

Outcome of the R&D projects implemented by CMER&TI, Lahdoigarh in last 10 years

Field of R&D projects: Silkworm improvement

	Project Code & title	Objectives	Project period	Outcome of the Research Project	How the outcome is utilized
1	ARE 5860 Development of diagnostics for muga, eri and other related silkworms of NE region	Development of Diagnostic tools for silk moths available in NE region	Oct. 2011 Sept., 2013	Diagnostic keys for silk moths available in NE region were developed. Diagnostic keys were developed for domesticated eri silkworm and wild eri silkworm. The name <i>Samia ricini</i> and <i>Samia canningi</i> were verified. 17 species of wild silk moths were collected from Manipur, Arunachal Pradesh, Meghalaya and Assam states of North East India. Illustrated diagnostics were developed for <i>Antheraea assamensis</i> , <i>Samia ricini</i> , <i>S. canningi</i> , <i>Attacus atlas</i> , <i>Acteas selene</i> of silkworm covering the characters like egg morphology, larval chaetotaxy, silk gland and cocoon morphology. Description for all the collected species will be published in the form of a Monograph.	The diagnostics keys will be utilized for identification of wild and domesticated silkworm species
2	AIE 5854 Exploration, collection, characterization and cataloguing of wild sericigenous insects available in NE India	Exploration, collection, host range, documentation and morphological characterization of wild sericigenous insects in N.E. India in ex-situ habitats Development of computerized database for wild sericigenous	October 2011 – September 2014	Twenty nine species of wild silk moths have been collected from Manipur, Arunachal Pradesh, Meghalaya, Mizoram, Nagaland and Assam states of North East India. All the species have been collected from Arunachal Pradesh, Nagaland, Assam, Manipur and Meghalaya. All the species' name updated from LEPINDEX and in one species, there is confusion according to LEPINDEX, the name is <i>Samia pryleri</i> , but Dr. Ian Kitching, Lepidoptera Leader, NHM, London informed that this is still in <i>Samia ricini</i> . Now, it is clarified and corrected in LEPINDEX database, which is approved by ICZN for current name of the species of order Lepidoptera. In	The collection made under the project is preserved at Insect Repository, Entomology Section, CMERTI, Lahdoigarh, which can be utilized as reference collection in future for clarification and identification of wild silk moths. As, Thailand people are producing silk from <i>C. trifinistrata</i> , so, five species can be commercialized viz., <i>Samia canningi</i> , <i>Attacus atlas</i> , <i>Cricula trifenistrata</i> , <i>Antheraea roylei</i> , <i>A. compta</i> . The collection and life cycles made for

		insects in N.E. India		India, still researcher using names <i>Samia cynthia ricini</i> / <i>Samia cynthia</i> / <i>Philosamia ricini</i> / <i>Philosamia cynthia ricini</i> , which are incorrect and the correct name is <i>Samia ricini</i> for domesticated species and <i>Samia canningi</i> for wild species. Both the species have peculiar characters in size, color, wing venation and genitalic features. According to recent survey, only three species are found in North Eastern India viz., <i>Samia ricini</i> , <i>Samia canningi</i> and <i>Samia kohlii</i> . During study, complexity was faced to identify the <i>Antheraea pernyi</i> , <i>A. compta</i> , <i>A. frithii</i> and <i>A. roylei</i> . But, now it is clarified with the help of male genitalic features. In all these species the labide of each species have different shape and size, which is used for identification of <i>Antheraea</i> spp	comer cialized / non-commercialized species and other related species can be sold for display purpose in the Indian museums.
3	AIB-5857 Evaluation and identification of eco-race(s) of eri silkworm <i>Samia ricini</i> (Donovan) 4suitable to semi-arid areas of Andhra Pradesh	To evaluate and identify eco-race(s) suitable to semi-arid areas of Andhra Pradesh utilizing castor and tapioca leaf	November, 2011- October, 2013	Eri silkworm eco-race(s) suitable to semi-arid areas of Andhra Pradesh would be identified for commercial exploitation with castor and tapioca leaves	The identified eri silkworm ecoraces would be commercially exploited in semi-arid areas of Andhra Pradesh
4	AIP 5851 Development of high yielding Muga silkworm breeds through population improvement	To develop breeds of muga silkworm with higher survivability and higher shell weight suitable in the climatic conditions of North-East India	Feb.'11 to Dec.'15	The average fecundity and hatching of the selected breed, CMR-1 at 21 th generation were recorded as 170 nos. and 80 % respectively against 160 nos. and 71.85 % respectively in control. The average fecundity and hatching of the backcross line, CMR-2 at 20 th generation were recorded as 165 nos. and 73.90 % respectively against 160 nos. and 71.85 % respectively in control.	To be achieved

5	APR-5858 Eri silkworm (<i>Samia ricini</i> Donovan) rearing and cocoon production in relation to host plant castor genotypes (<i>Ricinus communis</i> Linn.) raised under rainfed conditions in semi-arid region	To evaluate the varietal potential of commercial and perennial castor genotypes under rain-fed semi-arid conditions. To identify the castor genotypes suitable for eri silkworm rearing	November, 2011 to October, 2014	Eight castor genotypes comprising 3 pure, 3 hybrid and 2 perennial were evaluated. At the optimum growth period (120 DAS), the genotype CSH – 103 showed higher values for no. of leaves/ plant (21), plant height (245.07 cm), no. of branches (2) and leaf yield (9796.08 kg/ha) and it was followed by CSH–106 and CSH–105.	The identified castor genotypes suitable to semi-arid areas of Andhra Pradesh would be used for increased quality production of cocoons.
6	APS 5859 Development of egg preservation technique of eri silkworm <i>Samia ricini</i> (Donovan).	To develop a suitable egg preservation technique to ensure availability of sufficient quantity of quality Eri seed as per demand	October 2011- September 2013	Embryological studies were done to identify suitable stage of preservation. Preservation of eggs in BOD incubator at 5°C showed normal hatching of 75-80% up to 30 days preservation. Repeated trials were done to confirm actual preservation days. 18 days preserved and 3 days incubated lots were reared successfully. Cocoon characters of preserved lot were found to be similar to that of the control..	Developed technique will be utilized for egg preservation.
7	APS 5856 Development of Egg Preservation Schedule in Muga silkworm, <i>Antheraea assamensis</i> , Helfer.	To develop suitable technology for short and long term preservation of eggs of muga silkworm.	April, 2011- June, 2015	The longest embryonic developmental stage has been detected at the ages of 68 to 72 hr. old embryo. Embryonic chart has been prepared for different developmental stages of muga silkworm eggs. It has been observed that muga silkworm eggs can be preserved up to 15 days at 7 °C with > 85 % hatching which is almost equal to the control. Conducted preservation of 400 dfls of muga silkworm eggs of mix ages (24hr- 72 hr old embryos) at 7 °C in 4 replications for 15 days. Bioassays of the eggs	Developed egg preservation schedule will be verified and popularized

				showed average ERR of 53.19 % against 55.66 % in the control.	
8	AIP 5861 Molecular approaches in characterization and utilization of gut microflora from Muga Silkworm <i>Antheraea assamensis</i> for enhancing productivity of Muga culture in North Eastern India. (In collaboration with IARI, New Delhi)	Isolation, enumeration and molecular characterization of gut microbial diversity in different morphotypes and accessions of muga silkworm <i>A. assamensis</i> . Evaluation of positive influence of consortium of gut microbial isolates on the growth, development and economic parameters of <i>A. assamensis</i> .	June' 2012 - May, 2015	Different stages of muga silkworm larvae were collected from institutional farms and various localities of Assam & Meghalaya viz. Jorhat, Golaghat, Sibsagar, Maran, Boko, Mendipathar, Nongpoh, Lakhimpur, Narayanpur etc. during different crop seasons. The gut homogenate of the collected silkworms were prepared and cultured on Nutrient agar plates at 37 °C. The bacterial colonies grew on the NA plates were enumerated as total viable colony count. 54 pure cultures of gut-bacteria were subjected to morphological and biochemical characterization. Isolates were screened for qualitative Cellulase, Amylase, Lipase, Pectinase and Xylanase activity. Positive isolates were selected for <i>in-vitro</i> quantitative assay for cellulolytic and lipolytic activity. Pure cultures of gut-bacteria were screened for antimicrobial activity against three entomo-pathogenic bacterial strains <i>Pseudomonas aeruginosa</i> , <i>Escherichia coli</i> and <i>Bacillus subtilis</i> . Two most potential gut-bacteria were selected and identified by 16S rDNA homology study and the consensus sequences were submitted to NCBI database to acquire accession numbers. Muga silkworm gut-bacteria isolate no MGB-14 showed highest <i>in-vitro</i> lipolytic activity. Identification of the strains through polyphasic approach is under progress. Three selected beneficial gut-bacteria were mass cultured on nutrient broth medium and fed to muga silkworm during 3 rd instar rearing on som plant. The microbial load in the treatment was standardized at 10 ⁸ cfu.	The probiotic formulation will be helpful to increase the ERR by 35.7%

				<p>The larval weight of the mature treated worms has been recorded and further analysis is under progress. Two beneficial gut-bacteria consortium received from IARI, New Delhi were mass cultured on Nutrient broth medium. The culture broth was sprayed on som plants during the 3rd instar rearing of muga silkworm (<i>Jethua and Aherua crop</i>). During <i>Jethua crop</i>, results revealed that the average larval weight, cocoon weight, shell weight, SR% and ERR% has been increased in the gut-bacteria treated samples in comparison to the control (untreated silkworms).</p>	
9	<p>ARC 5864</p> <p>Studies on the insect fauna associated with Muga-ecosystem in North East India with emphasis on the illustrated diagnostics</p>	<p>Exploration, collection and preservation of insect fauna associated with Muga-ecosystem in North East India. Identification, morphological characterization and documentation. Development of computerized diagnostic tools and inventorization of insect fauna</p>	<p>Aug. 2012- July 2015</p>	<p>Collected specimens have been preserved in Silkworm Repository and identification process is going on. Microscopic photographs have been taken for developing diagnostic keys. Database for identified species has been completed for 900 specimens. Preparation of description for collected specimens of wild silk moth is in progress for publication as a Book</p>	<p>Database in the form of book will help the researchers to control the insect pests of host plants as well as insect predators of muga silkworm.</p>
10	<p>AIP 5850</p> <p>Isolation, identification and characterization of insect stimulants</p>	<p>Identification of chemical substances of muga host plants inducing attraction, biting</p>	<p>May, 2009 - December, 2012</p>	<p>Phenolic compounds from som leaves were extracted and found the presence of Quercetin, 3', 4' Dimethyl Quercetin, Morin, Myrcetin, 7',2',4' Trimethoxy dihydroxy flavone and 2',4' Dimethyl Morin in the extract. The identified chemicals along with some</p>	<p>Insect stimulants were sprayed on the leaves of selected som plants at farmers' fields during <i>Chotua</i> (March-April, 2014), <i>Aherua</i> (July-August, 2014) and <i>Kotia</i> crop (October-</p>

	from muga silkworm host plants and its functional properties.	and swallowing in muga silkworm. Role of the identified factors inducing attraction, biting and swallowing and on growth and development of muga silkworm		standard chemicals are being tested for their effectiveness as biting or attraction response for preparation of artificial diet.	November, 2014). Data indicated enhancement of ERR by 24-66 % over control.
11	MOE - 5863 Sustainable rural livelihood: adoption and refinement of improved technologies of eri culture in Brahmaputra Valley of Assam	To enhance the productivity in eri culture through adoption of improved technologies and to assess adoption, refinement and validation of the improved technologies at farmers' level. To develop new products and diversify the eri culture to improve income and employment generation	December 2012 - March 2015	Socio-economic survey was conducted in different places. 20 SHGs were formed covering 405 beneficiaries. 20 eri spinning machines, 90 plastic mountages and 90 bamboo platform rearing equipments and other critical inputs were distributed among the beneficiaries. Technology demonstrations, training /skill development programmes etc. were conducted. 4400 dfls of improved eri silkworm breed/race were distributed to farmers. Eri cocoon production enhanced from 7.20 to 12.85 kg per 100 dfls and yarn productivity up to 205 gm per 8 hours. Survey was also conducted to assess the market price of eri cocoon, yarn and fabrics, etc. in the farmers' fields. Bamboo platform rearing equipments has been refined by fitting with net to control uzi fly. Two training programmes on eri spinning covering 75 farmers conducted. Training programme was conducted on product design and dyeing of eri silk for 10 lead farmers in collaboration with DOS, Nagaland at Dimapur. Further, large scale training programmes were organized covering more than 150 women	Efforts are made to empower the women folk through adoption of improved technologies, demonstrations, training on both pre-cocoon and post-cocoon sectors for sustainable eri culture. Eri platform rearing appliances, plastic mountages, pedal cum motorized spinning machines were distributed free of cost to the farmers. Through constant guidance and motivation, farmers produced better quality eri cocoons, and converted to eri yarn and finally fabrics.

				farmers on dyeing and product development and diversification of eri silk. The beneficiaries of the project are bank/credit linked with HDFC Bank Ltd. and State Bank of India for setting up the eri silk based enterprises.	
12	PIN 5871 Development of Biointensive module for organic muga silk production (DST funded)	Identification of reliable and actual factors of muga production decline through field survey. Identification of strategies to alleviate the field problems of muga silk production and productivity. Development of bio-intensive organic silk production module to overcome large scale dependence of inorganic inputs in muga eco-system and to reduce mortality of muga silk.	November, 2014 - October, 2015	Documentation of Indigenous Knowledge Practices (ITKs) in respect of muga silkworm rearing, host plant management, pest, diseases and predator management has been done. Rearing of 30 muga dfls of the institute to identify the actual causes of muga silkworm mortality and identification of strategies to alleviate the field problems. Residual analysis has been initiated. Documented ITKs of muga silkworm rearing and developed an organic module applying organic inputs, viz. vermi-compost and bio-pesticides, phyto-chemicals etc. Identification of actual causes of muga production decline, documentation of ITKS, validation of ITK and development of Organic module against Flacherie disease.	The technology package may be utilized for production of organic silk.
13	AIB-5869 Popularization of new eri breed C2 at farmers' field (funded by CSB)	To popularize the identification of disease & insect pest of muga food plant and silkworm	October, 2014 - September, 2015	Conducted awareness programme at Koliapani, Tinsukia, Amsoi (Morigaon) and Danichapori under Dadhara SMV covering 400 farmers. Organized five batches of training programmes covering 150 farmers at Dhansripur (Dimapur), Makum (Tinsukia),	Farmers are interested for rearing of C2 breed as production is 30% higher than cultivated races

		through visual symptomology among the muga growers. To provide effective disease preventive and integrated management strategies to the farmers.		Danichapori (Golaghat), Dhanubhanga (Goalpara), Dhansiripar (Nagaland) and CMER&TI, Lahdoigarh in eri host plant management, improved rearing techniques and C2 breed seed production. Five groups have been identified for large scale seed production and order placed for equipments and other requisite inputs for establishing of 3 units at farmers field on community basis. One technology demonstration programme on C2 breed rearing was also organized. More than 37000 eri C2 breed were distributed to farmers under SMV and other farmers during 2015-16.	
14	ARP 5868 Isolation and characterization of anti fungal peptides from muga silkworm <i>Antheraea assamensis</i> Helfer (collaboration with NEIST, Jorhat and IIT, Kharagpur and funded by DBT)	Isolation, purification and characterization of anti-fungal peptides from the hemolymph of fungal challenged muga silkworm, <i>Antheraea assamensis</i> Helfer	April 2014 – June 2017	Haemolymph samples isolated from challenged with heat killed <i>Candida</i> and <i>Aspergillus</i> species from muga silkworms were analyzed through PAGE gel electrophoresis and protein bands of different size were observed. Purification of the bands is under progress. Haemolymph were collected from the treated as well as control larvae after different interval from time of treatment. 1. Haemolymph collected after different intervals of pupation. SDS PAGE being performed for detection of bands.	<i>A. assamensis</i> expresses a gloverin-like antimicrobial peptide in the haemolymph which acts as first line of defence in muga silkworm. Screening of the Muga silkworm genotypes producing larger amount of the peptides should be studied as future course of action. Synthesis of the peptides by manipulating bacterial genes may also be tried for its large scale production. The antifungal peptides have got human utility also. IIT, Kharagpur (Collaborating institute) was communicated for further study on response of fungi attack on human being which causes skin diseases.
15	AIB-5879 Development of suitable combinations /	To evolve suitable eri silkworm cross / breed for quantitative and	November, 2014 - October, 2017	Eri silkworm strains - YP, YS, YZ, GBP and GBS, GBZ have been isolated from promising Borduar and Titabar ecoraces. 5 th generation rearing is going on. Isolation of six pure line strains and rearing up to 5 th	The performance of the two combination YZXS and GBS×GBZ are superior than the existing C2 breed and hence the new

	hybrids of eri silk with sustainable performance for commercial exploitation	qualitative improvement. To evaluate the evolved crosses at farmers' level based on primary food plants (Castor and Kesseru)		<p>generations and seven crosses have been completed. Specific combining ability effect 6 x 6 diallel cross among the 15 combinations of YP, YS, YZ, GBP, GBS and GBZ, the YP X GBZ has showed significantly higher value in the economic trait of cocoon weight (male 0.88), shell weight (male 0.64 & female 0.48) and absolute silk yield value (25.14).</p> <p>The reciprocal test of 15 combinations indicated that GBS X GBZ is superior to other combinations. The combination showed highest fecundity value (111.17), highest absolute silk yield (46.61). Four experimental trials of seven crosses namely YP x GBZ, YZ x GBS, GBZ x YS, YS x GBS, YZ x YS, GBZ x YP, GBS x GBZ has been completed in different locations of SRC, SMV and potential eri growing areas for observation of performance of rearing and economic character of evolved combinations. Based on the analysis of crosses, YZX YS and GBZ and GBS X GBZ combinations are found to be the best among all seven crosses. YZ X YS showed highest average shell weight (0.53g) with highest fecundity (352 nos). GBS x GBZ showed highest average shell weight (0.55g) with highest fecundity (355 nos).</p>	<p>combinations may be recommended for commercial exploitation in the farmers.</p> <p>The new hybrid is under large scale multi-locational trial. The performance of the hybrid will placed before HAC meeting for authorization.</p>
16	MOT-5883 Impact of Training on Knowledge and Adoption Level of Improved Technologies of Muga Culture	To assess the extent of knowledge and adoption of improved technologies among the trained muga farmers. To identify socio-economic factors	September, 2016 – March 2018	<p>Impact of farmers training has a positive impact on knowledge and adoption of trained farmers which in turn increase the cocoon production and productivity of the muga farmers.</p> <p>Some of the improved technologies like Mother moth examination, egg surface sterilization, biological control of uzi fly, disinfection of rearing field and appliances and use of dfls have to be more stressed and practically oriented than it will more benefit to the</p>	<p>Training programme has a positive impact on cocoon production and productivity of trained farmers. Training programme has to be change from time to time, to gain knowledge and adoption of improved technologies by the farmers. Annexure-I have to be circulated to training section to improve the training</p>

		influencing for knowledge and adoption of technologies. To assess the impact of training on production of muga farmers		muga farmers. Accordingly training programme Commercial crop N Mean Std deviation Mean Difference Z p-value Trained 150 62.74 4.716 13.093 25.55 0.0001** Non Trained 150 49.65 4.179 has to be designed for better understand and adoption of improved technologies by muga farmers.	skills and to maintain database of the farmers accordingly.
17	APS-5881 Development of suitable incubation device for incubation of Eri silkworm eggs to overcome hatching problem during summer	To evaluate a suitable devices for incubation of eri silkworm egg for proper and uniform hatching	September, 2016 – July, 2018	Rearing performance of Eri silkworm hatched in different incubation devices as per treatments conducted at farmers field during June, 2018 at SMV, Titabar. Highest hatching percentage (79.5%) was observed in device 5, which is significantly different from rest of the devices while lowest hatching percentage (74%) was observed in device 6 (Control). Demonstration as well as practicing of best incubation device for the hot summer season can be exploited for poor eri farmers of the villages to overcome hatching problem.	Earthen pot dipped in normal water create a microenvironment inside and have a very positive impact by lowering the temperature 2 to 3°C less than the normal existing temperature causing the Eri dfls to hatch in congenial/favourable condition. It is low cost device. The intensity of environmental temperature can be controlled by more than 20% by using this low cost special device during the time of hatching where BOD incubator is not available at farmers level.
18	MOE 5873 Enhancement of rural economy through technology intervention for sustainable muga culture in Upper Brahmaputra Valley of Assam (funded by DBT)	1.To create awareness and popularize muga cultivation among the farmers of three upper Assam District 2.To increase income and employment	April, 2016 to Sept., 2019)	Benchmark survey for selection of 150 farmers in 3 districts (Sivasagar, Dibrugarh & Lakhimpur) is completed. Conducted awareness, training, technology demonstration and Field Days among the beneficiaries. 15 SHG's were formed. Extension communications and ToT programmes were organized through SHGs. 5000 nos. of improved (S-3) variety of 'Som' saplings were supplied to the beneficiaries for gap filling. 42175 nos. of Muga silkworm DFLs were supplied to	Average Dfls brushing of each individual farmer increased from 200 to 250 per crop. Before implementation of the project, yield per dfl was 39-51 (average 45.68) and average cocoon production was 9148. After implementation, it was increased to 47-59 cocoons per dfl (average 51.8) and average cocoon production

		<p>generation avenues among the rural youth of weaker section through adoption of SHG approach</p> <p>3.To train 150 beneficiaries for upgradation of skills for sustainable employment generation through activities like rearing of muga silkworm, rearing of cocoon, marketing of cocoon, yarn, fabrics, utilization of pupae etc.</p>		251 nos. of beneficiaries for conducting Muga silkworm rearing.	12969.
19	ARP 5888 Standardization & Popularization of Treated Bamboo Products in Ericulture (Collaboration with Rain Forest Research Institute, ICFRE, Jorhat and NABARD, Jorhat)	<p>1.To utilize the existing standard treatment processes of bamboo and its products in Ericulture.</p> <p>2.To study the impact of bamboo treatment on Eri</p>	March 2017-February 2019	The commonly available safe chemical insecticides, 8% Boric acid (hydrogen borate) and borax (sodium borate) at the ratio of 1.5:1 have been standardized for treatment of bamboo. Treated bamboo products/appliances on Eri and Muga silkworms has no adverse effect and about 98.75% good cocoon of Eri silk can be harvested on strip type collapsible mountage which is higher than the traditional Jali i.e. 95%. 38 numbers of entrepreneurs (maximum are practicing Eri and Muga silk) were developed. 15	Existing bamboo appliances such as Box type mountage, cocoon cage, khorika and chaloni etc. used in Muga culture may be replaced with treated bamboo and popularizes at large scale. Eri strip type collapsible mountage is at high demand. Existing plastic tray & Jali mountages may be replaced. State Sericulture Departments were advised to utilize

		<p>silkworms.</p> <p>3.Skill development and to develop entrepreneurship in value added bamboo products.</p> <p>4.To popularize the value added treated bamboo products in Ericulture to make it for cost effective and remunerative.</p>		<p>awareness cum demonstration programmes were organized covering 756 nos of participants (544 Eri and 212 Muga) of Sivsagar, Lakhimpur, Morigaon, Jorhat, Nagaon, Golaghat, Sonitpur and Dibrugarh districts of Assam and Dimapur district of Nagaland. 2715 numbers of strip type collapsible mountages and 690 treated bamboo Chalonis were distributed to farmers at different locations of Assam and Nagaland. Treated bamboo mountage is superior to the traditional jail due to higher benefit cost ratio (1:5.97) than the traditional jail (1:3.56). It can be utilized for both rearing of Eri silkworm up to 3rd instar and cocooning that is dual purpose. Harvesting on strip type collapsible mountage required very less time, i.e. 3-5 minutes to harvest 300 cocoons against 30-35 minutes in traditional jail.</p>	<p>the services and train entrepreneurs for manufacturing strip type collapsible mountage and other bamboo treated appliances like Box type mountage, cocoon cage. The list of trained and skilled entrepreneurs is available on CMER&TI's website</p>
20	<p>AIT-5872 Whole Genome Sequencing and functional genomics of Golden Silk Moth <i>Antheraea assamensis</i> (In collaboration with SBRL).</p>	<p>1. To perform whole genome sequencing of prototype of <i>A. assamensis</i> and its assembly.</p> <p>2. To analyze transcriptome profile of specific larval tissues of <i>A. assamensis</i> after bacterial infection and control normal larvae.</p> <p>3. Identification of</p>	<p>1st Nov. 2015- 31st March 2019</p>	<p>1) Whole genome sequence of muga silkworm with satisfactory coverage and depth has been completed, and is now being used for in-depth mining of genes involved in insect behavior, immune response, silk synthesis, sex determination, etc.</p> <p>2) Sequencing and analysis of expressed transcriptome of several tissues at different developmental stages has been completed. Expression analysis of a few interesting candidate genes is now going on for functional annotation of selected genes. Transcriptome of <i>A. assamensis</i> consists of several putative antimicrobial peptides that are known to act against gram positive and gram negative bacteria as well as fungi, namely, Attacin, Cecropin, Defensin, Moricin, Gloverin and Gallerimycin.</p>	<p>Data generated in this project will be very useful in improving the muga culture in Northeast India. The Phase II of the project may be proposed to utilize the genomic and transcriptomic resources generated in the first Phase. The project overall achieved the proposed objectives and the results are highly promising. The large data generated in this project will be highly useful in improving the muga culture through breeding etc.</p>

		functional gene makers associated with silk quality from silk gland by RNA sequencing.		<p>3) Complete mitochondrial genome of muga silkworm has been completed and published. The sequence with mapped genes has been submitted to NCBI for use by other researchers.</p> <p>4) This study is the first-ever report of the alimentary canal (AC), silk gland (SG) and residual body (RB) transcriptome of the 5th instar larvae of <i>Antheraea assamensis</i> fed on Som (<i>Persea bombycina</i>) leaves.</p> <p>5) Presence of putative silk gland factors (sgf) 1 and 3, homothorax and extradenticle transcripts with conserved forkhead, POU and homeodomains similar to that of <i>Bombyx mori</i> suggested the existence of a similar transcriptional regulatory mechanism in <i>A. assamensis</i>.</p> <p>6) A total of 71397 putative simple sequence repeat (SSR) markers were predicted within 36906 transcripts of <i>A. assamensis</i> amongst which T/A and AT/TA were the most abundant mono- and di-nucleotide SSRs.</p>	
21	APR 5882 Validation of Indigenous Technical Knowledge (ITK) associated in muga silkworm seed production system	<p>1. Scientific validation of the selected ITKs associated with muga culture</p> <p>2. Integration of the selected effective ITKs with the modern technology packages for enhancing the production and</p>	Aug. 2016 - March 2019	<ul style="list-style-type: none"> • A total of 26 ITKs and beliefs associated in muga culture were documented through survey. Six ITKs were selected for validation - Early stage muga silkworm rearing at Dighlati plant (<i>Litsea salicifolia</i>), Disinfection of appliances through smoke, Spread tulusi (<i>Oscimum sanctum</i>) twigs over the layings, De-pairing of moths using smoke, Burning at the rearing field, Direct mode of brushing. • Validating the ITK, it has established that 'depairing of moths using smoke' is effective for self de-pairing of moths as well as fecundity enhancement. Release of smoke generated by burning of thatch grass or paddy straw to the paired moths (after 	TOT is being conducted for popularizing methods of 'depairing of moths using smoke' during muga silkworm seed production and 'integrated practice of ITK and modern technology' for higher muga cocoon yield.

		<p>productivity of muga.</p> <p>3. Assessment of muga cocoon production through adoption of ITK hybridized modern technologies at farmers' field.</p>		<p>pairing of minimum 7-8 hours) for a period of 5-7 minutes, average self de-pairing was recorded to be higher (87.0%) than the normal practice (47.0%). Similarly, mean fecundity of winter and autumn seasons after exposing the moths in to smoke was observed significantly higher (168) against normal practice (142).</p> <ul style="list-style-type: none"> •The ITK "early stage rearing at Dighlati plants (<i>Litsea saliscifolia</i>)" was also found effective for higher cocoon yield in muga culture. Average production of 69 cocoons /df with 55.3% ERR through early stage rearing at Dighlati plants against 52 cocoons/df with 43.5% ERR in recommended practice during Dec-Jan, Feb-Mar and Apr-May crop season was highly significant. •Assessment of crop performance in integration of ITK (early stage silkworm rearing at dighlati plants) and recommended practices during Feb-Mar and Apr-May shown significantly higher cocoon yield (average 71 cocoons/df with 57.0% ERR) compared to the cocoon yield of recommended practice alone (57 cocoons/df with 50.0% ERR) <p>Similarly, no additional cost and labour is required for using the ITK 'early stage muga silkworm rearing at Dighlati plants'. Rather, net return from the cocoon production from 100g df using the ITK was calculated to be increased by 18.8% due to higher cocoon yield against the existing practice.</p>	
22	AIB 5894 : <i>In-situ</i> conservation of muga and other wild silk moths in Natural	1. Development of <i>in-situ</i> conservation site for muga silkworm	April 2016 - August 2019	Two <i>in situ</i> muga conservation cites at Upper Doigrung, Golaghat, Assam and at Kuklung Forest Area of Chirang District, BTC were established. MoU has been signed during 2017 and 2018 between	Two <i>in situ</i> muga conservation cites at Upper Doigrung, Golaghat, Assam and at Kuklung Forest Area of Chirang District, BTC were

	Habitat (NERTPS, Funded)	and other wild silk moths species 2. Utilization of muga silkworm germplasm for breeding and seed production		Assam Forest Department, DoS Assam and CMERTI Lahdoigarh for Upper Doigrung Wild Life area, Golaghat up to 30 years as <i>in situ</i> conservation site. Field survey for <i>in situ</i> Muga conservation at Meghalaya and Arunachal Pradesh is completed but signing of MOU is yet to complete under the scheme NERTPS. Muga conservation activities at <i>in situ</i> conservation site were monitored. Building-up of Muga population in both the conservation sites is very slow. Characterization of the muga silkworm as well as moth under the microclimate chamber could not achieve due to lack of instrument which was not yet procured.	established.
23	APR 5877 Role of hormesis in mitigating oxidative stress and its impact on growth and yield of Muga silkworm, <i>Antheraea assamensis</i> Helfer	1. Study on the impact of hormetic effect of heat shock on growth and yield of Muga silkworm 2. Understanding the levels of oxidative stress and antioxidants in Muga silkworm	Sept. 2016 – Aug. 2019	Hormesis is a phenomenon where mild stresses enhance the metabolic activity of an organism and heat treatment is considered as one of the important hormesis factors and studied in many organisms. In this regard, hormesis was induced to understand whether it can improve the functional ability of Muga silkworm by mitigating intrinsic stress. Heat treatment imposed to muga silkworm in different rearing seasons like Jethua, Aherua, Kotia, Jarua and chatua crops. Hatching pattern improved from scattered to uniform in egg treatment compared to control. Hatching % improved across different seasons in heat treatment compared to control by 5 to 10%. Survivability % of young larvae after hatching improved across different seasons in heat treated experiment compared to control by 2 to 5 %. Effective Rate of Rearing % improved across different seasons in heat treated experiments compared to control by 2 to 6%. Good cocoon%, Shell ratio % also improved in heat	It will further encourage us in mitigating the stress level of muga silkworm which will be promising for successful rearing and production of muga silk to the desired momentum.

				<p>treated experiment. Average fecundity improved across different rearing seasons in treatment compare to control by 8 to 12%. These results validate the role of hormesis induced improvement in the functional ability of Muga silkworm. Season specific stress, antioxidant levels, and combative effect of heat treatment on stress levels in different developmental stages were understood.</p>	
24	<p>ARP 5878: Next generation sequencing studies and bioinformatics analysis of microbiome of flacherie infected <i>Antheraea assamensis</i> Helfer for developing effective disease control measures</p>	<ol style="list-style-type: none"> 1. High throughput sequencing analysis of microbiome of flacherie infected muga silkworm. 2. Bioinformatics analysis and detection of causative bacterial pathogen responsible for flacherie disease in <i>Antheraea assamensis</i> 3. Establishing the bacterial pathogen and development of effective disease management practices 	<p>Sept. 2016 - August 2019</p>	<p>Muga insect gut microbiome associated with flacherie disease was established with high throughput sequencing analysis. NGS data revealed bacterial pathogens as <i>Enterococcus</i> sp., <i>Enterobacter</i> sp., <i>Bacillus</i> sp., <i>Pseudomonas</i> sp., <i>Erwinia</i> sp. in diseased silkworm midgut. A new disinfectant formulation is developed and tested on bacterial pathogens. Newly tested disinfectant had bacteriolytic activity on two potential muga silkworm pathogens <i>Pseudomonas</i> sp., and <i>Bacillus</i> sp. The technology for controlling flacherie disease was tested and field efficacy analyses were completed. The formulation can improve ERR by 15-18% over control in summer crops. Currently the formulation is being tested under trail of technology (TOT).</p>	<p>A chemical formulation is developed to control bacterial flacherie disease in Muga silkworm</p>

25	APS05002EF: Popularization and utilization of Foldscope for detection of pebrine disease (<i>Nosema assama</i>) in muga silkworm seed production areas (DBT funded)	Utilization of Foldscope for detection of pebrine disease in muga silkworm seed production areas	20 th March 2018 to 19 th March 2019	The foldscope microscopes of higher magnification (>400) are not currently and commercially available. The microscope is not yet suitable for diagnostic purposes for detection pebrine during grainages. Outreach programmes were organized in schools for creating awareness and also for practical teaching on application of microscope in	The microscope of desired magnification (>400) is under development/production as the available magnification is not sufficient to use for diagnosis of pebrine in seed production.
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Field of R&D projects: Host Plant Improvement

	Project Code & title	Objectives	Project period	Outcome of the Research Project	How the outcome is utilized
1	PIE 5853 Collection, characterization, evaluation and conservation of perennial host plants for eri silkworm rearing	To characterize different genotypes of Kesseru and <i>Ailanthus</i> and to evaluate suitable high yielding genotype (s) based on better agronomical traits, nutrition value and palatability to eri silkworm	October 2011 – September 2014	Ten Kesseru accessions identified and characterized for first time were maintained in the GPB. Passport data of all accessions were maintained. New pests of kesseru identified. Analysis of foliar chemical constituents of different genotypes and bioassay is has done. <i>Ailanthus</i> accessions are identified for eri silkworm rearing were maintained in the GPB with cultural operation. There is average 35.73% improvement in leaf yield recorded in HF 005 & HF 008 than benchmark of traditional practice in both kesseru accessions. Based on leaf morphological study four accessions of <i>Ailanthus grandis</i> i.e., AG 001, AG 002, AG 003, AG 004 and five accessions of <i>A. excelsa</i> i.e., AE 001, AE 002, AE 003, AE 004, AE 005 identified.	Promising genotypes HF 008 and HF 005 of Kesseru are on popularization among farmers for commercialization. Large scale multiplication has done regularly during nursery season.

2	APR-5858 Eri silkworm (<i>Samia ricini</i> Donovan) rearing and cocoon production in relation to host plant castor genotypes (<i>Ricinus communis</i> Linn.) raised under rainfed conditions in semi-arid region	To evaluate the varietal potential of commercial and perennial castor genotypes under rain-fed semi-arid conditions. To identify the castor genotypes suitable for eri silkworm rearing	November, 2011 to October, 2014	Eight castor genotypes comprising 3 pure, 3 hybrid and 2 perennial were evaluated. At the optimum growth period (120 DAS), the genotype CSH – 103 showed higher values for no. of leaves/ plant (21), plant height (245.07 cm), no. of branches (2) and leaf yield (9796.08 kg/ha) and it was followed by CSH-106 and CSH-105.	The identified castor genotypes suitable to semi-arid areas of Andhra Pradesh would be used for increased quality production of cocoons.
3	PRP 5862 Screening of Microbial Flora (Potential Biofertilizer) of Castor Rhizosphere and Development of INM Package in Ericulture.	Isolation, Screening and Identification of Microorganisms with biofertilizer potential and development of an INM package for castor plant with special reference to biofertilizer.	July, 2012 to July, 2015	Benchmark survey of the experimental plots, analysis of the soil biological properties following standard methods (Soil respiration, Soil dehydrogenase and Acid phosphatase assay), collection of castor rhizosphere soil samples have been completed from different localities of Assam (Majuli, Kaziranga, Sodiya, Jorhat, Golaghat, Sivasagar), foothills of Arunachal Pradesh and Nagaland. Pure culture of eight <i>Azospirillum</i> sp., fourteen <i>Azotobacter</i> sp., fifteen phosphate solubilizing bacteria (PSB) and eight <i>Pseudomonas</i> sp. were isolated from the castor rhizosphere soil samples using Okon's, Ashby's, Pikovskaya and <i>Pseudomonas</i> isolation agar media respectively. Morphological and biochemical characterization of all the pure culture isolates were done. Screening of the bacterial isolates viz., <i>Azospirillum</i> , <i>Azotobacter</i> and <i>Achromobacter</i> for nitrate reductase and Phosphate solubilizing ability, antimicrobial activity test for the isolated <i>Pseudomonas</i> sp against different plant pathogenic fungal strains, quantitative estimation of Phosphate solubilizing as well as Nitrate reducing bacteria have been	INM package are being popularized

				<p>completed. Mass culture of the selected pure culture isolates have been done and further implemented in the field along with vermicompost and charcoal during field trial. Based on the quantitative efficacy of the isolates, <i>Azospirillum</i> sp. KAZ AZP01, <i>Achromobacter</i> sp. KAZ AZB 05, <i>Pseudomonas</i> sp. MAJ PIA03 and <i>Bacillus</i> sp. MAJ PSB 12 were selected and identified by polyphasic approach. Mass culture of four selected bacteria was carried out in respective culture broth. Altogether, 10 treatment combinations of the biofertilizer strains were prepared by mixing carrier material (e.g. vermicompost and charcoal) with final microbial load @ 108 cfu/g. Treatment combinations were applied in the experimental castor plantation. Agronomical parameters like leaf number, leaf biomass, root biomass, length etc. under biofertilizer treated /untreated castor plantation were recorded. Post experimental analysis of soil biological properties has been completed</p>	
4	<p>AIP 5850 Isolation, identification and characterization of insect stimulants from muga silkworm host plants and its functional properties.</p>	<p>Identification of chemical substances of muga host plants inducing attraction, biting and swallowing in muga silkworm. Role of the identified factors inducing attraction, biting and swallowing and on growth</p>	<p>May, 2009 - December, 2012</p>	<p>Phenolic compounds from som leaves were extracted and found the presence of Quercetin, 3', 4' Dimethyl Quercetin, Morin, Myrcetin, 7',2',4' Trimethoxy dihydroxy flavone and 2',4' Dimethyl Morin in the extract. The identified chemicals along with some standard chemicals are being tested for their effectiveness as biting or attraction response for preparation of artificial diet.</p>	<p>Insect stimulants were sprayed on the leaves of selected som plants at farmers' fields during <i>Chotua</i> (March-April, 2014), <i>Aherua</i> (July-August, 2014) and <i>Kotia</i> crop (October-November, 2014). Data indicated enhancement of ERR by 24-66 % over control.</p>

		and development of muga silkworm			
5	APR - 5866 Sustainable eri silkworm rearing: evaluation of <i>Ailanthus</i> species	To evaluate and biochemical analysis of different <i>Ailanthus</i> germplasm To evaluate and define superior genotype (s) / species of <i>Ailanthus</i> through bioassay for eri silkworm rearing. To extend the information on silkworm nutrition of different <i>Ailanthus</i> species	March 2013-Feb., 2016	<p>has been estimated that full grown <i>Ailanthus grandis</i> tree (>8 years) produces 35-40 T of leaf biomass annually, whereas <i>Ailanthus excelsa</i> produces 28-30 T as compared to 20-22 T in case of Kesseru. Nursery raising techniques have been standardized. Incidence of <i>Batocera rufomaculata</i> (stem borer), wild silks <i>Attacus atlas</i> and <i>Samia canningie</i> have been recorded. 11 bio-chemicals constituents of Borpat (<i>A. grandis</i>), Borkesseru (<i>A. excelsa</i>), Kesseru (<i>Heteropanax fragrans</i>) and Castor (<i>Ricinus communis</i>) i.e. Carbohydrates, Total Phenol, Chlorogenic acid, Tannins, Lignins, Trypsin inhibitors, Phytic acid, Crude Fat, β- Sitosterol, Crude Protein and Crude Fibre have been analyzed for the samples in different maturity level of leaves (tender, Semi-tender and mature) in four seasons. Rearing and grainage performance on different food plant combinations have been evaluated in 4 selected seasons. Post-cocoon parameters have also been assessed. It was found that T2 (Castor+ Borpat) is the best treatment among all other combinations.</p> <p>Rearing of eri C2 breed on <i>Ailanthus grandis</i> was conducted with 294 farmers (2640 dfls) and recorded average single shell wt. (0.47 g), single cocoon wt. (3.58 g), cocoon yield per dfl (275 nos.), cocoon shell yield (12.93 kg per 100 dfls) and ERR (88.94%). Two awareness programmes were conducted on utilization of <i>Ailanthus</i> in eri silkworm.</p> <p>Analysed biochemical constituents of different <i>Ailanthus</i> species and found 32.3 to 40.07 % carbohydrate in <i>Ailanthus</i> which is at par with castor. Crude protein was highest in <i>Ailanthus excelsa</i> (15.23-18.67%). Phenol content was the</p>	<i>Ailanthus grandis</i> (Barpat) has been established as potential perennial food plant of Eri silkworm. Seedling has been raised and supplied through Kissan Nurseries. Leaf yield has been recorded as 32 MT/ha/yr against existing Kesseru leaf yield of 25 MT /ha/yr enhancing rearing capacity. Popularization and mass multiplication of Borpat will be taken in a Project mode as a future course of action.

				lowest in <i>Ailanthus grandis</i> . Evaluated different <i>Ailanthus</i> species for eri silkworm rearing. The lowest larval period (18.33 ± 0.58 days) was observed in the treatment 2, which was at par with <i>Ailanthus grandis</i> (T1). The highest mature larval weight was 9.61 ± 0.09 g in T2 and T4.	
6	PPS 5884: Soil health cards for sericulture farmers of Assam, Meghalaya, Manipur, Mizoram, Nagaland, Arunachal Pradesh and Sikkim	To make the farmers aware about the importance of soil fertility on the production of quality leaves of muga and eri host plants by issuance of soil health cards	1 st Sept 2016 - 31 st Aug 2019	The project target was to issue 2,000 SHC's among the muga and eri farmers of Assam, Meghalaya, Manipur, Mizoram, Nagaland, Arunachal Pradesh and Sikkim. Accordingly the target was divided in to three years of tenure with 600, 800 and 600 SHC's. Against the target assigned 608, 987 and 405 samples were collected, analysed and SHC's were distributed to the seri-farmers in the first (2016-17), second (2017-18) and third (2018-19) year respectively. Awareness was created among the farmers during Krishimela, Awareness programmes, Technology Orientation Training Programmes, state dept. Programmes and Trainings organized by the institute etc. The project was accomplished all the targets in framed time period	The finding of the project have enamours contribution to the Muga and Eri industry. Implementation of soil health card among the seri farmers has lot of positive things and most significant advantage is to obtain quality leaves by applying appropriate doses of fertilizers. This project was mainly focused on Eri/ muga farmers to create awareness among the farmers regarding soil health for harvesting successful crops.
7	AIT 5885: Development of microbial biocatalyst by heterologous expression of <i>hpaC</i> & <i>soxABC</i> gene cluster in biosurfactant producing bacterium for effective desulfurization of dibenzothiophene (DST)	1. High throughput sequencing analysis of microbiome of flacherie infected muga silkworm. 2. Bioinformatics	Sept. 2016 - August 2019	Biosurfactant and biodesulfurizing bacteria were isolated and characterized for biodesulfurization of dibenzothiophene (DBT). <i>Bacillus subtilis</i> and <i>Pseudomonas</i> sp. were found to be potential biosurfactant producers. Biodesulfurizing bacteria were identified as <i>Gordonia</i> sp. Molecular characterization of <i>Rhodococcus erythropolis</i> IGS08, MTCC 3552 and <i>Gordonia</i> sp., showed presence of <i>dszAB</i> gene of size 2.5 kb in <i>Rhodococcus erythropolis</i> IGS08, MTCC 3552, and presence of <i>dszC</i> gene of size 1.3 kb in <i>Gordonia</i> sp.	Biodesulfurizing bacteria i.e. <i>Gordonia amicalis</i> has been obtained and a protocol for biodesulfurization of DBT is developed. A formulation has been prepared / developed for application in the field.

	Fast track project)	analysis and detection of causative bacterial pathogen responsible for flacherie disease in <i>Antheraea assamensis</i> 3. Establishing the bacterial pathogen and development of effective disease management practices		Gene hpaC was cloned and bacterial consortia contained <i>Gordonia</i> sp I and biosurfactant producing bacteria together can effectively biodesulfurize the DBT up to 0.33 mM. Whole genome sequencing of <i>Gordonia</i> sp I was completed. <i>Gordonia</i> sp I was identified at species level as <i>Gordonia amicalis</i> I. The size of the genome was found to be 4.9 MB with 1,03,906 nos. scaffolds N-50. Gene prediction analysis revealed that a total of 4614 no of genes are present in <i>Gordonia amicalis</i> I genome.	
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Field of R&D projects: Disease and Pest Management

	Project Code & title	Objectives	Project period	Outcome of the Research Project	How the outcome is utilized
1	PRE 5852 Forecasting and forewarning for pest and diseases of muga host plants and silkworm	Development of forecasting and forewarning system for pests and diseases of muga host plants and silkworm to provide timely forecasts that	Jan., 2011- Dec., 2013	Survey was conducted in all the districts of Assam for the second year as per project schedule and collected data. Development of forecasting and forewarning system for pests and diseases of muga host plants and silkworm is under progress to provide timely forecasts that muga farmers able to take disease management strategies against the host plant and	The outcome will benefit the farmers for management of diseases and pests of muga host plants and silkworms and to curtail the cost of crop production

		muga farmers able to take disease management strategies against the host plant and silkworm diseases and pests		silkworm diseases and pests.	
2	PRP 5855: Identification of stable source of resistance against major foliar diseases of muga host plants Som (<i>Persea</i>	To assess responsiveness of available som (Genetic resource) against leaf spot and leaf blight during peak season of incidence under natural inoculum To recheck short listed resource es against these two foliar diseases in potted plant under artificial epiphytotics	Oct.2011– Sept. 2014	Data collected on 11 nos of som genetic resource under natural condition against intensity of leaf spot and leaf blight diseases. S3 and S6 morphotypes of som screened against leaf spot and leaf blight disease and showed resistant reaction.	S3 & S6 are being popularized
3	APR - 5865 Etiology of bacterial diseases and molecular characterization of the pathogens of muga silkworm in NE India	a) Isolation of bacterial pathogens through standardization of cultural media from diseased cadavers of muga silkworm. b) To study the biochemical and molecular characterization of the pathogens. To study the epidemiology of the disease	March 2013- March 2018	Survey was done in the institute's farms, farmers' fields of Cinatoli of Golaghat, Chukafa Nagar of Sivasagar, Tingrai of Digboi, Jorhat & Darrang districts. Specific selective media have been studied for the growth of specific bacteria from time to time. Pathogenicity test are being carried out on isolated bacterial samples of diseased cadavers of muga silkworms. Biochemical & Molecular characterization of the isolated bacterial pathogens were carried out <i>invitro</i> . Isolated Bacterial pathogens were fed to healthy larvae to observe the disease intensity following Koch's Postulates. Performing pathogenicity test, 3 bacterias were found to be pathogenic which are named as Patho-1, Patho-2, and Patho-3.	The causal organisms of the bacterial disease have been identified and management practices of the pathogens are evaluated. A new project has been formulated in this line. Disinfectant protocol has been developed.

				Biochemical studies revealed positive reaction of Patho-1 to Lysine utilization, Ornithine, Nitrate Reduction, Glucose, Adonitol and Sorbitol. Similarly Patho-3 revealed positive reaction to Ornithine and Glucose, Patho-2 showed positive reaction to Malonate and Arginine. The pathogens have identified based on sequencing of 16sRNA gene. 5 bacterial species have been identified	
4	ARP-5867 Characterization, transmission and cytopathology of infectious flacherie and cytoplasmic polyhedrosis virus in muga silkworm <i>Antheraea assamensis</i> Helfer	1) Characterization of infectious flacherie and cytoplasmic polyhedrosis virus in muga silkworm. 2) To study the transmission pattern of the viral agents. 3) To study the cytopathology of midgut and silk gland from infected larvae.	July, 2013 – March, 2018	Survey was conducted in different places of Meghalaya and Assam viz., Cinatoli (Golaghat), Chukafa nagar (Sivasagar), F/L, Titabor, Lakhimpur, Kamrup, Darrang, Jorhat and Tura (Meghalaya) for monitoring and collection of diseased samples. Silkworm pathogens are being isolated from the collected samples. Viral DNA/RNA were isolated by using Viral RNA/DNA mini kit and also by using Trizol's method. After isolation, the samples were run on agarose gel for detecting the presence of RNA / DNA. Amplification of Viral RNA/ DNA is further repeated. The TEM/SEM analyses have been completed and viral particles have been reported in the infected samples. The transmission patterns of the pathogens have been studied.	The viral agents have been reported and control measures for the agents/disinfectant protocol have been developed.
5	ARP 5878: Next generation sequencing studies and bioinformatics analysis of microbiome of flacherie infected <i>Antheraea assamensis</i> Helfer for developing effective disease control	4. High throughput sequencing analysis of microbiome of flacherie infected muga silkworm. 5. Bioinformatics analysis and detection of causative bacterial pathogen responsible	Sept. 2016 - August 2019	Muga insect gut microbiome associated with flacherie disease was established with high throughput sequencing analysis. NGS data revealed bacterial pathogens as <i>Enterococcus</i> sp., <i>Enterobacter</i> sp., <i>Bacillus</i> sp., <i>Pseudomonas</i> sp., <i>Erwinia</i> sp. in diseased silkworm midgut. A new disinfectant formulation is developed and tested on bacterial pathogens. Newly tested disinfectant had bacteriolytic activity on two potential muga silkworm pathogens <i>Pseudomonas</i>	A chemical formulation is developed to control bacterial flacherie disease in Muga silkworm

	measures	for flacherie disease in <i>Antheraea assamensis</i> 6. Establishing the bacterial pathogen and development of effective disease management practices		sp., and <i>Bacillus</i> sp. The technology for controlling flacherie disease was tested and field efficacy analyses were completed. The formulation can improve ERR by 15-18% over control in summer crops. Currently the formulation is being tested under trail of technology (TOT).	
6	MOE-5875 Effect of plant protection formulations on the growth, development and productivity of Muga Silkworm, <i>Antheraea assamensis</i> Helfer (Saturniidae: Lepidoptera).	1. To study the effect of chemical pesticides / plant protection formulations on the growth and development of Muga Silkworm. 2. To study the effect of biopesticides / biocontrol agents on the growth, development and productivity of Muga Silkworm. 3. To develop suitable methodologies / procedures to reduce the effect of pesticides on muga silkworm.	April, 2016 -August, 2019	Three commonly used insecticides in tea garden were identified i.e. Atom, Ennova and Instant and studied their effect on muga silkworm based on different parameters. Treatment with Atom on muga silkworms resulted in loss of appetite, vomiting, sluggishness, body colour changes and ultimately death. At high doses (>0.1%), the effects were immediate causing death instantly. Ennova and Atom had similar effects on the silkworms. The immediate effects were detrimental at higher doses. But at lower dose (< 0.1%), the effects were not immediate and the intensity was much lesser. Restoration of health, appetite, colour and stability was also recorded in the case of Ennova. Instant had the most profound impact on silkworm and died immediately even at very low concentrations (< 0.1%) with the symptoms included vomiting, complete loss of appetite, etc. resulting in immediate death. However, loss of colour change or physical changes was not observed. Mortality was highest in Instant. It has been observed that treatment at LD ₅₀ doses reduced fecundity and hatching. The effect was pronounced in case of Instant as it reduced the fecundity to only 82 nos. compared to 158 nos. laid by	A complete mutual mission mode multi-disciplinary project should be launched involving different stakeholders from sericulture, tea and oil sectors to develop long term strategies to achieve the goal for inclusive development all the sectors.

				untreated moths.	
7	ARP 5874 Development of Decision Support System for early warning of selected muga silkworm diseases & pests with geospatial technique. [In collaboration with NESAC]- CSB Funding	<ol style="list-style-type: none"> 1. Identification of Various landscapes and Climatic Parameters Crucial for Disease incidences. 2. Development of DSS for early Warning of selected Muga Silk Worm Diseases. 3. Dissemination of interactive advisory Services to farmers linking with SILKS portal. 	March 2016 - Sept. 2019	<p>Since the study is first ever of its kind in muga sericulture, the experimental results form an integral part of decision support system. The study shows the potential of a geospatial technology for identification of various landscape and climatic parameters crucial for muga silkworm disease incidence. Unmanned aerial vehicle plays an important role to get high resolution images as well as slope and aspect information of the selected farms to assess the overall condition of the farms. Model developed in this study to predict percent flacherie infestation will be useful for the farmers to take proper precautionary measures to avoid disease out-break at least 5-10 days in advance. Recommendations and model developed shows the potential of geospatial technology for farm level planning and management through a geoportal. More emphasis may be given to generate seri advisory by the expert groups of different institution involves in similar type of work and may be linked to SILKS geoportal to have wider use by the farmers as well as different stakeholders of the sericulture industry in the state.</p>	<p>The Muga silkworm rearing should be away from agricultural land, built-up area, factories etc as disease incidence highly correlate with increase in anthropogenic activity. Similarly, Muga farms surrounded by dense forest area are beneficial for optimal growth of silkworm due to balance in land surface temperature. The aspect of the farm must avoid south facing in hot and humid climate as Muga silkworms are shade lovers. Fifteen days average maximum temperature and maximum relative humidity data may be used to predict percent of flacherie infestation with the predicted model developed in the study before 10 days and 5 days of harvest coinciding with 4th and 5th Instars respectively.</p> <p>The Muga silkworm rearing farmers should take proper precautionary measures to</p>

					avoid disease out-break during the period when temperature exceed 30°C with relative humidity exceeding 80% for few consecutive days.
8	APS05002EF: Popularization and utilization of Foldscope for detection of pebrine disease (<i>Nosema assama</i>) in muga silkworm seed production areas (DBT funded)	Utilization of Foldscope for detection of pebrine disease in muga silkworm seed production areas	20 th March 2018 to 19 th March 2019	The foldscope microscopes of higher magnification (>400) are not currently and commercially available. The microscope is not yet suitable for diagnostic purposes for detection pebrine during grainages. Outreach programmes were organized in schools for creating awareness and also for practical teaching on application of microscope in	The microscope of desired magnification (>400) is under development/production as the available magnification is not sufficient to use for diagnosis of pebrine in seed production.