

AIB-3616

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

**DURATION: SEPTEMBER, 2017 TO
DECEMBER, 2019**

**Central Silk Board
Ministry of Textiles (Government of India)
BTM Layout, Madivala
Bangalore – 560 068**

**Principal INVESTIGATOR: Dr. A. K. Verma
(Scientist - D)**

**Silkworm Breeding, Genetics Laboratory
Central Sericultural Research & Training Institute
Central Silk Board: Ministry of Textiles: Govt. of India
Berhampore – 742 101, Murshidabad, West Bengal,
INDIA**

**PROFORMA FOR COLLECTION OF DATA OF RESEARCH PROJECTS IN
SERICULTURE**

PART-I: GENERAL INFORMATION

1. **Name of the Institute / University / Organization submitting the Project Proposal** : Central Sericultural Research and Training Institute, Berhampore, West Bengal
2. **Status of the Institute (s)** : N.A.
3. **Name (s) and designation(s) Of the Executive Authority Of the institute / University Forwarding the application** : Dr. Kanika Trivedy, Director
4. **Project Title** : **On-farm Trial of the multivoltine silkworm breeds/hybrids developed for high shell percentage and neatness of silk filament**
5. **Category of the Project** : Animal (A)
6. **Specific Area** : Silkworm Improvement
7. **Duration** : 2years 4months (Sept., 2017 to Dec., 2019)
8. **Total Cost** : 8.50 lakh
9. **Is the Project single Institutional or multi-institutional** : Single institutional
10. **If the Project is multi-institutional, please furnish the following :
Name , Designation and Address of the Project Co-Ordinator.** : N.A.

11. (a) Project Summary:

Based on the high shell percentage and high neatness values along with the high survival rate, several breeds had been collected from different institutes. From these breeds the best breeds with high shell% and high neatness were selected. These breeds were used as resource material or donor. Three productive high survival multivoltine breeds, selected as receptor, were taken from the germplasm bank of CSR&TI, Berhampore. 7 new multivoltine breeds with high shell% and high neatness have been developed. By using these breeds as one of the parent, multi x multi and multi x bi hybrids were also identified. Three nos. of multi x bi hybrids will be tested throughout the year in different RSRSs and RECs/DOS, farms. Hybrid evaluation will be conducted during the entire commercial crop seasons of West Bengal and other states. After the completion of the rearing, depending upon the performance, suitable hybrid will be identified for further exploitation.

11. (b) Aims and Objectives:

- i. To test the potentiality of the newly developed breeds.
- ii. To identify season specific, productive and improved silkworm hybrids.

PART-II: PARTICULARS OF INVESTIGATORS

12. a) Name:	: Dr. Anil Kumar Verma
Date of Birth	: 28.12.1960
Sex:	: Male
Indicate whether Principal Investigator/ Co-investigator	: Principal Investigator
Designation	: Scientist-D
Department	: Silkworm Breeding & Genetics Section,
Institute/University: Address	: CSRTI, Berhampore
b) Name:	: Dr.N.Chandrakanth
Date of Birth	: 24.04.1986
Sex:	: Male
Indicate whether Principal Investigator/ Co-investigator	: Co-Investigator
Designation	: Scientist-B
Department	: Silkworm Breeding and Genetics,
Institute/University: Address	CSRTI, Berhampore
c) Name:	: Shri.N.B.Kar
Date of Birth	: 04-01-1959
Sex:	: Male
Indicate whether Principal Investigator/	: Co- Investigator

Co-investigator

Designation : Scientist-D
Department : Reeling and Spinning Section,
Institute/University: Address CSRTI, Berhampore

d)Scientist-D/ In-charge- 1.RSRS, Jorhat; 2. RSRS, Koraput; 3 REC, Bhandara; 4.DOS-farm, Murshidabad; 5.DOS-farm, Malda; 6. DOS-farm, Birbhum and 7.DOS-farm, Nadia.

13. No. of Projects being handled by

Each investigator at present: Principal Investigator: Four projects
Co- Investigator: 1- Three project
Co- Investigator: 2 - Four

14. Proposed Research Fellows: N.A. [Detailed justification with work sharing is a must]

PART-III: TECHNICAL DETAILS OF THE PROJECT

15. Introduction

The Indian sericulture industry is beset with many problems. One of the main problems is the inability to produce quality silk of international grade. The quality silk can be produced only from bivoltines. The bulk of silk produced in India is from Multivoltines which are of inferior quality. Therefore, it is highly pertinent to have more productive multivoltine silkworm breeds capable of producing quality silk. In India, mulberry leaves are available throughout the year including the summer months. However, during summer the rearing of bivoltines are very difficult with frequent crop losses. Therefore, the farmers are forced to switch over to multivoltine x bivoltine hybrids which are comparatively more stable under such environmental conditions.

15.1 Definition of the Problem

(a) Origin of the project

Indian sericulture industry is multivoltine oriented and hence the quality of silk is of low grade. Quality silk can be produced only through bivoltines. However, the hot climatic conditions prevailing in India is not conducive to rear the bivoltines already available. Therefore, there is an urgent need to develop multivoltine breeds which can produce **high quality silk** under the adverse climatic conditions of the tropics.

b) Expected outcome

The successful completion of the project is expected to come out with the identification of new productive and improved hybrids which can produce high quality silk having higher shell content, higher neatness of filament and other improved characters.

15.2 Origin of the Proposal / Rationale of the Study

Eastern India, especially the state of West Bengal experiences extreme variation in temperature, relative humidity and rainfall. According to climatic conditions, the commercial seasons are broadly divided into two, favourable and unfavourable. During unfavourable season, because of prevalence of high temperature and humidity as well as

rainfall, most of the rearers rear indigenous multivoltine breed, Nistari or Nistari x M₁₂W during the period, which is low productive. Keeping the prevalence of variable climatic condition in mind and realizing the importance of season specific multivoltine x bivoltine hybrids as well as advantage of rearing of F1 hybrids during different commercial seasons, the project-AIB-3501- “**Development of Multivoltine silkworm (*Bombyx mori* L.) Breeds with high Shell Percentage and high neatness of silk filament**” has been undertaken, in which productive, improved with high shell weight/ shell% and neatness multi x multi and multi x bi hybrids were identified. These hybrids will be tested in different state farms and RSRs under the proposed project.

15.3 Relevance to the current issues and expected outcome

In West Bengal, Silkworm rearing for commercial purpose is practiced five times in a year at farms and farmer’s level due to availability of huge mulberry leaves for high rainfall and fertility of soil. The climatic situation of West Bengal is broadly categorized into two i.e., the favourable (November to March) and unfavourable (May to September). Therefore, farmers are forced to restrict their rearing only with Nistari, the indigenous multivoltine strain or its multi hybrid having horizontal tolerant potentiality both as P₁ and in commercial level during the adverse month. Even though Nistari is used for rearing in adverse climatic conditions, the quantitative and qualitative characters are very low. Hence, an attempt is made to find out the alternative multivoltine breed and their hybrids with high shell percentage and neatness, so that both the farmers and the reelers will be benefitted. The selected breed/ hybrid will be sent for large scale trial.

15.4 Objective

- 1. To test the potentiality of the new improved multivoltine breeds with high shell weight and high neatness developed in the concluded project-AIB 3501.**
- 2. To identify season specific silkworm hybrids for the plains of West Bengal, Jharkhand Odisha and Assam.**

16. Review of status of Research and Development on the subject.

16.1 International Status

Not applicable

16.2 National Status

Not applicable

16.3 Importance of the proposed project in the context of current status:

Now a day’s multivoltine and multivoltine x bivoltine hybrids are being widely reared at commercial level in West Bengal during adverse seasons. However, all the multivoltine breeds so far developed for this region are capable of producing inferior quality silk and the neatness of filament is not up to the desirable limits. The shell weight is also very less.

It is a challenge to overcome the problem by raising a sustainable multivoltine breed with high quality silk with genetic plasticity having high shell content and high neatness of filament to buffer against the adverse seasons (June, August and September) in West Bengal. Such breeds and their hybrids are urgently required to increase the Crossbreed cocoon production for the

production of hybrids to increase the productivity as well as quality of silk. This work will identify the suitable breeds and hybrids for different areas and also for different seasons.

16.4 Anticipated Products, processes/Technology, Packages/ Information or other outcome from the project and their expected utility:

The identified season and region specific multi x multi and multi x bi hybrids with better quality silk having higher shell content and neatness of filament suitable to the West Bengal Conditions, can be effectively utilized for higher and quality cocoon production throughout the year which can change the socio-economic condition of the poor farmers. After this these hybrids will be sent for Authorization trial.

16.5 Expertise available with proposed investigation group/institution on the subject of the project: Yes

16.6 List of Five Experts in India in Proposed Subject Area: Not applicable

17. WORK PLAN

This programme will be conducted jointly by CSRTI, Berhampore and DOS, West Bengal. CSRTI, Berhampore will produce the P₁ dfls, supply the seed as per the crop schedule of the unit/area. The data collection from different units, analysis and final recommendation will be done by the Institute, while other partners shall carryout rearing, data collection (as per the proforma to be supplied) and compilation and submit the same to the Institute. The selected breeds/ hybrids have been developed in the concluded project AIB-3501. The reeling parameter of the hybrids will be evaluated by the Institute with the cocoons sent by the units after each rearing.

- ❖ CSR&TI, Berhampore will supply four Multi x Bi hybrid combinations (3-5dfls per combination).
- ❖ Please follow standard rearing technique
- ❖ Maintain all the worms up to third moult
- ❖ Maintain three replication each with 300 worms after third moult

Please record Important economical parameters for rearing (Fecundity, 10 larval weight, Larval duration (total and fifthage), Pupation rate, ERR by wt. (Kg), single cocoon weight (g), Silk ratio, Cocoon Yield/100dfls.

- ❖ Please record disease incidence if any (Flacherrie%, Grassarie% and Muscardine%)
- ❖ Please supply 300gm cocoons per combination to CSR&TI, Berhampore for reeling analysis
- ❖ Record data on temperature and relative humidity inside the rearing house

The programme is to be implemented with the following Multi x Bi hybrids which have been identified in the concluded project-AIB-3501:

1. **M2 x (B.Con1 x B.Con4)**
2. **M1 x (SK6 x SK7)**
3. **M4 x (B.Con1 x B.Con4)**
4. **N x (SK₆ x SK₇) - control**

M1 = M.Con.1 x MH1, **M2** = M.Con.4 x MH1

M4 = Gen3 x M.Con.4^{ld}

Hybrid materials selected for this programme

As per the recommendation of the 45th Research Advisory Committee on 17.01.2017, the hybrids which are identified in the concluded project AIB- 3501 are being considered as hybrid materials for the said programme. Based on the performance, P1 rearing in unfavourable seasons and other factors three hybrids which are within 1-10 Mano's rankings along with control have been selected.

Table: Performance of first ten Multi x bi hybrid as per the Evaluation Index

Multi x Bi	Fec.	S.C.W. (g)	S.S.W(g)	Shell %	ERR-no.	ERR-wt	Neatness	E.I. Rank
M2x(B.Con.1x4)	506	1.720	0.336	19.55	9244	15.78	80	1
M1xMC4(O)	491	1.698	0.334	19.67	8933	15.97	85	2
M1x(B.Con.4x1)	501	1.781	0.346	19.43	8356	15.41	85	3
M1xSK3C	526	1.751	0.337	19.23	9378	16.04	80	4
M1xNB18	524	1.787	0.347	19.37	9178	16.18	78	5
M3xMJ2	501	1.547	0.320	20.67	9367	14.80	77	6
M3x(SK6x7)	472	1.792	0.350	19.51	9233	14.98	84	7
M4x(B.Con.1x4)	495	1.605	0.327	20.38	9355	15.79	75	8
M3xD6PN	496	1.736	0.334	19.26	9200	14.09	75	9
M1x(SK6x7)	510	1.769	0.349	19.73	8189	14.41	80	10

M1 = 8(W)-M.Con.1xMH1; **M2** =12(Y) -M.Con.4xMH1; **M3** =16(W)-N (M)xMH1

M4 = 21(Y)-Gen3xM.Con.4^{ld}; **M5** =22(Y) – (SK6xSK7) x M.Con.4^{ld}

These three hybrids will be tested in all the seasons as mentioned below:

Table 4: Scheme for On-farm trials of multi x bi hybrids

Centre	Season	No. of DFLs/ Crop/hybrid	Total dfls /crop	Tentative date of brushing
1.RSRS Jorhat	Autumn & Spring	05	20	25 th September 15 th March
2.REC, Bhandara	Autumn & Spring	05	20	2 nd October 25 th February
3.RSRS, Koraput	Autumn & Spring	05	20	20 th October 20 th February
4.DOS-Farm, Murshidabad	Agrahayani, Falguni, Baishaki, Jaistha (May-June) & Aswina-(Aug.-Sept.)	05	20	31Oct-5 th Nov. 26 th -30 th Jan 28-30 th March 20 th -22 nd May 23 rd -25 th August
5.DOS-Farm, Malda	Agrahayani, Falguni, Baishaki, Shrivani-(June-July) & Bhaduri-(August)	05	20	31Oct-5 th Nov. 6 th -9 th Feb 28-30 th March 20 th -23 rd June 4 th -6 th August
6.DOS-Farm, Birbhum	Agrahayani, Falguni, Baishaki, Jaistha (May-June) & Aswina- (Aug.-Sept.)	05	20	31Oct-5 th Nov. 26 th -30 th Jan 28-30 th March 20 th -22 nd May 23 rd -25 th August
7.DOS-Farm, Nadia	Agrahayani, Falguni, Baishaki, Shrivani-(June-July)& Aswina-(Aug.-Sept.)	05	20	31Oct-5 th Nov. 26 th -30 th Jan 28-30 th March 20 th -23 rd June 23 rd -25 th August
Total			140	

METHODOLOGY

- CSRTI, Berhampore will rear the P₁ and hybrid dfls will be prepared and supplied to different units.
- The RSRSs, RECs and DOS units will rear the hybrids along with control in different seasons as per their brushing schedule (Table), each with 3 replications.
- After every rearing, 300 gm of green cocoons of each hybrid will be sent to the Institute for reeling analysis.
- Detail report of the rearing will be sent to the Institute after each crop.
- The generated data will be analyzed for identification of region and season specific hybrids which will be placed for large scale trial.

17.2 Organization of Work Elements:

Responsibilities	Organization
Rearing of parents and generation of seed cocoons Preparation of F1 hybrids from the seed cocoons	CSRTI, Berhampore
Distribution of dfls to respective regions	CSRTI, Berhampore
Rearing and data compilation	Respective units
Crop monitoring	CSRTI, Berhampore
The cocoons will be reeled and the post cocoon parameters will be evaluated.	CSRTI, Berhampore
Over all data compilation, identification suitable hybrids and recommendation	CSRTI, Berhampore

17.3 Proprietary / Patented items, if any, expected to be used for this Project: NA

17.4 Suggested plan of action for utilization of the expected outcome from the project:

The identified season and region specific multi x bi hybrids with better quality silk having higher shell content and neatness of filament suitable to the West Bengal and other eastern States conditions, will be sent for Large Scale trial.

17.5 Time Schedule of activities giving milestones:

Sl.	Milestone/ Activity	Expected Date of	
		Starting	Completion
1	P ₁ rearing and Preparation of hybrids by CSRTI	September 2017	October 2017
2.	Distribution of hybrids along with checks to the RSRS, REC and DOS units and supervision of crops	October 2017	November 2017
3.	Reeling analysis	December 2017	December 2017
4.	Collection of rearing performance data	December 2017	December 2017
6	The same activity of Sl.No.1 to 4 will be repeated in all the crops	December 2017	August 2019
7	Data analysis and recommendation	September 2019	December 2019

17.6 Project Implementing Agency /Agencies :

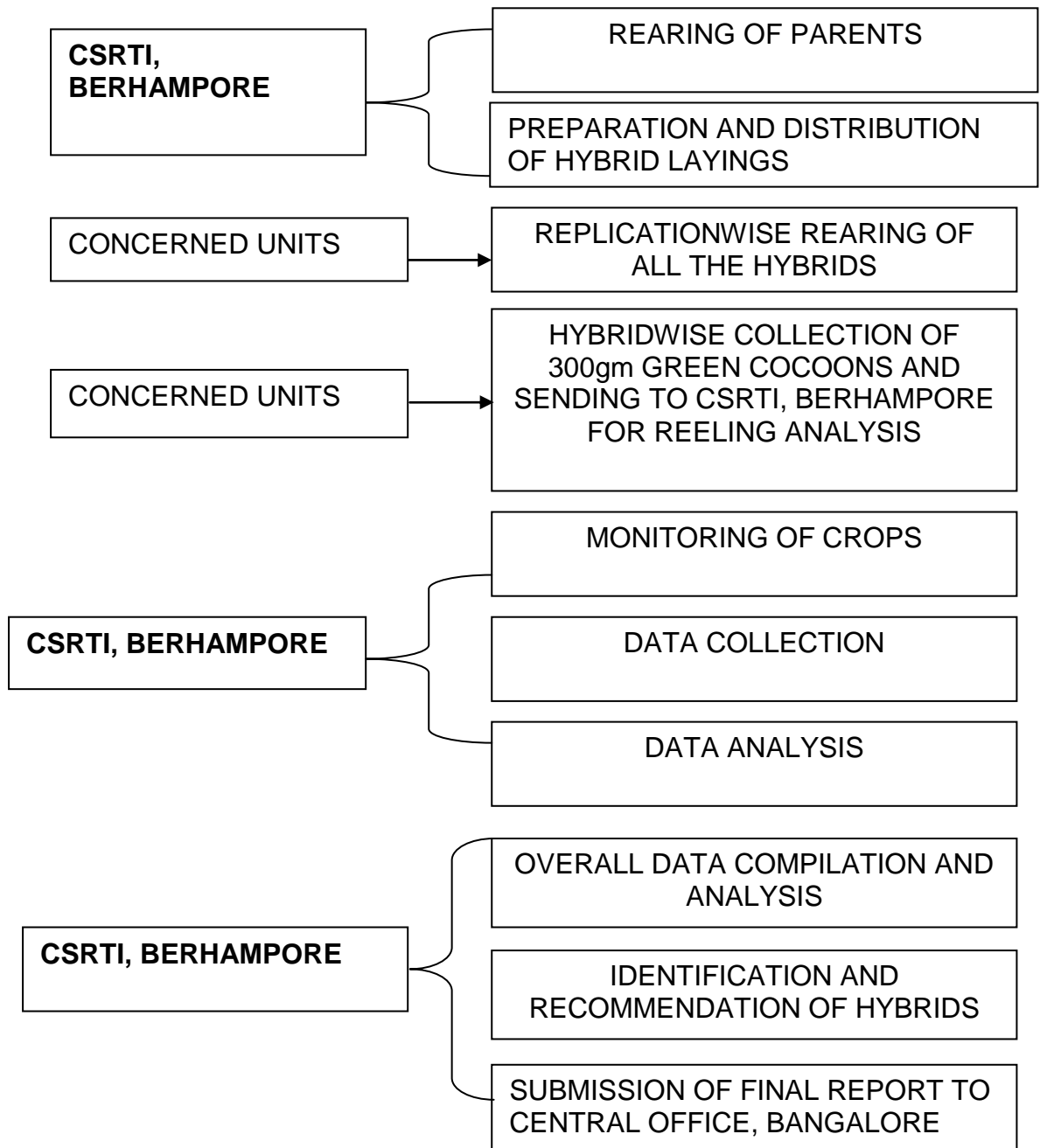
Name of the agency	Address of the agency	Proposed Research Aspects	Proposed Amount	Cost Sharing %
CSB	CSB, Bangalore Pin-560068			

PART-IV: BUDGET PARTICULARS

18. **BUDGET** (in Lakhs) : [In case of multi-institutional projects, the budget details should be provided separately for each of the Institute]

ITEM	YEAR 1	YEAR 2	Total
A. RECURRING			
SALARIES [APPORTIONED COST]	--	--	-
1. SCIENTIFIC STAFF	--	--	-
2. TECHNICAL STAFF			
WAGES/FELLOWSHIPS [AC]	--	--	-
3. SUPPORTING COST	--	--	
4. LABOURERS	--	--	
5. TRANSPORT & TRAVEL	2.000	2.000	4.000
CONTINGENCIES [APPORTIONED COST]	0.500	0.500	1.000
6.COST OF MATERIALS & SUPPLY-Bleaching, Labex etc.	1.000	1.000	2.000
7. OTHER COSTS			
B. NON-RECURRING [APP. COST] AC -2 and Refrigerator-1	1.500	0.000	1.500
GRAND TOTAL (in lakhs)	5.000	3.500	8.500

FLOW CHART OF ACTIVITIES



PART VII: BIODATA OF PRINCIPAL INVESTIGATOR

1.	Full Name (in Block letters)	DR. ANIL KUMAR VERMA
2.	Designation	Scientist-D.
3.	Department/Institute/University	Silkworm Breeding Section, Central Sericultural Research & Training Institute, Berhampore(WB)-742101
4.	Date of birth	28.12.1960.
5.	Sex	Male.

6. Education (Post Graduation onwards & Professional careers)

Name of the University	Degree passed	Year of passing	Subjects taken with specialization	Class / Division
1. University of Kalyani, Nadia, West Bengal.	M.Sc.	1983	Zoology, Spl.: Entomology.	I
2. Bidhan Chandra Krishi Viswavidyalaya, West Bengal	Ph. D	1990	<u>Title of the Thesis-</u> Studies on whitefly as vector of plant viruses in West Bengal. Under Prof. Sankar Mukhopadhyay and Prof. S.S.Ghatak	-

7. Position held/research experience in various Institutions:

Employer	Designation of the post held	Date of joining	Date of leaving
Central Silk Board	Senior Research Assistant	12.10.1990	
-do-	Senior Research Officer	12.10.2000	
-do-	Scientist-C	12.10.2006	
-do-	Scientist-D	01.01.2015	

8.	Memberships/Fellowships:	NASSI,
9.	Patents/ Breeds & Hybrids authorized:	5 Hybrids developed and authorized
10.	Publications (numbers only)	24 Papers and 38 Technical Reports

11. TRAINING UNDERGONE:

COURSE NAME/ SUBJECT	ADDRESS OF INSTITUTE	DURAT ION	PERIOD
1. Refressor training course programme (Non-mulberry)	CTR TI, Ranchi.	26 days	22.6.94 to 15.7.94
2. S.W. Seed production techniques (Mulberry)	SSTL, Kodathi	15 days	15.11.94 to 29.11.94
3. Statistical methods for Sericultural research.	CSB, Bangalore	4 days	19.5.03 to 22.5.03
4. Computer Application	ITI, Murshidabad	6 days	07.7.03 to 12.7.03
5. Right to Information Act-2005	R.O. New Delhi	2 days	24.02.10-25.02.10
6. Disciplinary Proceedings Training	CSRTI, Berhampore	4 days	16.11.10-19.11.10

12. Project(s) submitted / being pursued / carried out:

Sl. No.	Title of the project	Funding agency	Duration From To
1	Utilization of Syngenic lines for improvement of shell weight and survival in silkworm, <i>B. mori</i> . L	CSB	Dec., 1998 to Dec.,2004
2	Introgression of higher shell weight, higher survival character/gene through the development of multivoltine and bivoltine congenic breeds and identification of biochemical marker in silkworm, <i>B. mori</i> . L.	CSIR, Delhi	April, 2002 to March,2005
3	On farm trial of congenic silkworm hybrids for commercial exploitation	CSB	Sept.,2004- Dec06
4	On Farm trial of evolved bivoltine and multivoltine Congenic breeds and their hybrid performance at farmer's level (In collaboration with DOS, W.B.	CSB	Dec' 05-Nov' 2007
5	Mulberry Silkworm race Authorization Programme (MSRAP) – Phase- vii	CSB	2005-2008
6	Multi location Trial of New Silkworm Breads/Hybrids at Farm Level	CSB	Dec. 2007- Mar. 2010
7	Institute Village Linkage Programme (IVLP)	CSB	Ph.I:07-10 PhII:10-13
8	Study on the efficacy of newly developed Bed disinfectant (Sericillin) in hot spot areas for the control of Muscardine disease of silkworm, <i>B. mori</i> L..	CSB	Aug.2010-- Jul2012
9	Validation trial of the Ready Reckoner of sulphur fertilizer application for obtaining targeted yields of mulberry	CSB	2010-12
10	Validation trial of technology for Prevention of Gattine disease in hot spot areas in silkworm <i>B. mori</i> L.	CSB	2012-14
11	Development of Multivoltine silkworm breeds with high shell percentage and neatness of silk filament	CSB	Jul, 2013 - Jun2016
12	Post Authorization Trial of Silkworm hybrids in Eastern and North-Eastern India	CSB	Jun,2012 - Dec2014
13	Survey and surveillance of silkworm diseases in traditional districts of West Bengal	CSB	Jul,2013- Jun,2016
14	Silkworm disease monitoring of seed and commercial crop rearing of West Bengal	CSB	Apr,2013- Mar,16
15	Maintenance of Multivoltine and Bivoltine Germplasm.	CSB	Continuous.
16	Pre-Authorisation Trial of Silkworm hybrids in Eastern and North-Eastern India	CSB	Jun,2014- Dec2016
17	Development of silkworm <i>Bombyx mori</i> L. Breeds from a gene pool with higher genetic plasticity	CSB	Sept.2012 – Aug.2016
18	Development of multivoltine congenic / NIL breed of silkworm <i>Bombyx mori</i> L. Through introgression of Id gene and its use	CSB	Jun.2014 - May2017

13. Highlights of outcome / progress of the project(s) handled during the past 10 years, their outcome and utilisation (in 200 words):

Project	Outcome	Utilisation
1. Utilization of Syngenic lines for improvement of shell weight and survival in silkworm, <i>B. mori</i> . L	Isozyme based seven multivoltine and one sex linked bivoltine syngenic lines, four high cocoon shell weight multivoltine congenic breeds & four high survival bivoltine congenic breeds developed. Biochemical marker for high shell weight and high survival identified	The hybrids of the developed congenic breeds are under Post Authorization Trial.
2. Introgression of higher shell weight, higher survival character/gene through the development of multivoltine and bivoltine congenic breeds and identification of biochemical marker in silkworm, <i>B. mori</i> . L.	Isozyme based three syngenic lines of Nistari and one high survival bivoltine congenic breeds developed. Two biochemical marker identified similar to above project.	The hybrids of the developed breeds are under Post Authorization Trial.
3. Institute Village Linkage Programme (IVLP)	Mulberry leaf yield (MT/ha/year) increases from initial 8 to 10.47(30.86%). Average Mulberry holding (in acre) increases from initial 0.5 to 0.66(32.00 %). Average rearing capacity (DFLs/farmer/crop) increases from initial 75 to 125 (66.66 %). Cocoon yield/ 100 DFLs (kg.) increases from initial 28.99 to 36.62(26.31 %.)	Plantation of High Yielding Variety like S1635. Plant to plant & row to row spacing- 2 ft.X 2 ft. Use of Plant Growth Hormone like Morizyme-B. Use of Vermicompost. Use of Biofertilizers like Nitrofert and Phosphofert to reduce the application of chemical nitrogen and phosphorus. Use of promising hybrids in place of existing one. Use of Bleaching Powder for general disinfection and Labex as bed disinfection. Use of dichlorovos for control of Whitefly infestation.
4. Validation trial of the Ready Reckoner of sulphur fertilizer application for obtaining targeted yields of mulberry	Soil from individual farmers analyzed to determine the extent of sulphur, based on this recommendation for sulphur application has been worked out.	Farmers are utilising this recommendation for use of sulphur in their field

Introduced a **method for introgression of a trait controlled by multiple genes** for developing

Congenic Breed (Chattopadhyay et al., 2001a, b, 2005).

Developed **four promising silkworm breeds** viz., M Con.1, M Con.4 (Multivoltine), B Con.1, B. Con.4 (Bivoltine)

Identified **five promising hybrid** combinations.

M Con.1 x M Con.4, N x M Con.4 (Multivoltine x Multivoltine)

M Con.1 x B Con.4, M Con.4 x B Con.4 (Multivoltine x Bivoltine)

B Con. 1 x B Con.4 (Bivoltine x Bivoltine)

Registration of breeds: Six (6) congenic breeds viz., V³ CB5-Con.Ow, V³ M6DPC-Con.C, V² D6p-Con.Ow, V² D6p- Conc., V² D6p-Con.F and one sex limited breed (JPN^{+HS}) was send for registration at CSGRC, Hosur.

Biochemical study / Markers: Established that **amylase** is one of the most important enzymes in tropical silkworm having **positive correlation with high survival**.

It has been identified **224kDa Protein as a biochemical marker at pH-8.5 for high survival**. The apparent native protein in haemolymph is the possessor of α -Est s are exclusively present in multivoltine.

It has been Identified that **180 kDa protein as a biochemical marker for high cocoon shell weight (at pH-8.5)**. The apparent native protein in haemolymph is the possessor of α -Est s and exclusively present in bivoltine.

β -amylase presence in haemolymph and digestive of Silkworm, *Bombyx mori* L. and **Identified specific and non-specific esterases** using α - and β -naphthyl-acetate separately as non-specific substrates. The non-specific β -esterase-Est-3 in haemolymph is a **thermo-stable enzyme ($80 \pm 1^\circ\text{C}$), which has been considered as one of the molecular factor for thermo-tolerance**.

Specific **Isozyme possessor native proteins** are associated with **non-hibernation and hibernation character** of silkworm has been identified some (CSIR Final report)

In the Project **AIB-3501**, **seven multivoltine lines** with high SR% (**more than 17%**) and high neatness (**more than 80 points**) have been developed.

Besides, best two Multi x Multi and two Multi x Bi hybrids are also identified.

In the Project **AIB-3480**, **two six way bivoltine converged gene pool for high Shell weight and three multivoltine converged gene pool for high survival are developed**.

These lines will be used to develop 2 multivoltine congenic lines with high shell weight (>0.24g) and 2 bivoltine congenic lines with high survival (>90%) in Phase-II.

14. PUBLICATION:

1. Ph.D. Work guided-1
2. Book-3
3. Leaflet-9
4. Paper published-24

LIST OF IMPORTANT PUBLICATIONS

1. Chattopadhyay, G.K, Sengupta, A. K.; **Verma, A. K**, Sen, S. K. and Saratchandra, B. (2001c) Esterase isozyme polymorphism, Specific and nonspecific esterase, syngenic line development and natural occurrence of a thermo stable esterase in tropical silkworm *Bombyx mori* L., *Insect Biochem. Mol. Biol. (USA)*, **31**: 1191-1199.
2. Chattopadhyay, G.K., Sengupta, A. K.; **Verma, A. K.**, Sen, S. K and Saratchandra, B. (2000a) Utilization of congenic line in silkworm breeding. In: *Pers.in Cytol. & Genet. Ed by G. K. Manna and S. Roy.* **10**: 717-724.
3. Chattopadhyay, G.K., Sengupta, A. K.; **Verma, A. K.**, Sen, S. K and Saratchandra, B. (2001b) Transgression of shell weight- A multigenic trait, through development of congenic breed in tropical silkworm, *Bombyx mori* L. *Sericologia*, **41(1)**: 33-42.
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8. **Verma, A. K**, Chattopadhyay, G. K.; Sengupta, A. K, Das, S. K. and Sarkar. A. (2006) New Multi x Bi silkworm hybrids for Eastern India. In: *Workshop* on appropriate technology for Mulberry sericulture in Eastern and North Eastern India. 17th -18th January. Central Sericultural Research & Training Institute. Berhampore-742101, West Bengal: **97-100**.
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10. Chattopadhyay, G. K.; **Verma,A.K**; Das N.K. Saratchandra.B.; Bindroo, B.B and Saha ,A.K (2013) Performance of parents, their Syngenic lines, Congenic breeds and hybrids of silkworm, *Bombyx mori* ,L – A Comparison. *J. Exp. Zool, Vol.16, No.2, pp. 509-518*.
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12. Suresh Kumar, N, **Verma, A.K.** and Saha, A.K. (2016) Breeding strategies for development of silkworm breeds/ hybrids foe Eastern and North-Eastern India. In “ Proceeding of the Silkworm Breeders’ Meet 2015 22th September 2015, CSRTI, Mysuru”, pp. 14-20.
13. **Verma,A.K**, Chatterjee, G.K., Kar, N.B. Saha ,A.K., and Suresh Kumar, N. (2016). Esterase α , β - the biochemical markers for quantitative and qualitative traits of Silkworm, *Bombyx mori* L. *Sericologia*, **56(2)**: 94-102.

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PART VII: BIODATA OF CO- INVESTIGATOR

1. Full Name (in Block Letters) : N CHANDRAKANTH
2. Designation : Scientist - B
3. Department /Institute /University : CSRTI, Berhampore
4. Address for communication : SBG, CSRTI, Berhampore
5. Date of birth : 24/04/1986
6. Sex : Male
7. Education onwards & (Post Graduation onwards & Professional Career)

Name of the university	Degree Passed	Year of Passing	Subjects taken with Specialization	Class/ Divn.
Punjab Technical University, Jalandhar	M. Sc.	2009	Biotechnology	I
University of Mysore, Mysore	Ph.D.	2016	Biotechnology	-

8. Awards: [Not required for house personnel]:

Year	Award	Agency	Purpose	Nature
Nil	Nil	Nil	Nil	Nil

9. Position Held / Research Experience in various institutions:

[Not required for in –house personnel]

10. Memberships/Fellowships: [Not required for in-house personnel] :

11. Patents: [Not required for in-house personnel]:

12. Publications (Number only): 12

Books: 01

Research Papers, Reports: 11

General articles: Ni

13. Project(s) submitted / being pursued / carried out by Investigator:

Sl.No.	Title of the Project/ Program	Funding agency	Duration From and To	No of Scientists /Associates working under the project	Total approved cost of the project (Rs.in lakh)
1	Development of thermotolerant bivoltine breeds / hybrids of silkworm, <i>Bombyx mori</i> through marker assisted selection- AIB 3602	Central Silk Board	Nov 2016 to April 2021	4	10.55
2	Development of high temperature and high humidity tolerant bivoltine breeds of silkworm, <i>Bombyx mori</i> L.- AIB 3547	Central Silk Board	June 2015 to June 2017	3	0.33
3	Development of region specific bivoltine silkworm breeds suitable for highly	Central Silk Board	Aug 2011 to Dec 2016	3 scientists from CSRTI,	10.00

	fluctuating and seasonally variable climatic conditions of Eastern and North-Eastern India- AIB 3466			Berhampore and Sub unit incharges of 5 stations	
4	Improvement of leaf quality and productivity through external application of seaweed extracts in mulberry (<i>Morus alba</i> L.)- PIN 3587	Central Silk Board	Oct 2016 to Sep 2017	3	0.40
5	Evaluation of multivoltine germplasm to identify potential parents for developing cross breeds suitable for Southern and Eastern India- AIB 3577	Central Silk Board	March 2016 - February 2019	8	Total- 21.20 For Institute – 3.90
6	Validation of the DNA markers in silkworm breed developed by introgression of DNA markers associated with NPV resistance using Marker Assisted Selection breeding and large scale field trial of the breed- ARP-3605	DBT funded collaborative project with SBRL, Bengaluru	April 2017 to	8	2.46
7	Maintenance of silkworm germplasm- BAI(RP)-003	Central Silk Board	Continuous	4	-

14. Highlights of outcome / progress of the project (s) handled during the past 10 years their outcome and utilization (in 200 words).
NIL

PART VII: BIODATA OF CO- INVESTIGATOR

1. NAME : **Shri . N.B Kar**
2. EMPLOYEE NO. : 003322
3. OFFICIAL DESIGNATION : Scientist-D (Reeling & Spinning)
4. PROJECT DESIGNATION : Co-Investigator
5. EXPERTISE AREA : Mechanical Processing of Textiles
6. INSTITUTE NAME : Central Sericultural Research & Training Institute, Berhampore-742 101, West Bengal.
7. INSTITUTE ADDRESS : Central Sericultural Research & Training Institute, Berhampore-742101, West Bengal.
8. TELEPHONE : 03482 – 251046, 251233, 253962
9. TELEX/E-MAIL : karnb@rediffmail.com
10. FAX : 03482 –251046
11. BIRTH YEAR : 1959
12. SEX : Male
13. EDUCATIONAL :

HIGHEST DEGREE	YEA	UNIVERS	COUNTR	SUBJECT
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(DEGREE ON WARDS	R	ITY	Y	
B. Sc. (Tech) in Textile Technology	1980	Calcutta	India	Spinning, Weaving, Dyeing & Printing, Fibre Science, Testing etc.
M.Sc(Tech) in Mechanical Processing of Textiles	1999	Calcutta	India	Spinning, Weaving, Fibre Science etc.

14. TRAINING UNDERGONE:

COURSE NAME/ SUBJECT	ADDRESS OF INSTITUTE	DUR ATIO N	PERIOD		SPONSOR ED AGENCY
			FROM	T O	
1. Refresher Training on Mulberry	CTR&TI, Ranchi	Three Weeks	1987		CSB
2. Tribal Orientation Training Programme	Tribal Research Institute, Ranchi	One Week	1987		
3. Trainers' Training Programme	CSTRI, Bangalore	Ten days	1992		
4. Entrepreneur Development Programme	NISIET, Hyderabad	Two weeks	1993		
5) Computer Training	CSR&TI, Berhampore	Two weeks	1994		
6) Orientation Training	CSTRI, Bangalore	One day	2001		

15. EXPERIENCE:

ORGANISATIO N/ INSTITUTE	DESI GNA TION	DURATI ON	PERIOD		SUBJECT AREA	SIGNIFICANT ACHIEVEMENT
			From	To		
CTR&TI, Ranchi	SRA	4 yrs	1986 (July)	1990 (May)	Research on Tasar Reeling, Spinning & fiber technology	Design & development of Reeling Cum Twisting machine (1987 – 1990). <ul style="list-style-type: none"> • DESIGN & DEVELOPMENT of Studies on a User-Friendly 2-Spindle horizontal Tasar Reeling machine (1988 – 1990). • Studies on the weaving of Tasar raw, dyed & waste spun yarn for product diversification (1988 – 1990).
RSDTC,	SRA	1¼ year	1990	1991	Tasar	ASSOCIATED WITH

Fakirpur, Orissa			(May)	(Aug)	Research Extension & Training	RESEARCH EXTENSION UNDER CTR&TI, RANCHI.
DCTC, Dabok, Rajasthan	SRO	App. 2½ years	1991 (Sept)	1994 (Mar)	Mulberry Research Extension & Training	<ul style="list-style-type: none"> • Associated with extension activities under NSP • Associated with Research extension under CSTRI, Bangalore
CSR&TI, Berhampore	SRO	3½ years	1994 (Mar)	1997 (Dec)	Research on Mulberry Reeling, Spinning & fibre Technology	<ul style="list-style-type: none"> • Designing of Reeling machine suitable for West Bengal condition to reel N, Nx G & N x Bi cocoons (1988 – 1994) • Development of cocoon drying chamber suitable for West Bengal Condition (1989 – 1994). • Development of Water Correction Kit for cooking and reeling with reference to the states of eastern region (1987 – 1994).
Study Leave	SRO	2 years	1998 (Jan)	1999 (Dec)	Mechanical Processing of Textiles	Obtained M.Sc (Tech) degree from Calcutta University
DCTSC, Madhughat, Malda, West Bengal.	SRO	4¼ years	2000 (Jan)	2004 (Apr)	Mulberry Research Extension & Training	Associated with Research extension under CSTRI, Bangalore.
CSR&TI, Berhampore	SRO	App. 4 years	2004 (May)	2006 (August)	Research on Mulberry Reeling, Spinning & fibre Technology	<ul style="list-style-type: none"> • Associated with 4 no. Ongoing & 5 no. Concluded Research Projects as CI. • Associated with 2 no. Ongoing & 4 no. Concluded Research Projects as non-CI. • Associated with 03 no. Ongoing & 4 no. Concluded Research Programmes.
CSR&TI, Berhampore	Scientist - C	App. 8 years	2006 (Aug)	2014 (Feb)	Research on Mulberry Reeling, Spinning & fibre Technology	
CSR&TI, Berhampore	Scientist - D	App. 2 years	2014 (Feb)	Till date	Research on Mulberry Reeling, Spinning & fibre Technology	

16. ACTIVITY :
 a) PRESENT DISCIPLINE OF WORK : Reeling & spinning
 b) PRESENT AREA OF WORK : Post Cocoon Technology
17. TIME ALLOCATION [IN %] & COST :
 [NOTE: One week = 2%] [For one year]

SL. NO.	NATURE OF WORK	TIME %	NO. OF WEEKS	COST [RS. IN LAKHS]	COST [RS. IN LAKHS]

18. PROJECTS PURSUED:
 A) PROJECTS UNDER PROGRESS

SL. NO.	PROJECT CODE	PROJECT TITLE	RESEARCH TIME SPENT [%]	COST [RS.]
1	BAI(P) - 014	Studies on the Reelability of Multivoltine Hybrid Cocoons during adverse climatic condition in Eastern and Northeastern Region	50%	0.024
2	AIB - 3480	Development of Silkworm (<i>Bombyx mori L</i>) Breeds from a Gene Pool with Higher Genetic Plasticity	9%	0.024
3	AIB - 3466:	Development of Region Specific Bivoltine Breeds suitable for Highly Fluctuating Seasonally Variable Climatic Condition of Eastern & North-Eastern India	9%	0.024
4	Other Programmes		32%	0.024
5				0.172
TOTAL			100 *	

B) COMPLETED PROJECTS

APR 3250: Development of Rearing Package for optimizing cocoon yield in West Bengal

APS 3238: Induction of Trimoulting in Bivoltine silkworm by physiologically active chemicals and their utilization as male parents for multi x bi hybrid production.

AIG 002: Utilization of Syngenic Lines for Improvement of Shell Weight & Survivals in *Bombyx mori-L*

PPA 3249: Effect of Integrated Plant Nutrition Systems on Mulberry Crop Production & Protection

PPA 3223 Updation of Improved Package of Practices for newly Authorized Mulberry Varieties under Irrigated Condition

- AIB 3237 Utilization of Polyvoltine Breeds for Improvement of Survivals in Bivoltine Silkworms *Bombyx Mori-L*.
- AIB 3291 Evaluation of viable Sex Limited Bivoltine Breeds of *Bombyx Mori-L*.
- PPA 3358 Organic Farming in Mulberry-An Approach for Improvement of Silk Industry.
- PPA 3366 Development of Integrated Package for Raising Chawki Leaves & Young Age Silkworm Rearing for Successful Cocoon Crops

Other Projects & Programmes:

* = 100% IS THE TOTAL RESEARCH TIME WHICH IS EQUIVALENT TO THE % OF THE TIME SPENT ON RESEARCH AS INDICATED UNDER 'RESEARCH' AGAINST POINT NO. 17.

19. Highlight of the outcome/ progress of the project (s) handled during the past 10 years, their outcome and utilization (in 200 words):

The findings of the various research projects from the different sections particularly Silkworm Breeding and Genetics Section and Silkworm Physiology and RTI Section are finally substantiated by the post-cocoon assessment. Satisfaction of a reeler has the ultimate role for acceptance of a technology developed either by SBG or RTI. Part contribution of a reeler acts behind the success of a breeder. Previously eastern part of India reared only Nistari and Nx Bi dfls in 3-5 seasons according to the meteorological area. Now after introduction of various high yielding silkworm breeds, both multi x multi and multi & bivoltine the productivity of the farmers per unit laying and the rearing capacity of the farmers have been increased which also enable them to fetch higher income. A suitable alternative to Bivoltine component NB4D2 has been found and as such SK6 x SK7 (FC) is going to replace NB4D2 successfully that can be reared throughout the year irrespective of climatic vagaries. Extensive study on breed development has also pave the way for some other combinations of silkworm races viz.; M.Con.1 x M.Con.4, Nistari x M.Con.4, M.Con.1 x B. Con.4 and M.Con.4 x B.Con.4 to replace the existing low productive breeds / hybrids. I was actively associated as co-investigator with all the projects during last seven years formulated by SBG or RTI section. Some work on formulation of an ideal package of practices of rearing during different climatic conditions has also come out with definite recommendation. Large scale testing of breed / hybrid at farm level, Cluster Promotion Programme at different zones has supported the breeds to become popular at commercial level.

PART-VI: DECLARATION / CERTIFICATION

It is certified that

- a. The research work proposed in the project does not in any way duplicate the work already done or being carried out elsewhere on the subject.
- b. The same project has not been submitted to any other agencies for financial support.
- c. The emoluments for the manpower proposed are those admissible to persons of corresponding status employed in the institute/ university or as per the Ministry of Science & technology guidelines (Annexure-III).
- d. Necessary provision for the project will be made in the Institute in anticipation of the sanction of the scheme.
- e. If the project involves the utilization of genetically engineered organism, it is agreed that we will ensure that an application will be submitted through our

institutional bio-safety committee and we will declare that while conducting experiments , the bio-safety guidelines of the Department of Biotechnology would be followed in toto.

- f. If the project involves field trials / experiments / exchange of specimens etc we will ensure that ethical clearances would be taken from the concerned ethical committees of Biotechnology before implementing the project.
- g. It is agreed by us that any research outcome or intellectual property right(s) on the interven (s) arising out of the project shall be taken in accordance with the instructions issued with the approval of the Ministry of Finance . Department of Expenditure as contained in annexure-V
- h.. We agree to accept the terms and conditions as enclosed in Annexure-IV .The same is signed and enclosed.
- i. The institute agrees that the equipment , the basic facilities and such other administrative facilities as per terms and conditions of the grant will be extended investigators through out the duration of the project .
- j. The institute assumes to undertake the financial and other management responsibilities of the project.

**1. Signature of Executive Authority of
Institute with Seal Date:**

2. Signature of Principal Investigator

3. Signature of Co-Investigator-1

4. Signature of Co-Investigator-2

Name of co-investigators:

Dr.Ganashyam Singh : Scientist-D, REC, Bhandra
Dr.Sunil Kr.Mishro : Scientist-C, RSRS, Koraput
Dr.U.C.Barua : Scientist-D, RSRS, Jorhat
Extension Officer : DOS- Farm, Murshidabad
Extension Officer : DOS- Farm, Malda
Extension Officer : DOS- Farm, Nadia
Extension Officer : DOS- Farm, Birbhum

**Signature of Executive Authority of
Institute with Seal Date:**

To,
The Director,
C S R & T I
Berhampore

Dated: 29.06.2017

Madam,

Sub: Submission of a Project entitled “ On-farm Trial of the breeds/hybrids developed in the Project-AIB 3501”
for coding as suggested by 45th RAC on 17.01.2017. - Reg:

I am submitting herewith submitting a Project entitled “**On-farm Trial of the breeds/hybrids developed in the Project-AIB 3501**” for coding by Central Office as suggested by 45th RAC on 17.01.2017.

This is for your kind information and needful action.

With regards,

Yours faithfully,

(Dr. A. K. Verma)
Scientist –D
SBG, CSR&TI. Berhampore

To,
The Commissioner, Textiles & Sericulture
Govt. of West Bengal
Kolkata-13

Dated: 08.08.2017

Madam,

Sub: Implementation of a Project entitled "AIB-3616: On-farm Trial of the multivoltine silkworm breeds/hybrids developed for high shell percentage and neatness of silk filament" in different districts - Reg.

I am forwarding herewith four copies of a Project entitled "AIB-3616: On-farm Trial of the multivoltine silkworm breeds/hybrids developed for high shell percentage and neatness of silk filament". This project is for testing three new improved multi x bi hybrids developed by this Institute along with control in four districts viz., Malda, Murshidabad, Birbhum and Nadia. This testing may be done in anyone of your centre each in these four districts. The detail methodology etc. is given in the project.

This is for your kind information and needful action.

With regards,

Yours faithfully,

(Dr. Kanika Trivedy)
Director

To,
The Scientist-D,
RSRS, Central Silk Board
Rowriah, Jamuguri
Jorhat-785005
Assam

Dated: 08.08.2017

Sir,

Sub: Implimentation of a Project entitled "AIB-3616: On-farm Trial of the multivoltine silkworm breeds/hybrids developed for high shell percentage and neatness of silk filament" in your centre - Reg.

I am forwarding herewith a Project entitled "AIB-3616: On-farm Trial of the multivoltine silkworm breeds/hybrids developed for high shell percentage and neatness of silk filament". This project is for testing three new improved multi x bi hybrids developed by this Institute along with control in your centre.

This is for your kind information and needful action.

Yours faithfully,

(Dr. Kanika Trivedy)

Director

To,
The Scientist-D,
RSRS, Central Silk board
MOT, Govt. of India
Koraput-764020
Odisha

Dated: 08.08.2017

Sir,

Sub: Implimentation of a Project entitled "AIB-3616: On-farm Trial of the multivoltine silkworm breeds/hybrids developed for high shell percentage and neatness of silk filament" in your centre - Reg.

I am forwarding herewith a Project entitled "AIB-3616: On-farm Trial of the multivoltine silkworm breeds/hybrids developed for high shell percentage and neatness of silk filament". This project is for testing three new improved multi x bi hybrids developed by this Institute along with control in your centre.

This is for your kind information and needful action.

Yours faithfully,

(Dr. Kanika Trivedy)
Director

To,
The Scientist-D,
REC-Central Silk Board
D.R.D.A. Building Kachhari More
Lohardaga-835302
Jharkhand

Dated: 08.08.2017

Sir,

Sub: Implimentation of a Project entitled "AIB-3616: On-farm Trial of the multivoltine silkworm breeds/hybrids developed for high shell percentage and neatness of silk filament" in your centre - Reg.

I am forwarding herewith a Project entitled "AIB-3616: On-farm Trial of the multivoltine silkworm breeds/hybrids developed for high shell percentage and neatness of silk filament". This project is for testing three new improved multi x bi hybrids developed by this Institute along with control in your centre.

This is for your kind information and needful action.

Yours faithfully,

(Dr. Kanika Trivedy)

Director