBE-0198, BBI-0084, BBI-0302, BBE-0214, BBE-0241, BBI-0368, BBI-0326, BBE-0242, BBI-0389, BBE-0247, BBI-0275, BBE-0240, BBI-0299, BBE-0002, BBE-0013, BBE-0155, BBI-0366, BBE-0009, BBI-0370, BBI-0289, BBI-0070, BBI-0324, BBE-0265, BBI-0135, BBI-0304, BBE-0218, BBE-0143, BBI-0345, BBE-0194, BBI-0339, BBE-0156, BBI-0379

Trait	Range	Accession No.
Wt of 10 larvae (g)	47.53-42.76	BBI-0363, BBE-0145, BBI-0301, BBI-0357, BBI-0376, BBI-0382, BBI-0121, BBI-0109, BBE-0169, BBI-0344, BBI-0345, BBI-0360, BBI-0349, BBI-0103, BBE-0162, BBI-0172, BBI-0367, BBI-0129, BBI-0378, BBI-0343, BBI-0371, BBI-0133, BBI-0362, BBE-0164, BBI-0381, BBI-0114, BBI-0385, BBI-0342, BBI-0101, BBE-0144, BBI-0125, BBE-0148, BBE-0206, BBE-0155, BBI-0377, BBI-0334, BBE-0153, BBI-0389, BBI-0099, BBI-0087, BBE-0266, BBI-0105, BBI-0299, BBE-0236, BBE-0156, BBE-0154, BBI-0116, BBI-0122, BBE-0332, BBE-0197
ERR by no. (10000 larvae)	9920-9720	BBI-0124, BBI-0377, BBI-0131, BBI-0100, BBE-0002, BBI-0340, BBI-0123, BBI-0115, BBI-0135, BBE-0049, BBI-0125, BBI-0130, BBI-0278, BBI-0118, BBI-0119, BBI-0379, BBI-0283, BBI-0104, BBI-0120, BBE-0152, BBE-0040, BBE-0158, BBE-0005, BBI-0110, BBI-0325, BBI-0105, BBI-0117, BBE-0020, BBE-0023, BBI-0112, BBI-0111, BBI-0116, BBE-0160, BBI-0095, BBI-0296, BBI-0108, BBE-0009, BBI-0291, BBE-0032, BBE-0012, BBI-0084, BBI-0303, BBE-0150, BBI-0337, BBE-0145, BBI-0368, BBI-0279, BBE-0029, BBI-0082, BBI-0380
ERR by wt.(kg) (10000 larvae)	15.5-14.4	BBI-0095, BBI-0099, BBI-0086, BBI-0096, BBE-0150, BBI-0340, BBI-0364, BBI-0087, BBI-0377, BBI-0368, BBI-0379, BBI-0366, BBI-0360, BBI-0118, BBI-0387, BBI-0116, BBE-0145, BBI-0297, BBI-0089, BBI-0125, BBI-0101, BBI-0295, BBI-0303, BBI-0102, BBI-0296, BBI-0365, BBI-0336, BBI-0111, BBI-0363, BBI-0345, BBI-0369, BBE-0148, BBI-0104, BBI-0126, BBI-0115, BBE-0146, BBE-0142, BBI-0350, BBI-0389, BBI-0135, BBI-0121, BBI-0376, BBI-0330, BBI-0138, BBI-0105, BBI-0362, BBE-0160, BBI-0097, BBI-0137, BBI-0334
Pupation rate (%)	98.6-96.6	BBI-0340, BBE-0002, BBI-0100, BBI-0124, BBI-0118, BBI-0123, BBE-0005, BBI-0131, BBI-0115, BBI-0135, BBI-0125, BBI-0377, BBE-0158, BBI-0111, BBI-0095, BBI-0116, BBI-0379, BBI-0278, BBI-0215, BBI-0119, BBI-0110, BBI-0105, BBE-0191, BBE-0009, BBI-0325, BBE-0262, BBE-0160, BBI-0120, BBE-0152, BBE-0023, BBI-0130, BBE-0040, BBI-0303, BBI-0117, BBE-0181, BBE-0211, BBI-0108, BBI-0112, BBI-0283, BBI-0084, BBI-0387, BBI-0104, BBI-0106, BBE-0245, BBI-0203, BBE-0241, BBE-0206, BBE-0145, BBI-0297, BBE-0183
Cocoon wt. (g)	1.94-1.716	BBI-0336, BBI-0386, BBI-0341, BBI-0343, BBI-0375, BBI-0344, BBI-0376, BBI-0338, BBI-0342, BBI-0382, BBE-0152, BBI-0350, BBI-0366, BBI-0362, BBI-0137, BBI-0345, BBI-0330, BBI-0385, BBI-0371, BBI-0357, BBI-0349, BBE-0162, BBI-0367, BBI-0374, BBI-0389, BBI-0339, BBI-0361, BBE-0148, BBI-0360, BBI-0303, BBI-0301, BBE-0169, BBI-0131, BBE-0155, BBI-0136, BBI-0337, BBE-0164, BBI-0348, BBI-0299, BBE-0153, BBI-0334, BBI-0347, BBI-0115, BBI-0379, BBI-0383, BBI-0335, BBI-0296, BBI-0133, BBI-0099, BBI-0364
Shell wt. (g)	0.42-0.329	BBI-0386, BBI-0374, BBI-0362, BBI-0137, BBI-0343, BBI-0375, BBI-0368, BBI-0338, BBI-0389, BBI-0345, BBI-0385, BBI-0344, BBI-0349, BBI-0336, BBI-0366, BBE-0332, BBE-0162, BBI-0364, BBI-0339, BBI-0299, BBI-0330, BBI-0350, BBI-0367, BBI-0341, BBI-0102, BBE-0152, BBI-0347, BBI-0376, BBI-0381, BBE-0169, BBI-0382, BBI-0363, BBI-0357, BBI-0361, BBI-0377, BBI-0370, BBI-0360, BBI-0348, BBE-0153, BBI-0116, BBI-0379, BBI-0378, BBE-0155, BBE-0197, BBI-0346, BBI-0334, BBI-0340, BBE-0148, BBI-0303, BBE-0262

Trait	Range	Accession No.
SR (%)	23.63-20.26	BBI-0368, BBE-0262, BBE-0197, BBI-0374, BBE-0332, BBI-0386, BBI-0362, BBI-0137, BBI-0363, BBI-0389, BBI-0364, BBI-0370, BBE-0171, BBE-0267, BBE-0264, BBE-0270, BBI-0102, BBI-0349, BBI-0299, BBI-0345, BBE-0198, BBE-0227, BBI-0377, BBI-0381, BBI-0385, BBI-0338, BBI-0340, BBE-0182, BBE-0179, BBE-0230, BBI-0275, BBI-0339, BBI-0375, BBI-0134, BBI-0116, BBE-0180, BBI-0290, BBI-0343, BBE-0178, BBI-0347, BBE-0162, BBE-0174, BBE-0175, BBI-0366, BBE-0240, BBE-0229, BBE-0231, BBI-0378, BBE-0186, BBE-0210
AFL (m)	1275-987	BBI-0362, BBI-0277, BBI-0380, BBI-0389, BBI-0375, BBE-0030, BBI-0368, BBI-0364, BBE-0332, BBI-0080, BBI-0367, BBI-0365, BBI-0116, BBI-0374, BBI-0137, BBI-0361, BBI-0378, BBE-0152, BBI-0386, BBE-0035, BBE-0147, BBI-0381, BBI-0125, BBI-0379, BBI-0138, BBI-0337, BBI-0303, BBI-0349, BBE-0267, BBI-0347, BBE-0149, BBI-0357, BBE-0150, BBI-0338, BBI-0335, BBI-0326, BBI-0132, BBI-0369, BBI-0126, BBI-0136, BBI-0134, BBI-0330, BBI-0363, BBE-0154, BBE-0153, BBI-0350, BBI-0360, BBE-0158, BBI-0373, BBI-0292

Table 45. Top ranking bivoltine germplasm accessions identified for multiple traits

Acc.No.	No. of traits	Trait No. and values
BBI-0303	7	1(414), 4(9740), 5(14.7), 6(96.8), 7(1.77), 8(0.33), 10(1038)
BBI-0389	7	2(97.48), 3(43.26), 5(14.5), 7(1.786), 8(0.382), 9(21.41), 10(1200)
BBI-0379	7	2(97.15), 4(9820), 5(14.9), 6(97.4), 7(1.732), 8(0.336), 10(1060)
BBI-0116	7	3(42.9), 4(9760), 5(14.85), 6(97.4), 8(0.338), 9(20.53), 10(1097)
BBI-0362	6	3(44.48), 5(14.45), 7(1.84), 8(0.401), 9(21.96), 10(1275)
BBI-0381	6	1(406), 2(98.03), 3(44.26), 8(0.35), 9(20.8), 10(1062)
BBI-0345	6	2(97.21), 3(45.42), 5(14.6), 7(1.819), 8(0.38), 9(20.86)
BBI-0377	6	3(43.36), 4(9900), 5(15), 6(97.6), 8(0.348), 9(20.81)
BBI-0340	6	1(435), 4(9860), 5(15.15), 6(98.6), 8(0.335), 9(20.79)
BBI-0368	6	2(97.55), 4(9740), 5(14.9), 8(0.387), 9(23.63), 10(1150)
BBI-0360	5	3(45.25), 5(14.85), 7(1.773), 8(0.344), 10(1000)
BBI-0357	5	1(472), 3(46.46), 7(1.802), 8(0.349), 10(1021)
BBE-0152	5	4(9800), 6(97), 7(1.851), 8(0.353), 10(1078)
BBE-0162	5	2(98.27), 3(44.85), 7(1.799), 8(0.367), 9(20.4)
BBI-0364	5	5(15.1), 7(1.716), 8(0.366), 9(21.41), 10(1143)
BBI-0350	5	1(410), 5(14.5), 7(1.849), 8(0.36), 10(1001)
BBI-0366	5	2(97.37), 5(14.85), 7(1.846), 8(0.37), 9(20.31)
BBI-0363	5	3(47.53), 5(14.65), 8(0.349), 9(21.42), 10(1006)
BBI-0338	5	1(402), 7(1.868), 8(0.386), 9(20.79), 10(1019)
BBI-0349	5	3(45.21), 7(1.8), 8(0.376), 9(20.95), 10(1038)
BBI-0105	5	1(460), 3(43.08), 4(9780), 5(14.45), 6(97.2)
BBI-0378	5	2(98.14), 3(44.72), 8(0.336), 9(20.27), 10(1084)
BBI-0115	5	1(445), 4(9860), 5(14.55), 6(97.8), 7(1.734)

Acc.No.	No. of traits	Trait No. and values
BBI-0299	5	2(97.45), 3(43.02), 7(1.74), 8(0.364), 9(20.9)
BBI-0125	5	3(43.9), 4(9840), 5(14.75), 6(97.8), 10(1062)
BBI-0137	5	5(14.4), 7(1.83), 8(0.399), 9(21.91), 10(1094)

Figures in parantheses indicates the actual value of the traits

1.Fecundity (Nos.), 2. Hatching (%), 3.Wt of 10 larvae (g), 4.ERR (No.), 5.ERR (Wt.), 6.Pupation Rate (%), 7.Single Cocoon Weight (g), 8.Single Shell Weight (g), 9.Cocoon Shell Ratio (%), 10. Average filament length (m).

Data analysis indicated that, accession **BBI-0303,BBI-0389, BBI-379 and BBI-0116** were the best performers qualifying for seven traits followed by, BBI-0362, BBI-381, BBI-345, BBI-0377, BBI-0340 and BBIO-0368 for six traits and BBI-0360, BBI-0357, BBE-0152, BBE-0162, BBI-0364, BBI-0350, BBI-0366, BBI-0363, BBI-0338, BBI-0349, BBI-0105, BBI-0378, BBI-0115, BBI-0299, BBI-0125 and BBI-0137 for five traits.

E-04: Evaluation for growth and reproductive traits of mutant silkworm genetic resources

Evaluation of 23 mutant genetic stocks revealed the following variability statistics on the important economical traits and is presented in Table-46. Statistical analysis of data revealed higher co-efficient of variation for single shell weight (26.22), Wt of 10 larvae (14.67), shell ratio (13.27), single cocoon weight (12.81) and fecundity (12.74).

Table 46. Variability in economical traits of 23 mutant genetic stocks

Traits	Mean	Min	Max	SD	CV%
Fecundity (No.)	297	218	363	37.79	12.74
Hatching (%)	93.12	82.97	97.55	3.82	4.11
Wt. of 10 larvae (g)	22.82	17.66	31.70	3.35	14.67
Total larval duration (h)	537	518	548	8.21	1.53
V age larval duration (h)	127	108	144	10.05	7.89
ERR. by no. (10000 larvae)	9329	8887	9620	204.05	2.19
ERR.by wt. (kg) (10000 larvae)	9.48	8.12	11.62	0.81	8.58
Pupation rate (%)	93.29	88.87	96.20	2.04	2.19
Single cocoon weight (g)	1.036	0.714	1.326	0.13	12.81
Single shell weight (g)	0.132	0.077	0.229	0.03	26.22
Shell ratio (%)	12.71	10.93	17.47	1.69	13.27

S-03: A- 01: Conservation of Multivoltine SWGRs

All the 83 multivoltine accessions were conserved by conducting rearing for four conservation crops (115th to 118th generation) and the eggs were preserved at a temperature of 5º C for 35 days with backups for 45 and 60 days in the cold storages located at Hosur and Mysuru. The multivoltine accessions were maintained true to type on par with catalogue data without any loss ensuring disease freeness.

S-04: A- 01: Conservation of Bivoltine SWGRs

All the 369 bivoltine accessions were conserved by conducting rearing in three batches and the egg layings were preserved under 10 months hibernation schedule with one crop per year. As a backup, the egg layings of all the three batch accessions were also conserved under 12 month hibernation schedule

in the cold storages located at Hosur and Mysuru. The accessions were maintained true to type on par with the catalogue data without any loss and ensuring disease freeness. So far, first batch accessions have completed 26 generations, second batch accessions 23 generations and third batch accessions 16 generations from the year 2004.

S-05: A-01: Conservation of Mutant SWGRs

All the 23 bivoltine mutant genetic stocks were conserved following 6 months hibernation schedule at 2 crops per year. These 23 mutant accessions have completed 36-37 generations. As a back-up, the accessions were conserved under 8 months hibernation schedule in the cold storages located at Hosur and Mysuru. The accessions were maintained true to type on par with the catalogue data without any loss and ensuring disease freeness.

S-03, S-04, S-05: A- 02: Supply and Utilization of SWGRs

During the year, One multivoltine silkworm accession was supplied to SBRL, Kodathi for research purpose (Table-47).

Table 47. Supply of silkworm genetic resources

SN	Indenter	No. of times	No. of MV SWGRs	Purpose
4	SBRL, Kodathi	1	1	Research purpose
Total		**01**	**01**	

6. SERVICES RENDERED

- Smt. G. Punithavathy, Dr.S. Masilamani and Dr.G. Thanavendan handled classes for sericultural farmers and Junior Inspector of sericulture (JISs) of Tamil Nadu state on sericulture topics under the Central Sector Schemes, Cluster Development Programme and ISDS and ATMA programme at TNSTI, Hosur.
- As IGNOU academic Counsellor Dr. S. Masilamani and Smt. G. Punithavathy handled theory classes for students of Certification in Sericulture (CIS) at the IGNOU programme study centre of TNSTI, Hosur.

7. TRAINING

Training imparted by the Scientists

Training Programme	Place	Faculty from Institute
Training for sericultural farmers of Tamil Nadu state	Tamil Nadu Sericulture Training Institute (TNSTI), Hosur	Dr.S. Masilamani, Sci-D Smt. G. Punithavathi-Sci-D, Dr.G. Thanavendan, Sci-C

Trainings attended by the Scientist

Training Programme	Place	Faculty from Institute
Training-cum- demonstration programme on **eCocoon** mobile App for Seed Analyst & Seed Officers.	RSRS, Central Silk Board, Salem. Organized by NSSO, Central Silk Board, Bengaluru	Dr. G. Lokesh, Sci-D

8. PUBLICATIONS

Research papers

- Maheswari M., Lokesh G., Murthy G.N., Sekar S., Somaprakash D.S. and Mishra R.K. (2019). Evaluation of bivoltine silkworm genetic resources through cluster analysis and identification of better performing bivoltine accessions. *International Journal of Genetics* 11(5) : 601-603.
- G. Thanavendan, G. Lokesh and Geetha N. Murthy (2020). Explorative Survey of Wild Mulberry Silkworm Genetic Resources. *Singapore J.Sci.Res.* 10 : 28-34.
- Maheswari M., Lokesh G., Ritwika S Chaudhuri, Jameela Khatoon, Somaprakash D S, Muthulakshmi M, Kishore Kumar C M, G C Das, A K Verma and Mishra R K (2020). Evaluation of exotic bivoltine breeds to identify promising parental genetic resources for tropics. *International Journal of Genetics* 12(1) : 693-697.
- G. Lokesh, M. Maheswari, Ritwika Sur Chaudhuri, D. S. Somaprakash, S. Sekar and R. K. Mishra (2020). Evaluation of mutant silkworm genetic resources for important morphological and quantitative characters. *Asian Journal of Applied Sciences.* 13(2) : 84 -93.

Technical report

- Thanavendan, G. (2020). Survey, exploration and collection of new Mulberry Germplasm in Tura, West Garo Hills of Meghalaya, CSGRC, Hosur.

9. PARTICIPATION IN CONFERENCE / SEMINAR / MEET / WORKSHOP

- One day Young Scientist's Meet attended by Dr. Ritwika Sur Chaudhuri, Scientist-C and Dr. G. Thanavendan, Scientist-C on 27th February, 2020 at Central Office, CSB, Bangalore.

10. VISITORS

A total of **444** persons visited the Institute, as per following details and obtained firsthand knowledge on the activities of the centre :

Details of the visitors

Sl. No.	Name / Institution	Particulars / Purpose	No of Visitors
1.	R.K. Gopalakrishnan and N. Srinath Agriculture Entomology, Annamalai University, Chidambaram, TN	Institute visit	02
2.	Dr. Divya S.H. and Students Dept. of Sericulture, University of Mysore	M.Sc. Students	35
3.	Mr. P. Muruganandham Tamil Nadu Sericulture Tanning, Hosur	Sericulture farmers	37
4.	Dr. Azizul Rahaman, Extension Officer Directorate of Sericulture, Assam	Extension Sericulture Staff	08
5.	Dr. S.V. Krishnamurthy, Proff & Head, Dept. of Sericulture, FC&RC, TNAU, Mettupalayam	M.Sc. Students	10
6.	Dr. Rohith Shankar, Dept. of Sericulture, Yuvaraja College, Mysuru	B.Sc. Students	43
7.	Dr. Rajshekhar, SSTL, NSSO, Kodathi	Trainers of Karnataka DOS (Sericulture Inspectors)	12
8.	Dr. Pallavi, Asst. Prof. (Seri), College of Sericulture, UASB, Karnataka	Student and staff	32
9.	Dr. Srivinas, Madhagondapalli Modern School, Hosur	Student and staff	123
10.	Dr. A.D. Jadhav Dept. of Zooology, Shivaji University, Kolhapur	Student and staff	14
11.	Dr. K.A. Murugesh, Asst. Prof. Forest College and Research Institute, TNAU, Mettupalayam	Student and staff	23
12.	Ms. Maya C Chennai Pvt. Entrepreneurs, Chennai.	Institute Exposure visit	04
13.	Dr. I. Vetha Pother, Anna University, Trichy	Student and staff	02
14.	Government Arts and Science College, Dharmapuri	Student and staff	75
15.	Sher-e-Kashmir University of Agricultural Sciences & Technology, Shalimar, Srinagar, J&K	Institute Extension visit	12
16.	Dr. Suraksha Chitra, In-charge Poonch Campus, University of Jammu, J&K	Institute Extension visit	12
		TOTAL	**444**

11. COMPOSITION OF COMMITTEES

Research Advisory Committee

Dr. Chandish R. Ballal, Director, National Bureau of Agricultural Insect Resources	**Chairperson**
Dr. K.S. Varaprasad Project Director (Retd), Directorate of Oilseeds Research Rajendranagar, Hyderabad	Member
Dr. B. Sarath Babu Principal Scientist & Head, ICAR-NBPGR Regional Station, ARI Campus, Rajendra Nagar, Hyderabad	Member
Dr. Modhumita Dasgupta, Scientist F, Institute of Forest Genetics and Tree Breeding (ICFRE)	Member
Director (Tech), Central Silk Board, CSB Complex, Bangalore	Member
Director, Central Sericultural Germplasm Resources Centre, P.B.No.44, Thally Road, Hosur	Member – Convener

Research Council

Director, Central Sericultural Germplasm Resources Centre P.B.No.44, Thally Road, Hosur - 635 109	**Chairman**
Scientist-D, Central Sericultural Germplasm Resources Centre P.B.No.44, Thally Road, Hosur - 635 109	Member – Convener

Germplasm Registration Committee

Director (Tech.), Central Silk Board, Bangalore - 560 068	**Chairman**
Director, Central Sericultural Research and Training Institute, Mysuru - 570008	Member
Director, Central Tasar Research and Training Institute Ranchi -835 303	Member
Director, Central Muga and Eri Research and Training Institute, Lahdoigarh -785 700	Member
Director, Central Sericultural Germplasm Resources Centre, Hosur - 635 109	Member – Convener

Germplasm Supply & Exchange Committee

Director, Central Sericultural Germplasm Resources Centre Hosur - 635 109	**Chairman**
Director (Tech.), Central Silk Board, Bangalore – 560 068	Member
Scientist-D, Central Sericultural Germplasm Resources Centre, Hosur – 635 109	Member
Scientist-D, Central Sericultural Germplasm Resources Centre, Hosur – 635 109	Member – Convener

12. राजभाषा कार्यान्वयन

कार्यशाला

- के.रे.ज.सं.के., एस.एस.पी.सी., ई.एस.एस.पी.सी., होसूर, आरइसी, बेरेगइ के समस्त वैज्ञानिकों / अधिकारियों / कर्मचारियों को दिनांक 26.06.2019 को एनएसएसओ, केरेबो, बैंगलुरू, से आमंत्रित व्याख्याता श्रीमति जयश्री. सी. पी., सहायक निदेशक (राजभाषा) ने प्रतिभागियों को प्रशासनिक कार्यों में सरल हिन्दी भाषा का उपयोग, राजभाषा हिन्दी का परिचय, पारिभाषिक शब्दावली एवं कार्यान्वयन आदि के बारे में जानकारी दी तथा उक्त का अभ्यास करवाया ।
- केरेउएंप्रसं, केन्द्रीय रेशम बोर्ड, बैंगलूर से आमंत्रित व्याख्याता श्री. विजोय कुमार, सहायक निदेशक (राजभाषा) ने 21.09.2019 को भाषा, शब्दावली एवं बोल चाल की हिन्दी, राजभाषा हिन्दी का परिचय देना, राजभाषा नीति और नियम आदि के विषय पर हिन्दी कार्यशाला का आयोजन किया ।
- दिसंबर 2019 को केन्द्र की कनिष्ठ अनुवादक हिन्दी, श्रीमती. शीबा. वी. एस ने राजभाषा हिंदी कार्यान्वयन के संदर्भ में राजभाषा हिंदी के प्रगामी प्रयोग को बढ़ावा देने हेतु, राजभाषा संबंधी अधिनियमों, नियमों एवं आदेशों के अनुपालन तथा राजभाषा के प्रति प्रेरित करने के उद्देश्य से भाषा, शब्दावली, हिन्दी लेख का पठन, हिन्दी प्रेरणात्मक वीडियो को देख कर अपने विचारों को हिन्दी में प्रस्तुत करना आदि के विषय पर एक परस्पर संवादात्मक हिन्दी कार्यशाला का आयोजन किया गया।

राभाकास बैठक

राभाकास बैठक दिनांक को 02.06.2019, 28.09.2019, 18.12.2019 को आयोजित की गई।

हिंदी पखवाड़ा

केरेजसंके, होसूर में दिनांक 16.09.2019 को भारतीय भाषाओं के सौहार्द दिवस के रूप में हिंदी दिवस तथा 16.09.2019 से 28.09.2019 तक हिंदी पखवाड़ा केरेजसंके, ईएसएसपीसी एवं एसएसपीसी, होसूर के वैज्ञानिकों / अधिकारियों / कर्मचारियों एवं प्रक्षेत्र कामगारों के सहयोग के साथ मनाया गया। हिंदी पखवाड़े के दौरान कुल चार हिंदी प्रतियोगिताएं आयोजित की गई। केरेजसंके, होसूर, ईएसएसपीसी और एसएसपीसी होसूर के वैज्ञानिकों / अधिकारियों / कर्मचारियों एवं प्रक्षेत्र कामगारोंने विविध प्रतियोगिताएं जैसे स्मुति परिक्षण, नोटिंग एवं पत्र लेखन, शब्दावली व सही लेखन (300 शब्द), आदि में सक्रियता से भाग लिया। दिनांक 28.09.2019 को डॉ. डी. एस. सोमप्रकाश, वैज्ञानिक-डी एवं प्रभारी, केरेजसंके, होसूर की अध्यक्षता में समापन सह पुरस्कार वितरण समारोह मानाया गया।

अन्य गतिविधियां

- कार्यालय द्वारा प्रकाशित न्यूजलेटर व वार्षिक प्रतिवेदन द्विभाषी में किये गये।
- केन्द्र के वेबसाइट के आर टी आई, स्टाफ लिस्ट, लेटर हेड, रबड सील, विजिटिंग कार्ड आदि को द्विभाषी में अपडेट किया जा रहा है।

- वित्तिय वर्ष 2019-20 के दौरान केन्द्र की 01 वैज्ञानिक – डी एवं चार कर्मचारियों को सरकारी कामकाज मूल रूप से हिंदी में संपादित करने हेतु प्रोत्साहन राशि से सम्मानित किया गया।
- इस केंद्र में केंद्रीय हिंदी प्रशिक्षण संस्थान, नई दिल्ली द्वारा वर्ष 2018 में आयोजित किये गए हिंदी प्रबोध, प्रवीण एवं प्राज्ञ अल्पकालिक गहन प्रशिक्षण तथा पाठ्यक्रम के प्रतिभागियों को संबंधित प्रमाण पत्र और उक्त नगद पुरस्कार से पुरस्कृत किया गया।
- हिंदी का अल्पज्ञान रखनेवाले अधिकारियों एवं कर्मचारियों को सप्ताह में दो दिवस बोल चाल की हिंदी पर कक्षायें आयोजित की जा रही है।

13. OTHER ACTIVITIES

Brainstorming meeting to formulate strategies for effective conservation and utilization of seri-genetic resources

In accordance with the recommendation of the Research Co-ordination Committee (RCC) of Central Silk Board, Bengaluru, a meeting was convened on 30th April 2019 at CSGRC Hosur in the august presence of Shri Rajit Ranjan Okhandiar IFS, Member Secretary, Central Silk Board, Bengaluru as Chairperson, Dr.B.Saratchandra, former Director of CSGRC Hosur, former scientists of CSGRC Hosur, experts in the fields of germplasm conservation, genomics and Directors of CSB. The experts offered recommendations to formulate strategies for effective conservation and utilization of seri-genetic resources.

Research Advisory Committee Meeting

The 38th meeting of the RAC of the Centre was organized on 30th August 2019. The Committee and participants deliberated upon the research work undertaken at the Centre presented by the Scientists of the Centre and action to be taken for improvement were recommended.

Germplasm Supply & Exchange Committee Meeting

The 35th meeting of the Committee was convened on 22nd June 2019 wherein the supply of mulberry and silkworm germplasm as per the indents was approved with advice to collect feedback information from the concerned indenters.

Germplasm Registration Committee Meeting

The Germplasm Registration Committee meeting of CSGRC, CSB Hosur was convened on 26th July 2019 wherein two mulberry varieties *Viz.,* C-2038 and Tr-23 submitted by CSR&TI Berhampore authorized after multilocational trials were considered for registration.

Scientific / Technical Audit

The Scientific / Technical Audit of the centre was taken up by the Research Co-ordination Section of CSB Bengaluru on 16.01.2020. During the audit, the Action Taken Report on the recommendations during previous audit and the outcome of projects concluded since 2017 as well as status of ongoing projects were reviewed and recommendations were given for effective implementation and monitoring of projects.

Pebrine Monitoring

The scientists nominated in the Pebrine Monitoring Team visited the Centre and undertook incidence of pebrine in different crops as per schedule. During the period under report no incidence of pebrine was reported in the crops.

Swachh Bharat

1. ***Swachhta Hi Seva (SHS)*** Campaign was organized to create awareness about harmful effects of using plastics, especially single use plastic and importance of segregation of plastic waste and proper disposal.
2. An Awareness Programme on Harmful effects of plastic and Plastic waste management was organized at CSGRC, Campus on 27.09.2019 for the staff and skilled Farm workers of CSGRC, ESSPC, SSPC, Central Silk Board, Hosur.
3. A Public Awareness programme and a Road show on Harmful effects of plastic were arranged on 30.09.2019 at Anthivadi village, Thally Road, Hosur.
4. An awareness programme for Sericulture farmers and DoS staff was conducted on 01.10.2019 at Tamil Nadu Sericulture Training Institute, DoS, Hosur.

Celebration of Constitution day

The Central Sericultural Germplasm Resources Centre, Hosur has celebrated constitution day on 31.01.2020 and organized one quiz programme for Officers, staff and TSFWs. On the same day one invited talk on the "Fundamental Rights and Duties of Indian Citizens" was delivered by Dr. K.V. Ramaraj, M.A., M.L., Ph.D. Senior Advocate, Hosur.

International Women's Day

International Women's Day celebration was organised at CSGRC, Hosur on 09.03.2019. All officers and staff participated in the event by sharing their views on gender equality.

14. ADMINISTRATIVE AND FINANCIAL REPORT

a. Staff strength as on 31.03.2020

Category	No.
Director	-
Scientific	
Scientist-D	7
Scientist-C	2
Scientist-B	2
Sub-total	**11**
Technical	
Technical Assistant	4
Field Assistant	1
Sub-total	**5**
Administrative	
Asst. Director (A&A)	2
Asst. Director (Comp)	1
Asst. Supdt.	1
UDC	2
Stenographer (Grade I)	1
Junior Engineer	1
Library & Information Asst.	1
Junior Translator (Hindi)	1
Asst. Technician	1
MTS	2
Driver	2
Sub-total	**15**
Total	**31**
Supporting (Skilled Farm workers)	35

b. Personnel posting position as on 31.03.2020

Division / Section	Name	Designation
	Dr. R.K. Mishra	Director Addl. Charge
Mulberry	Dr. S. Masilamani	Scientist-D (up to 31.05.19)
	Dr. Geetha N. Murthy	Scientist-D (from July 2019)
	Dr. G. Thanavendan	Scientist-C
	Dr. M.C. Thriveni	Scientist-B
	Shri. Raju Mondal	Scientist-B
Silkworm	Dr. D. S. Somaprakash	Scientist-D (from 02.07.2018)
	Dr. C.M. Kishor Kumar	Scientist-D (from 12.03.2020)
	Dr. M. Maheswari	Scientist-D
	Smt. G. Punithavathy	Scientist-D
	Dr. G. Lokesh	Scientist-D
	Dr. Ritwika Sur Choudhury	Scientist-C (from 25.06.2019)
Post Cocoon Technology	Dr. Jameela Khatoon	Scientist-D (R&S)
PMEC	Dr. Geetha N. Murthy	Scientist-D
Computer Section	Shri. S. Sekar	Assistant Director (Computer)
Administration	Shri. M. Jagajeevan	Assistant Director
	Smt. K. Gayathri	Assistant Director (from 03.02.2020)
Hindi	Smt. V.S. Sheeba	Junior Translator (Hindi)

Superannuation / Voluntary Retirement from Service (VRS)

The following officers / officials superannuated during the year under report:

1. Dr. S. Masilamani, Scientist-D
2. Smt. Mary Chitra, Asst. Supdt. (VRS)

c. Abstract of receipts and expenditure statement for the year 2019-20 [Rs. In lakhs]

Fund Head	GIA received [Rs.]	Expenditure [Rs.]	Balance surrendered [Rs.]
Plan General	67.64	63.66	3.98
Plan Capital	5.34	5.33	0.009
Total (PL)	**72.98**	**68.99**	**3.989**
Plan Salary **(PLS)**	534.58	529.87	4.71
SCSP	152.98	152.94	0.04
TSP	7.86	7.53	0.33
Total (PLS)	**695.42**	**690.34**	**5.08**
Grand total (PL+PLS)	***768.40***	***759.33***	***9.07***

15. METEOROLOGICAL DATA

SUMMARY OF METEOROLOGICAL DATA APRIL 2019 TO MAR 2020											
Month and Year	**Temperature (°C)**			**Relative humidity (%)**			**Total Rain Fall (mm)**	**No. of rainy days**	**Avg. Wind Speed (m/sec)**	**Wind Direction**	**Sun Duration (Min.)**
	Min.	**Max**	**Avg.**	**Min.**	**Max.**	**Avg.**					
Apr. 2019	19.50	33.53	26.52	48.78	55.36	52.07	101	6	1.48	S	343
May 2019	21.05	33.12	27.09	49.54	81.96	65.75	172	11	1.64	WSW	346
June 2019	21.35	30.22	25.79	61.13	90.73	75.93	27	8	2.36	WSW	340
July 2019	20.27	29.00	24.64	59.32	91.32	75.32	17	5	2.69	W	328
Aug. 2019	19.98	27.30	23.64	76.67	97.91	87.29	131	14	2.74	WSW	315
Sep. 2019	20.21	27.60	23.91	71.36	99.13	85.24	172	15	2.06	SW	334
Oct. 2019	19.56	26.78	23.17	78.87	96.70	87.78	254	19	1.43	SSE	326
Nov. 2019	18.22	26.73	22.48	70.12	97.20	83.66	30	5	2.00	SE	323
Dec. 2019	17.59	25.38	21.48	70.67	99.90	85.28	32	6	1.94	S	276
Jan. 2020	15.70	28.55	22.12	43.41	78.16	60.78	0	0	1.61	SE	302
Feb. 2020	16.26	29.96	23.11	20.86	67.86	44.36	0	0	2.00	SE	314
Mar. 2020	18.80	32.49	25.65	33.24	71.54	52.39	8	1	1.61	SSE	332
						Total	**944**	**90**			

Minimum Temperature recorded is 15.7°C in Jan. 2020
Maximum Temperature recorded is 33.53°C in Apr. 2019
Minimum Relative Humidity recorded is 15.14% in Jan. 2020
Maximum Relative Humidity is 100%

RAC Meeting (30.08.2019)

Hindi Workshop (18.12.2019)

World Environment Day (05.06.2019)

Meeting to formulate Strategy for Effective Maintenance and Utilisation of Serigenetic resources (30.04.2019)

Constitution Day of India (31.01.2020)

Swacch Bharat Activity (30.09.2019)





for further details please contact

Director

Central Sericultural Germplasm Resources Centre (CSGRC)
Central Silk Board, Ministry of Textiles, Govt. of India
Hosur - 635109, Krishnagiri District, Tamil Nadu
Phone : 04344-222013, 221148

http://www.csgrc.res.in

csgrchos.csb@nic.in