

Development of region specific bivoltine breeds suitable for highly fluctuating and seasonally variable climatic conditions of Eastern and North-Eastern India

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SUBMITTED BY

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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.S.Nirmal Kumar, Director
4. **Project Title** : Development of region specific bivoltine breeds suitable for highly fluctuating and seasonally variable climatic conditions of Eastern and North-Eastern India.
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5. **Category of the Project** : Animal (A)
6. **Specific Area** : Silkworm Improvement
7. **Duration** :
8. **Total Cost** :
9. **Is the Project single Institutional or multi-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:

Collect promising bivoltine breeds from all the breeding centres in India. Make all possible foundation crosses of the collected breeds. Send all the crosses to different RSRSs for its rearing and selection at the respective places . Continue those lines in the respective places. Bring those lines back to the institute and continue in Institute also. Screen for disease tolerance in those batches. Select the batches with more tolerance. Estimate esterase in al the batches and select batches with high esterase. The lines from different places may be brought to the institute and lines from Institute to all the different places. Evaluate and undertake selection and continue the shuttling

process at every alternate generation till the lines are fixed. Instead of continuing with all the lines promising lines may be short listed. After fixation, hybrids have to be prepared involving the institute lines as well as the RSRS lines. Hybrid evaluation should be conducted simultaneously in the centres covering all the seasons of the year. After evaluation, promising hybrids from respective centres may be selected. Small quantity of layings may be tested with farmers in the respective centres for validation before commercialization

11. (b) Aims and Objectives:

The main aim and objective of the project is to develop bivoltine breeds with genetic plasticity to buffer against adverse climatic conditions of West Bengal

PART-II: PARTICULARS OF INVESTIGATORS

12. a) Name: : Dr.N.Suresh Kumar
Date of Birth : 01-06-1956
Sex: : Male
Indicate whether Principal Investigator/
Co-investigator : Principal Investigator
Designation : Scientist-D
Department : Silkworm Breeding and Genetics,
Institute/University: Address CSRTI, Berhampore

b) Name: : Dr.A.K.Saha
Date of Birth : 27.08.1957
Sex: : Male
Indicate whether Principal Investigator/
Co-investigator : Co- Investigator
Designation : Scientist-D
Department : Silkworm Breeding and Genetics,
Institute/University: Address CSRTI, Berhampore

c) Name: : Dr.S.Sreekumar
Date of Birth : 15-06-1956
Sex: : Male
Indicate whether Principal Investigator/
Co-investigator : Co- Investigator
Designation : Scientist-D
Department : Silkworm Breeding and Genetics,
Institute/University: Address CSRTI, Berhampore

d) 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

e) Name: : Dr. Satadal Chakravorty
Date of Birth : 09-12-1964
Sex: : Male
Indicate whether Principal Investigator/
Co-investigator : Co- Investigator
Designation : Scientist-C
Department : Silkworm Pathology Section,
Institute/University: Address CSRTI, Berhampore

f) Name: : Dr.Debaraj
Date of Birth :
Sex: : Male
Indicate whether Principal Investigator/
Co-investigator : Co- Investigator
Designation : Scientist-D
Department : RSRS Jorhat,
Institute/University: Address CSRTI, Berhampore

g) Name: : Dr.Ganashyam Singh
Date of Birth :
Sex: : Male
Indicate whether Principal Investigator/
Co-investigator : Co- Investigator
Designation : Scientist-D
Department : RSRS, Ranchi
Institute/University: Address CSRTI, Berhampore

h) Name: : Ms Chndana maji
Date of Birth :
Sex: : Female
Indicate whether Principal Investigator/
Co-investigator : Co- Investigator
Designation : Scientist-D
Department : RSRS,Kalimpong
Institute/University: Address CSRTI, Berhampore

i) Name: : Dr.N.R.Rao
Date of Birth : 01-05-1956
Sex: : Male
Indicate whether Principal Investigator/
Co-investigator : Co- Investigator

Designation : Scientist-C
 Department : RSRS, Koraput
 Institute/University: Address CSRTI, Berhampore

13. No. of Projects being handled by
 Each investigator at present

Name of the Scientists	Designation	No of projects
Dr.N.Suresh Kumar	Scientist-D	-
Dr.A.K.Saha	Scientist-D	2
Dr.S. Sreekumar	Scientist-D	-
Mr. N.B.Kar	Scientist-D	1
Dr.Stadal Chakraborty	Scientist-C	2
Dr.Ganashyam Singh	Scientist-D	-
Dr.Debaraj	Scientist-D	1
Dr. N.R. Rao	Scientist-C	-
Mrs Chandana Maji	Scientist-D	-

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 bivoltine silkworm breeds capable of producing quality silk. However, the hot climatic conditions of India is not conducive to rear productive bivoltines. Hence, there is an urgent need to develop bivoltine breeds which can yield stable crops under the adverse climatic conditions. Accordingly, efforts should be focused by the silkworm breeders to develop bivoltine breeds with genetic plasticity to buffer against the adverse climatic conditions. The main constraint of the tropical

environment is the high temperature coupled with high and low humidity. It is a well established fact that the bivoltines are highly vulnerable to high temperature coupled with high and low humidity especially in the late instars. The hot climatic conditions of tropics prevailing particularly in summer are contributing to the poor performance of the bivoltine breeds and the most important aspect is that many quantitative characters such as viability and cocoon traits decline sharply when temperature is high. The silkworm breeds developed for tropical conditions in India have to adapt to both seasonal and local conditions for stable cocoon production under the high temperature associated biotic and abiotic conditions. 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. Since, the rearing of bivoltines in summer months becomes very difficult, the concept of bivoltine throughout the year to produce quality silk becomes jeopardized. In India, the adverse climatic conditions during summer is not the same throughout and some location having high temperature coupled with high humidity and in some high temperature with low humidity besides, poor leaf quality at times. Summer breeds are having significant importance in increasing cocoon production through rearing bivoltine hybrids round the year in tropical areas. The advantages of summer hybrids are high pupation rate, adaptabilities to high temperature coupled with high and low humidity and inferior food quality during the rearing. Stable cocoon crop under the bad conditions of high temperature with low quality mulberry leaves are difficult, but summer breeds/hybrids should have the potentiality for increasing production under such un-favourable weather 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 bivoltine breeds which can withstand the adverse climatic conditions of the tropics.

b) Expected outcome

The successful completion of the project is expected to come out with the development of bivoltine breeds with genetic plasticity to buffer against the adverse climatic conditions.

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 during the period, which is low productive. Keeping the prevalence of variable climatic condition in mind and realizing the importance of season specific hybrids as well as advantage of rearing of F1 hybrids during different commercial season, bivoltine breeds will be developed and their hybrids will be reared in three commercial seasons with adverse climate for two years. From these, selection of season specific better performing breeds will be made.

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 (April to September). It has been observed that bivoltine P₁ rearing to prepare multi x bi hybrid dfls for three commercial crop (June-July, August-September and November-December) is not successful as the P₁ bivoltine rearing to prepare multi x bi layings for aforesaid commercial seasons fall under unfavourable season [high temperature (>35⁰ C) and high humidity (>85-99 %)] which are not congenial for bivoltine silkworm rearing. Therefore, farmers are forced to restrict their rearing only with

Nistari, the indigenous multivoltine strain having horizontal tolerant potentiality both at P₁ and in commercial level during the adverse month. Now a day's multivoltine hybrid of Nistari is being widely reared at commercial level in West Bengal during adverse seasons though the production.

15.4 Objective

To Develop of bivoltine breeds with genetic plasticity to buffer against the adverse climatic conditions of East, North East and UP

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

16.1 International Status

In Japan seasonal studies have been carried out in mulberry silkworm. The different breeds have expressed that differently during different climatic conditions (Watanabe, 1928; Ueda *et al.*, 1969). In China also several bivoltine hybrids have been identified for different seasons. He *et al.* (1991) have developed the hybrid "Xuhua and Qiuxing" for summer and autumn rearing. Shao *et al.*(1990) have developed a bivoltine hybrid "Fangshan × Xing.Ming" for rearing during summer seasons. In Japan seasonal studies have been carried out both in non-mulberry and mulberry silkworm. Significant research was carried out and screened season specific hybrids *viz.*, Jamsui 106 x J108, J119 X J120, Kyuntri x Yeunil.

China also raised many productive hybrids for rearing during different seasons. Hybrid "Feng I x 54a" and "Xuhua and Qiuxing for summer and autumn rearing raised by He *et al.*, 1989, 1991. Shao *et al.*(1987, 1990) raised a hybrid Lantin x Baiyun and a bivoltine hybrid "Fangshan × Xing.Ming" for rearing during summer seasons. Xiafang × Qiubai,, (Su3 · Qiu3) × (Su4·Su12) and Huanghe × Zhaoxia showed better performance in summer season. Other new hybrids such as Quingsong x Haoyue, Su-5 x Su-6, Chunlei x Zhenzhu, Furong x Xianghui, (Su-3) (Qiu-3) x Feng1 x 54 A. Zhongqiu x Jinling, Xuhua x Quixing are exploited for summer and autumn seasons (Datta and Nagaraj,1987). Kato *et al.* (1989) reported that, resistant to high temperature is a heritable character and it may be possible to develop silkworm breeds tolerant to high temperature. Penkov and Long (1987) made breeding and genetic studies of some silkworm (*Bombyx mori* L) breeds reared at high temperature and humidity and analyzed the inheritance of quantitative characters under high temperature condition.

Huang *et al.* (1979) and He and Oshiki (1984) suggested that survival rate of silkworm as a main criterion for evaluating thermo-tolerance. Tazima and Ohnuma

(1995) while synthesizing high temperature resistant silkworm races confirmed the genetic nature of thermo tolerance by selection based on pupation rate of silkworm reared under high temperature conditions in 5th instar.

Kato *et al.* 1989 subjected silkworm larvae to 25, 32 and 36 °C for early three and last three days of 5th instar. Sensitivity to high temperature was found more pronounced at 36 °C of last three days. Shirota (1992) attempted to develop temperature resistant breed from the Japanese strain “NK” by selecting healthy silkworm based on pupation rate reared under high temperatures suggested by Kato *et al.* (1989) and conf that high temperature resistant character was dominant.

Shao *et al.*(1987) developed the silkworm hybrids “Xinhang” and “Keming” for summer rearing in China by crossing polyvoltine race with productive bivoltine race and subjecting for temperature treatment of 29-32 °C and humidity of 85%.

Burdon (1987) opined that heat stress to animal cells is the vigorous but transient activation of a small number of specific genes, previously either silent, or active at low levels. New mRNAs are actively transcribed from these genes and are translated into proteins, known collectively as the heat shock proteins. Gene sequence data reveal specific nucleotide sequences upstream of the transcription start sites that are essential for induction. These are known as ‘heat shock elements’ and are present in the region to which activated ‘heat shock transcription factors’ to facilitate hsp gene transcription. The limits of tolerance are not fixed. Indeed it has been known for some time that exposure to a near lethal temperature often leads to a degree of adaptation so that a previously lethal temperature is tolerated. So, determination of lethal temperature is important for silkworm to find out thermo-tolerant capacity.

16.2 National Status: Although, there is scope for summer and autumn rearing, no adequate efforts have been made to identify season and region specific hybrids suitable to specific region. Since the climatic condition of North East is hot and humid particularly during summer (June to August) having 28-38°C and 90-98% relative humidity together with rainfall that sometimes cause the failure of commercial cocoon crops during the period, which makes it different from rest of the country and so the existing hybrids are unable to satisfy the demands of the local farmers. The proposed work is the first attempt at the CSRTI, Berhampore in the identification of promising bivoltine breeds suited to different agro-climatic conditions

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. The

former falls between October to March, when the climatic conditions are congenial for silkworm rearing. Autumn (Nov) and Spring (Feb) crops comes during this period. April (Baisakhi), commercial crop is also considered as partially congenial for silkworm rearing in terms of prevalence of low humidity (Das *et al* 2005). On the other hand, the unfavourable period starts from May to September are not conducive for silkworm rearing, since temperature and humidity are high. June-July (Shravani) and Aug-Sep (Badhuri & Aswina) crops are conducted during this period. Because of prevalence of high temperature and humidity as well as rainfall, most of the rearers rear indigenous breed, Nistari during the period, which is low productive. But multi x bi hybrid can be successfully reared during autumn and spring seasons of the plains, which could increase the silk production (Sengupta, 1987). Because F1 are superior to parental strains in terms of higher tolerance to disease, higher adaptability to unfavourable environmental situation and produce uniform and stable crops due to hybrid vigour. But the major problem is the rearing of parent silkworm during seed crop, because most of the seed crop seasons fall during unfavourable season, when temperature as well as humidity remains high. Conducting seed crop for Autumn (Agrahayani) commercial crop is very much difficult, because of prevalence of high temperature & high humidity during the period (Sep-Oct). The unsuccessful rearing of bivoltine parent rearing leads to unsuccessful production of multi x bi eggs.

The Central Sericulture Research and Training Institute, Berhampore identified several productive silkworm hybrids according to requirement of the region. Two multi x multi hybrids viz., M12(W) x M6M81, M12(W) x M6DP© and two three way cross M12(W) x (SK6 x SK7), M6DP© x (SK6 x SK7) were identified utilizing the improved multivoltine breeds *Viz.*, M12 (W), M6M81 and M6DP©. Finally, few season specific hybrids viz., M12(W) x M6M81 for unfavourable season, M12(W) x KPG-B for spring and M6DP© x (SK6 x SK7) for autumn are identified for West Bengal climatic conditions through Provincial Race Authorization programme. The congenic multivoltine lines M.Con1 and M.Con4 along with two congenic bivoltine lines B.Con1 and B.Con4 (Chattopadhyay *et al.*, 2001) were selected in the Race Authorization Test – Phase VIII.

Quite a good number of multivoltine × bivoltine hybrids and bivoltine hybrids have been developed by research institute of Central Silk Board and have been authorized for commercial exploitation in different regions in India. Seasonal studies made both in mulberry and non-mulberry silkworm revealed that different hybrid expressed differently when tested under varied climatic conditions (Krishnaswami and

Narasimhana, 1974). At CSR&TI, Mysore bivoltine hybrids such as CSR18 × CSR19, CSR46 and CSR47 and CSR50 × CSR51 were developed for rearing during summer seasons (Suresh Kumar *et al.*, 2002, Suresh Kumar *et al.*, 2006 ; Dandin *et al.* 2006). Some promising bivoltine hybrids like Dun 6 × Dun 21, Dun 6 × Dun 22, ATR16 × ATR29, and RSJ3 × RSJ1, RSJ14 × RSJ11 were developed by RSRS, Dehradun and RSRS Jammu respectively and they performed well in field (Khan, 2006). KSSRDI, Bangalore has developed two bivoltine hybrids KSO1 × NP2 and KSO1 × SP2 suitable for rearing during summer season (Krishna Rao , 1994). Further, one high temperature tolerant bivoltine hybrid APSHTO5 × APSHTP2 developed by Andhra Pradesh State Sericulture Research and Development Institute (APSSRDI) was recommended for commercial utilization in Andhra Pradesh during summer season (Raju, 2010 and Lakshmi *et al.*, 2010). HTO5 × HTP2 a thermo-tolerant breed was developed by APSSRDI for summer rearing (Raju *et al.* 2010). Thermo-tolerant hybrids, Dun 6 × Dun 21, Dun 6 × Dun 22, ATR 16 × ATR 29 and RSJ 3 × RSJ 1, RSJ 14 × RSJ 11 were developed by RSRS Dehradun and RSRS Jammu and they are performing well in the field. Begum *et al.* (1999) evolved bivoltine silkworm hybrids *viz.* A 3 × 935 E (HSP1) and A3 × 961 B (HSP2) suitable for tropical climate with higher survival and better cocoon character.

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

Now a day's multivoltine hybrid is being widely reared at commercial level in West Bengal during adverse seasons. To solve this problem, development of temperature tolerant region and season specific bivoltine hybrids is highly required at present situation.

It is a challenge to overcome the problem by raising a sustainable bivoltine breed with genetic plasticity to buffer against the adverse seasons (June, August and September) in West Bengal. Such breeds are urgently required to increase the P₁ bivoltine cocoon production for the production of multivoltine hybrids to increase the productivity as well as quality of silk.

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

The successful completion of the project will lead to the development of robust bivoltine breeds/hybrids suitable to the West Bengal Conditions and the bivoltine pure breeds can be reared in adverse seasons and can be effectively utilized for the production of multivoltine × bivoltine hybrids throughout the year without any difficulty.

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

Name of the Scientists	Designation	Experience
Dr.N.Suresh Kumar	Scientist-D	More than 22 years of experience in silkworm breeding
Dr.A.K.Saha	Scientist-D	More than 25 years of experience in rearing technology and silkworm breeding
Mr. N.B.Kar	Scientist-D	More than 20 years of experience in reeling
Dr.S..Sreekumar	Scientist-D	More than 22 years of experience in Molecular biology
Dr.Stadal Chakraborty	Scientist-C	Adequate experience in Disease screening techniques
Dr.Ganashyam Singh	Scientist-D	Adequate knowledge in silkworm rearing
Dr.Debaraj	Scientist-D	More than 25 years experience in silkworm breeding & silkworm rearing
Dr. N.R.Rao	Scientist-C	Adequate knowledge in silkworm rearing
Mrs Chandana Maji	Scientist-D	Adequate knowledge in silkworm rearing

16.6 List of Five Experts in India in Proposed Subject Area:

Sl. No.	Name	Designation	Address
1	Dr.R.K.Datta	Director (Rtd)	Silver Oak, Srirampura II stage, Mysore
2	Dr.H.K.Basavaraja	Scientist-E(Rtd)	APPSSRDI, Hindupur
3	Dr.P.J.Raju	Director	APPSSRDI, Hindupur
4	Dr. K.C.Narayanaswamy	Professor	UAS, Bangalore
5	Dr.G.Subramanya	Professor	University of Mysore, Mysore

17. Work Plan:

17.1 Methodology:

1. Collection of Breeding resource material

The following **38** promising robust bivoltine breeds from all the breeding centres in India will be collected

Sl.No.	Breeds	Sl.No.	Breeds	Sl.No.	Breeds	Sl.No.	Breeds
CSRTI, Berhampore		CSRTI, Mysore		RSRS Jammu		RSRS Dehradun	
1	BHR2	1	CSR18	1	RSJ1	1	Dun6
2	BHR3	2	CSR19	2	RSJ3	2	Dun21
3	SK6	3	CSR46	3	RSJ11	3	Dun22
4	SK7	4	CSR47	4	RSJ14	4	ATR16
5	B-Con.1	5	CSR50	KSSRDI, Bangalore		5	ATR29
6	B-Con 4	6	CSR51	1	KSO1	APSSRDI, Hindupur	
7	SK4C	7	CSR52	2	NP2	1	APSHTO5
8	D6PN	8	CSR53	3	SP2	2	APSHTP2
9	SK4	9	Gen3			3	APS5
10	SK3	10	Gen2			4	APS4
						5	APS12
						6	APS45

2. Initiation of cross

Make all possible foundation crosses of the collected breeds

3. Initial evaluation and selection

Send all the crosses to different RSRSs for its rearing and selection at the respective places . Continue those lines in the respective places. Bring those lines back to the institute and continue in Institute also.

1. Screen for disease tolerance in those batches. Select the batches with more tolerance

4. Shuttling of lines

The lines from different places may be brought to the institute and lines from Institute to all the different places. Evaluate and undertake selection and continue the shuttling process at every alternate generation till the lines are fixed.

1. Screen for disease tolerance in those batches. Select the batches with more tolerance

5. Short listing of lines

Instead of continuing with all the lines promising lines may be short listed

1. Screen for disease tolerance in the lines. Select the lines with more tolerance

2. Estimate α - amylase and esterase in all the lines and select lines with high amylase and esterase

6. Hybrid evaluation

After fixation, hybrids have to be prepared involving the institute lines as well as the RSRS lines. Hybrid evaluation should be conducted simultaneously in the centres covering all the seasons of the year.

1. Screen for disease tolerance in the hybrids. Select the batches with more tolerance

7. Selection of hybrids

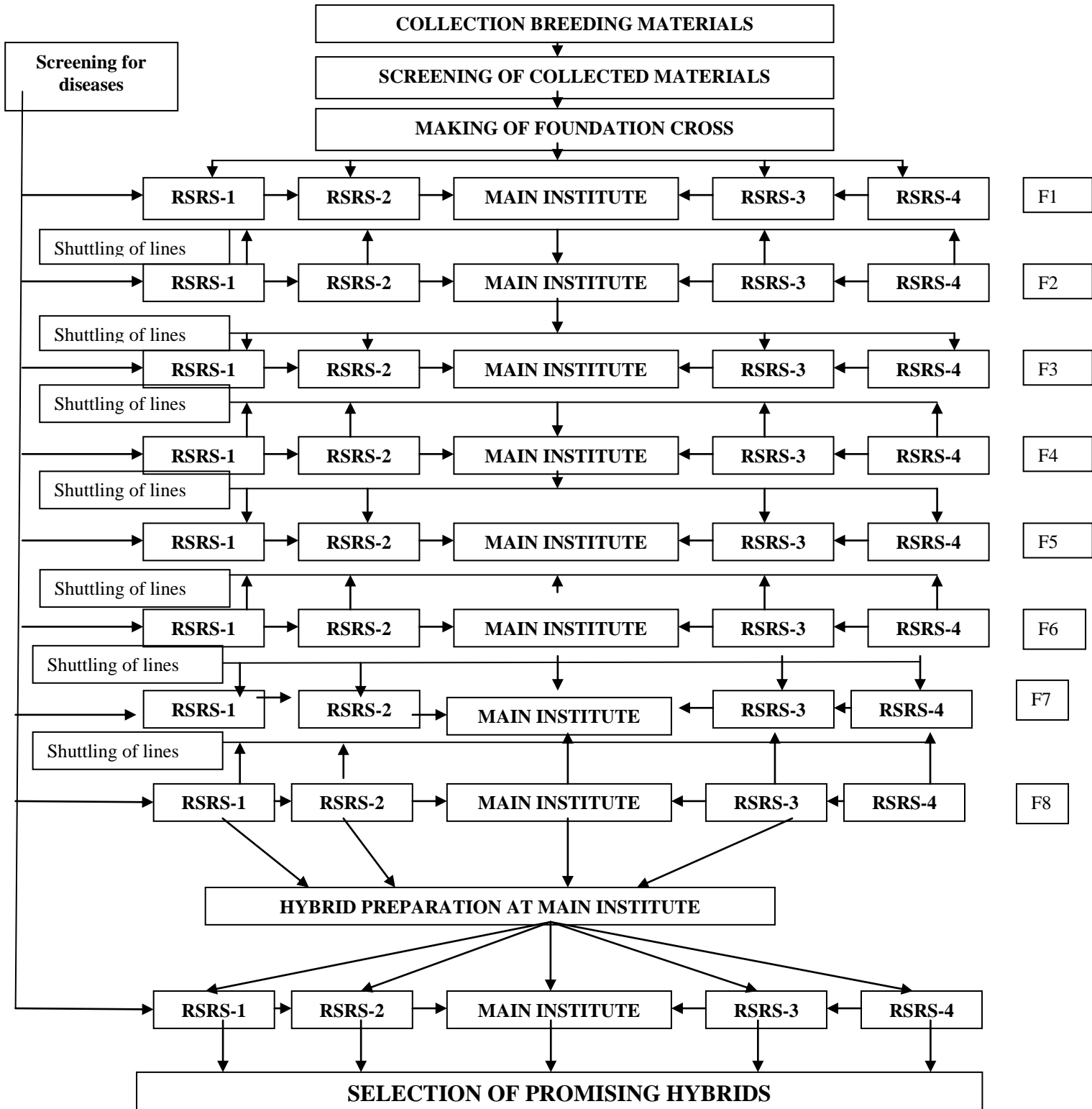
After evaluation, promising hybrids from respective centres may be selected.

1. Screen for disease tolerance in the hybrids. Select the batches with more tolerance

8. Testing of hybrids

Small quantity of layings may be tested with farmers in the respective centres for validation before commercialization

Flow chart of breeding methodology



17.2 Organization of Work Elements:

Name of Scientists	Designation	Time	Organization of work elements.
Dr. N. Suresh Kumar	Scientist-D	60%	Principal Investigator will carry out the Panning and execution of the project
Dr. A. K. Saha	Scientist-D	20%	Co-Investigator will assist in the execution of the project
Shri.N.B.Kar	Scientist-D	25%	Co-Investigator will carry out the assessment of post cocoon parameters
Dr.S.Sreekumar	Scientist-D	25%	Co-Investigator will carry out the Biochemical studies
Dr.Satadal Chakraborty	Scientist-C	25%	Co-Investigator will carry out the screening for diseases
Dr.Debaraj	Scientist-D	25%	Co-Investigator will carry conduct the rearing at RSRS and selection of breeding lines.
Dr. Ganashyam Singh	Scientist- D	25%	Co-Investigator will carry conduct the rearing at RSRS and selection of breeding lines
Dr. N.R. Rao	Scientist-C	25%	Co-Investigator will carry conduct the rearing at RSRS and selection of breeding lines
Mrs Chanadana Maji	Scientist-C	25%	Co-Investigator will carry conduct the rearing at RSRS and selection of breeding lines

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 developed new breeds will be submitted for race authorization and if authorized after large scale testing will be released to the field.

17.5 Time Schedule of activities giving milestones:

Sl. No.	Milestone/ Activity	Expected Date of		Expected Outcome / visible / Measurable Indicators
		Starting	Completion	
1.	Collection of Breeding resource material	August 2011	August 2011	
2.	Rearing , screening and selection of Breeding resource material	September 2011	August 2012	
3.	Foundation cross making	September 2012	October 2012	
4	Rearing of Foundation crosses at all the places	October 2012	September 2013	
5.	Shuttling of Foundation crosses	October 2013	November 2013	
6.	Short listing of lines	December 2013	May 2014	
7.	Selection of breeds	June 2014	June 2014	
8.	Hybrid preparation	July 2014	August2014	
9.	Hybrid evaluation	August2014	July 2016	
10	Selection of hybrids	August 2016	September 2016	

11	Testing of hybrids	September 2016	December 2016	
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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			100%

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]

A) Non-Recurring (e.g.equipments, accessories, etc.)

C. BUDGET ESTIMATES: SUMMARY

(In lakh Rupees)

ITEM BUDGET						
BUDGET						
	1 ST Year	2 nd Year	3 rd Year	4 th Year	5 th Year	Total
A. Recurring						
1. Remuneration/salaries	-	-	-	-	-	-
2. Consumables	1.00	2.00	2.00	1.00	1.00	7.00
3. Travel	0.40	0.40	0.40	0.40	0.40	2.00
4. Other costs	0.20	0.20	0.20	0.20	0.20	1.00
B. Non-recurring Permanent equipment		-	-	-		
Grand Total (A+B)	1.60	2.60	2.60	1.60	2.60	10.00

DETAIL BUDGET FOR TRAVEL

(In lakhs)

Item Budget	1 ST Year	2 nd Year	3 rd Year	4 th Year	5 ^h Year	Total
Travel 1. Local	0.10	0.10	0.10	0.10	0.10	0.50
2. Out Station	0.30	0.30	0.30	0.30	0.30	1.50
Total	0.40	0.40	0.40	0.40	0.40	2.00

DETAIL BUDGET FOR OTHER COSTS

(In lakhs)

Item Budget	1 ST Year	2 nd Year	3 rd Year	4 th Year	5 th Year	Total
a) Consumables	1.00	2.00	2.00	1.00	1.00	7.00

b) Others	0.20	0.20	0.20	0.20	0.20	1.00
Total	1.20	2.20	2.20	1.20	1.20	8.00

PART-V: EXISTING FACILITIES

19. Available equipment and accessories to be utilized for the project :

Essential equipments , accessories and rearing appliances to carry out the project is available in the laboratory

PART-VI : REFERENCES

- Begum, A N, Ahsan, M.M and Datta, R.K.(1999). Breeding of two bivoltine silkworm, *Bombyx mori* L for higher survival and moderate silk productivity. *Korean J. Seric. Sci.*, 41: 94 – 101.
- Chattopadhyay, G.K.; Sengupta, A. K.; Verma, A. K.; Sen, S. K. and Saratchandra, B. (2001) Esterase isozyme polymorphism, Specific and nonspecific esterase, syngenic line development and natural occurrence of a thermostable esterase in tropical silkworm *Bombyx mori* L., *Insect Biochem. Mol. Biol.* (USA), 31: 1191-1199.
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- Shirota, T. (1992) Selection of healthy silkworm strain through high temperature rearing of fifth instar larvae. *Rep. Silk. Sci. Res. Inst.* 40: 33-40.
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- Suresh Kumar, N., Basavaraja, H.K., Joge, P.G., Mal Reddy, N., Kalpana, G.V., Dandin, S.B., 2006, Development of a new robust bivoltine hybrid (CSR46 x CSR47) of *Bombyx mori* L. for the tropics. *Indian J.Seric.*,45 : 21-29.
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PART VII: BIODATA OF PROJECT COORDINATOR /PRINCIPAL INVESTIGATOR / CO-INVESTIGATOR(S)

1. Full Name (in Block letters): DR.N.SURESH KUMAR
 2. Designation: Scientist-C
 3. Department/ Institute/ University: Silkworm Breeding and Genetics, CSRTI, Berhampore
 4. Address for Communication: Silkworm Breeding and Genetics, CSRTI, Berhampore-742101

5. Date of birth: 01-06-1956
 6. Sex: Male

7. Education (Post Graduation onwards & Professional Career):

Name of the University	Degree Passed	Year of Passing	Subjects taken with Specialization	Class/ Dvn.
University of Kerala, Trivandrum	BSc.	1978	Zoology (Main) Botany, Chemistry (Subsidiaries)	I Class
University of Kerala, Trivandrum	MSc.	1980	Zoology	II Class
University of Madras, Chennai	Ph.D	1986	Zoology (Entomology)	

Title: “ Bio-ecological studies on some insects predatory on thrips (Thysanoptera : Insecta)”

Guide : Prof. T.N.Ananthakrishnan, Formerly Director, Zoological Survey of India

7. Awards:
 [Not required for in-house personnel]

Year	Award	Agency	Purpose	Nature

8. Positions Held / Research Experience in various institutions:
 [Not required for in-house personnel]

Employer	Designation of the post held	Date of Joining	Date of leaving

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

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

11. Publications (Numbers only):

- Books: 03
 Research Papers, Reports: 80
 General articles: 20

List of important publications whose contents can be used in the proposed area of work:

10 important publications

1. **Suresh Kumar, N**, Kishor Kumar, C.M, Basavaraja,H.K, Mal Reddy, N, Ramesh Babu,M and Datta, R.K (1999) Comparative performance of robust and productive bivoltine hybrids of *Bombyx mori* L under high temperature conditions. *Sericologia*. **39**(4) : 567-571
2. **Suresh Kumar, N**; Yamamoto, T; Basavaraja, H.K and Datta, R.K. (2001)Studies on the effect of high temperature on F1 hybrids between polyvoltine and bivoltine silkworm races of *Bombyx mori* L. *Int. J. Indust.Entomol.* **2** (2) : 123-127
3. **Suresh Kumar, N**, Basavaraja, H.K, Kalpana, G.V., Mal Reddy, N, Jayaswal, K.P., Thippeswamy, T., and Datta, R.K. (2002) Cocoon filament size deviation in bivoltine silkworm, *Bombyx mori* L. *Indian J.Seric.*, **41**(1) : 42-48.
4. **Suresh Kumar, N** , Basavaraja, H.K, Kishor Kumar, C.M., Mal Reddy, N., and Datta, R.K. (2002) On the breeding of “ CSR18 x CSR19”- A robust bivoltine hybrid of silkworm, *Bombyx mori* L. for the tropics . *Int.J.Indust.Entomol.* **5**(2) : 155-162.
5. **Suresh Kumar, N.**; Basavaraja, H.K.; Mal Reddy, N. and Dandin, S.B. (2003) Effect of high temperature and high humidity on the quantitative traits of parents, foundation crosses, single and double hybrids of bivoltine silkworm, *Bombyx mori* L. *Int. J.Indust. Entomol.*, **6**(2) : 197-202.
6. **Suresh Kumar, N.**, Basavaraja, H.K., Kalpana, G.V. Mal Reddy, N., and Dandin, S.B. (2003) Effect of high temperature and high humidity on the cocoon shape and size of parents, foundation crosses, single and double hybrids of bivoltine silkworm, *Bombyx mori* L. *Indian J. Seric.***42** (1) : 35-40.
7. **Suresh Kumar, N.**, Basavaraja, H.K., Kalpana, G.V. Mal Reddy, N.,, Kariappa, B.K and Dandin, S.B. (2003). Evaluation of bivoltine breeds and hybrids as male component with Pure Mysore under different temperature and humidity conditions. *Indian J. Seric.***42** (1) : 41-45.
8. **Suresh Kumar, N.**, Basavaraja, H.K., Kalpana, G.V. Mal Reddy, N.,, Kariappa, B.K and Dandin, S.B. (2003). Evaluation of bivoltine breeds and hybrids as male component with Pure Mysore under different temperature and humidity conditions. *Indian J. Seric.***42** (1) : 41-45.
9. **Suresh Kumar, N.**, Basavaraja, H.K. and S.B. Dandin (2004). Breeding of robust silkworm, *Bombyx mori* L. for temperature tolerance – A review. *Indian J. Seric.*, **43**(2) : 111-124.
10. **Suresh Kumar, N.**; Basavaraja,H.K.; Joge, P.G.; Mal Reddy, N.; Kalpana, G.V. and Dandin, S.B.(2006) Development of a new robust bivoltine hybrid (CSR46 x CSR47) of *Bombyx mori* L. for the tropics . *Indian J.Seric.*,**45**(1) : 21-29.

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

Sl. No	Title of the project	Funding agency	Duration From To	No. of Scientists/ Associates working under the project	Total approved cost of the project
1	Development of bivoltine silkworm breeds/hybrids suitable to adverse climatic conditions of Eastern India	Central Silk Board	2010 to 2015	Nine	

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

1. The hybrids viz., **CSR2 x CSR4 and CSR2 x CSR5** (shell ratio >23.0% and raw silk % -19-20 *and 2A to 3A grade*) were authorized (1997) and are being popularised on a large scale at farmers level during favourable months (Sept-Feb).
2. Three productive hybrids **CSR12 x CSR6, CSR3 x CSR6 and CSR16 x CSR17** (raw silk % 18- 20 and 2A to 3A grade) were authorized during 1999 for commercial exploitation during favourable months. .
3. Two double hybrids, (**CSR6 x CSR26**) X (**CSR2 x CSR27**) for easy rearing of foundation crosses at P1 level with high egg recovery (10 –15 % more) are developed. The hybrid, (**CSR6 x CSR26**) X (**CSR2 x CSR27**) was submitted for Race Authorization test.
4. One robust hybrid **CSR18 x CSR19** (survival > 80 % at 36 ± 1 °C) has been authorized during 1999 for rearing throughout the year and is being popularised on a large scale at farmers level.
5. One more robust hybrid, **CSR46 x CSR47** (survival > 80 % at 36 ± 1 °C) with better productivity traits than CSR18 x CSR19 has been developed.
6. The productive bivoltine hybrid, **CSR48 x CSR5** with raw silk (20.6%), longer filament length (> 1300 m), thin filament size (2.45 d), relatively tolerant to high temperature (77% survival at 36 ±1°C and 85±5% RH) and low boil-off loss (23.8%) has been
7. The breed **CSR8(SL)** with sex-limited for cocoon colour for easy sex separation based on cocoon colour at grainages (yellow cocoons females and white cocoons males) has been developed.
8. To avoid the misuse of CSR2 normal breed as male component with PM, the new breed “**CSR2 (SL)**” with sex-limited for cocoon colour for easy sex separation based on cocoon colour at grainages (yellow cocoons females and white cocoons males) has been developed.
9. One more robust hybrid, **CSR50 x CSR51** tolerant to high temperature and tolerant to silkworm diseases have been developed

PART VII: BIODATA OF PROJECT COORDINATOR /PRINCIPAL INVESTIGATOR / CO-INVESTIGATOR(S)

1. Full Name (in Block letters) : DR. ATUL KUMAR SAHA
 2. Designation : Scientist – D
 3. Department/ Institute/ University : Sericulture Division, CSR&TI Berhampore
 3. Address for Communication : Central Sericultural Research & Training Institute, Berhampore,
 Dist. Murshidabad, West Bengal-742101
 4. Date of birth : 27.08.1957
 5. Sex: :Male

6. Education (Post Graduation onwards & Professional Career):

Name of the University	Degree Passed	Year of Passing	Subjects taken with Specialization	Class/ Div.
Burdwan University	M.Sc.	1980	Zoology (Entomology)	1 st class
Burdwan University	Ph.D	2003	Reproductive Physiology of <i>Bombyx mori</i>	NA

7. Awards:

[Not required for in-house personnel]

Year	Award	Agency	Purpose	Nature

8. Positions Held / Research Experience in various institutions:

[Not required for in-house personnel]

Employer	Designation of the post held	Date of Joining	Date of leaving

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

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

11. Publications (Numbers only): 39

Books: -

Research Papers, Reports: 29

General articles: 10

List of important publications whose contents can be used in the proposed area of work:: Nil

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

Sl.No.	Title of the project	Funding agency	Duration From To	No. of Scientists/ Associates working under the project	Total approved cost of the project
1.	Maximization of cocoon production and quality through demonstration of cost efficient and improved technologies suitable for West Bengal	DST	2010 to 2013	04	33.54 lakh
2.	Development, validation and				

	utilization of SCAR markers for powdery mildew (<i>Phyllactinia corylea</i>) resistance in mulberry	DBT	2009 to 2012	03	46.21 lakh
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13. Highlights of outcome / progress of the project(s) handled during the past 10 years, their outcome and utilisation (in 200 words).

The outcome from the project APS 3238 led to an identification of a chemical which induced trimoulting on freshly moulted 4th instar silkworm larvae. Since trimoulting led to shortening of the larval period by 4-5 days, the technology evolved could be helpful in increasing the production of bivoltine cocoons during P₁ September crop(adverse season) and its utilization in producing multi x bi dfls for subsequent commercial crop.

The salient findings from the project APR 3250 led to a development of a season specific rearing package for eastern and north eastern regions, giving higher cocoon yield over existing practice.

The outcome of the project PPA 3366 was in the form of a package of practices developed for establishment of chawki garden to support young age silkworm rearing for qualitative and quantitative increase in cocoon production.

PART VII: BIODATA OF PROJECT COORDINATOR /PRINCIPAL INVESTIGATOR / CO-INVESTIGATOR(S)

1. Full Name (in Block letters): DR.S. SREEKUMAR
 2. Designation: Scientist-D
 3. Department/ Institute/ University: Silkworm Breeding and Genetics, CSRTI, Berhampore
 4. Address for Communication: Silkworm Breeding and Genetics, CSRTI, Berhampore-742101

5. Date of birth: 21.05.1956
 6. Sex: Male

7. Education (Post Graduation onwards & Professional Career):

Name of the University	Degree Passed	Year of Passing	Subjects taken with Specialization	Class/ Dvn.
University of Kerala, Trivandrum	BSc.	1976	Zoology (Main) Botany, Chemistry (Subsidiaries)	I Class
University of Kerala, Trivandrum	MSc.	1978	Zoology	II Class

Calicut University, Calicut Ph.D 1986

Title: "Reproductive Physiology of the Freshwater Shrimp, *Macrobrachium idella*"

Guide : Prof. Dr. K.G. Adiyodi,,

Formerly Vice Chancellor, Cochin University of Science & Technology

7. Awards:
 [Not required for in-house personnel]

Year	Award	Agency	Purpose	Nature

8. Positions Held / Research Experience in various institutions:
 [Not required for in-house personnel]

Employer	Designation of the post held	Date of Joining	Date of leaving

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

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

11. Publications (Numbers only):

- Books: Nil
 Research Papers, Reports: 55
 General articles: 10

List of important publications whose contents can be used in the proposed area of work:

10 important publications

Sreekumar, S., Ashwath, S.K., Nirmal Kumar, S. and Kamble, C.K. 2008. Molecular markers as selection tools for gene tagged breeding in the mulberry silkworm, *Bombyx mori*. *Proc. Mulb.Silkworm Breeders' Meet.* CSRTI, Mysore. 10.6.2008. pp: 36-40.

Sreekumar, S., Ashwath, S.K., Monika,S., chitra,s., Rekha, M. and Kamble, C.K.2008. Analysis of RAPD DNA profiles between normal and sex-limited breeds of mulberry silkworm, *Bombyx mori*. *Entomon.* 33(3): 159-170.

Sreekumar, S., Ashwath, S.K., Chitra , S., Basavaraja, H.K., Dandin, S.B., Subarna, P and Kamble, C.K. 2008. DNA profiling of a few indigenous and evolved silkworm breeds of india using microsatellite markers. *Ind. J. Seric.* 47(2): 204-213.

Sreekumar, S., Ashwath, S.K., Krishnakumar, A., Slathia, M., Chandrashekhar, S. and Qadri, S.M.H. 2009. Sex-chromosomes of the mulberry silkworm, *Bombyx mori* – a review. *Green Farming.* 2(4): 243-246.

Chitra, S., **Sreekumar, S.**, Suresh Kumar, N., Ashwath, S.K., Dandin, S.B. And Kamble, C.K. 2009. Studies on the haemolymph protein profiles of the silkworm *Bombyx mori* under induced thermal stress. *Uttar Pradesh J. Zool.* 29(1): 97-103.

Sreekumar, S., Ashwath, S.K. Soumyashree, Monika, S., Aswathi, K. and Qadri, S.M.H. 2009. Assessment of genetic diversity among few indigenous and evolved mulberry silkworm breeds (*Bombyx mori*) by Random Amplified Polymorphic DNA (RAPD) markers. *J. Curr.Sci.* 14(1): 355-362.

Ravindra Singh, **Sreekumar, S.**, Gangopadhyay, D., Nirupama, R. and Ashwath S.K. 2009. Assessment of homozygosity using RAPD markers in silkworm breeds developed through application of androgenesis and parthenogenesis. *Sericologia.* 49(3): 261-266.

Ashwath, S.K., **S. Sreekumar**, J.T. Toms , S.B. Dandin and C.K. Kamble. (2010). Identification of RAPD markers linked to digestive amylase genes using Near Isogenic Lines of mulberry silkworm, *Bombyx mori*. *J. Insect Sc.* 84: 1-10.

Sreekumar, S., Ashwath, S.K., Monika, S., Nirmal Kumar, S. and Qadri,S.M.H. 2011. Detection of a single nucleotide polymorphism (SNP) DNA marker linked to cocoon traits in the mulberry silkworm , *Bombyx mori* (Lepidoptera: Bombycidae). *European J. Entomol.* 108 : 347-354.

Sreekumar, S, Nagayasu, K. Kadono-okkuda and Hara, W. (2010) . Identification of 2nd chromosome region translocated onto the w chromosome by RFLP with EST c-DNA clones in Gensei-Kouken strains of the mulberry silkworm, *Bombyx mori* l. *Genetics and Molecular biology*, 33 (1), 27-35

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

Sl. No	Title of the project	Funding agency	Duration From To	No. of Scientists/ Associates working under the project	Total approved cost of the project

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

- ❖ Molecular Ids for 26 silkworm breeds established with an objective for the protection of breeder's right using Microsatellite markers
- ❖ A PCR product of 500 bp containing the larval marking gene & 300 bp for “Y” gene of the 2nd autosomal fragment translocated onto the w chromosome responsible for the development of sex limited breeds identified.
- ❖ RAPD marker discriminating diapausing and non-diapausing breeds identified
- ❖ DNA marker linked to amylase gene was cloned, sequenced and found to be located on the 8th chromosome
- ❖ Bulked segregant analysis was taken up using EST SNP markers and identified two SNP markers of 21st linkage group closely linked to cocoon weight and shell weight.
- ❖ 6. Planned and formulated Indo-Japanese joint project which was sanctioned by DST-JSPS. Visited NIAS, Tsukuba, Japan during 20th to 31st January 2010 and trained in advanced molecular biology protocols.
- ❖ Genomic DNA of about 60 Indian breeds, 10 Japanese breeds, 6 Brazilian breeds extracted and are being used for various experiments.
- ❖ 240 Est-cDNA clones pertaining to 28 LG groups are prepared and are used for analysis
- ❖ SNP markers pertaining to 4 and 5 banded cathodic amylase genes of multivoltine breeds were identified, which were introgressed into the “Null” type of amylase present in the gut juice of bivoltine breeds
- ❖ An SNP marker which can discriminate breeds having high amylase activity and null type of activity was found out which is located in the 8th chromosome at the proximal end
- ❖ A search for the origin of maternal chromosome (W) in Indian breeds were initiated. Study indicated that in contrast to the Japanese breeds which have a common maternal ancestor (Japanese W-EVE), the Indian breeds have different maternal chromosome.
- ❖ OPA 01 primer has been identified as a putative DNA sequence which can recognise the introgressed amylase genes onto the genetic background of bivoltine breeds.
- ❖ DNA sequences linked to tolerance against viral infection (BmNPV) has been identified

PART-VII: BIODATA OF PROJECT COORDINATOR / PRINCIPAL INVESTIGATOR/ CO-INVESTIGATOR(S)

1. Full Name (in Block Letters) : DR.N.RAJESWARA RAO
2. Designation : Scientist-C
3. Department /Institute /University : RSRS, Koraput
4. Address for communication : RSRS, Central Silk Board,
Landiguda, Koraput- 764020
5. Date of birth : 1956
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.
Maratwada University	MSc	1984	Endocrinology	I Divison
Andhra University	Ph.D	1993	Studies on Pelecypods of Vishakhapatnam coast with special reference to the Wedge clam <i>Donax cuneatus</i> Linneases	

8 Awards: [Not required for house personnel] :

Year	Award	Agency	Purpose	Nature

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)

Books: Nil
 Research Papers , Reports : 06
 General articles : 04

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

Sl.No.	Title of the Project	Fund ing agen cy	Duration From To	No of Scientists /Associates working under the project	Total approved cost of the project (Rs.in lakh)
1	MOE 3396	CSB	2010-2013		
2	PRE-3345	CSB	2010-15		

PART VII: BIODATA OF PROJECT COORDINATOR /PRINCIPAL INVESTIGATOR / CO-INVESTIGATOR(S)

1. Full Name (in Block letters) : MR. N. B.KAR
2. Designation : Scientist-D
3. Department/ Institute/ University: CSR&TI, Berhampore
3. Address for Communication : Reeling Section, CSR&TI, Berhampore, Murshidabad, West Bengal-742101
4. Date of birth : 04.01.1959
5. Sex : Male
6. Education (Post Graduation onwards & Professional Career):

Name of the Univ	Class/ Dvn.	Degree	Year of passing	Subjects taken
Calcutta University	First	B. Sc. (Tech)	1980	Spinning, Weaving, Dyeing & Printing.
Calcutta University	First	M. Sc. Tech	1999	Spinning, Weaving, Fibre Science

7. Awards:
[Not required for in-house personnel]

Year	Award	Agency	Purpose	Nature
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8. Positions Held/ Research Experience in various institutions: Not required for in-house personnel

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

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

11. Publications (Numbers only):

Books:

Research Papers, Reports: 15

General articles:

List of important publications whose contents can be used in the proposed area of work:

1. A.K.Saha, T.Datta (Biswas),S.K.Das & N.B.Kar (2007) Antijuvenoid Action of Terpenoid midazole Compound on Larval-Pupal-Adult Development of Silkworm, *Bombyx mori* L. *Int. J. Indust. Entomol.* **14(2)** : 127 – 135.
2. T.Datta (Biswas), A.K.Saha, S.K.Das, N.B.Kar & A.Sarkar (2006). Appropriate Rearing technology for assuring better cocoon crop in Eastern India, *In the proceeding of the Workshop on Appropriate technologies for Mulberry sericulture in Eastern and North Eastern India*, **1** : 101 –105.

3. T.Datta (Biswas),A. K. Saha, S.K.Das & A.Sarkar (2007) A Comparative Study of Spinning of Silkworm in two types of Mountages. *Bull. Ind. Acad. Seri.*11(2) :39 – 42
4. T.Datta (Biswas) ,A. K. Saha, S.K.Das and N.B. Kar (2008) Plastic ollapsible Mountage, an alternate to Bamboo Spriral mountage in Eastern India. *Uttar Pradesh J. Zool.* 28 (3) : 319 - 328.
5. A.K.Saha, T.Datta (Biswas), S.K.Das, N.B.Kar and A. Sarkar (2005) Induction of trimoulting in bivoltine breeds of silkworm *Bombyx mori* L. and its contribution for producing multi x bi hybrid dfls during unfavourable climatic condition of Eastern India. *In the proceeding of the 20th Congress of International Seri. Com.* 1 : 219 – 223.

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

Sl. No.	Title of the project	Funding agency	Duration From To	No. of Scientists/ working under the project	Total cost of the project

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

Project APR 3250: Development of a season specific rearing package for eastern and north eastern regions, giving higher cocoon yield over existing practice.

Project PPA 3366 : Developed a package of practices for establishment of chawki garden to support young age silkworm rearing for qualitative and quantitative increase in coccon production.

Project APS 3238 : Identification of a chemical which induced trimoulting on freshly moulted 4th instar silkworm larvae. Since trimoulting led to shortening of the larval period by 4-5 days, the technology evolved could be helpful in increasing the production of bivoltine cocoons during P₁ September crop(adverse season) and its utilization in producing multi x bi dfls for subsequent commercial crop.

PART VII: BIODATA OF PROJECT COORDINATOR /PRINCIPAL INVESTIGATOR / CO-INVESTIGATOR(S)

1. Full Name (in Block letters): DR.SATADAL CHAKROBARTY
 2. Designation: Scientist-C
 3. Department/ Institute/ University: Silkworm Pathology Section, CSRTI, Berhampore
 4. Address for Communication: Silkworm Breeding and Genetics, CSRTI, Berhampore-742101
 5. Date of birth: 09.12.1964
 6. Sex: Male
 7. Education (Post Graduation onwards & Professional Career):

Sl No.	Institution Place	Degree Awarded	Year	Field of Study
1.	Visva Bharati University	M.Sc	1994	Zoology (Spl.paper Parasitology & Nematology)
2.	The University of Calcutta	Ph.D.	2006	Zoology Title: 'Studies on Pebrine disease of silkmoths in Assam'

7. Awards:

[Not required for in-house personnel]

Year	Award	Agency	Purpose	Nature

8. Positions Held / Research Experience in various institutions:

[Not required for in-house personnel]

Employer	Designation of the post held	Date of Joining	Date of leaving

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

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

11. Publications (Numbers only):

Publications (Numbers only) 13

Books : Nil Research Papers, Reports : Nil General articles : Nil

Patents : Nil Patent Pending Others (Conferences): Nil

List of important publications whose contents can be used in the proposed area of work:

Selected peer-reviewed publications (Ten best publications in chronological order)

- 1) Chakrabarti, S. and Manna, B. (2006) Three new species of *Nosema* from non-mulberry silkworms in Assam: light, scanning and transmission electron microscopy studies, *Journal of Parasitic Disease*, 30 (2): 125-133.
- 2) Chakrabarti, S. and Manna, B. (2009) Studies on ultrastructure and life cycle of *Nosema assamensis* (Protozoa: Microsporidia), a parasite of muga silkworm, *Antheraea assamensis* Ww. *Indian Journal of Sericulture*, 48(1): 60-67.
- 3) Chakrabarti, S. and Manna, B. (2008) Effect of Microsporidian infection on reproductive potentiality on Mulberry silkworm, *Bombyx mori* L. (Lepidoptera: Bombycidae) in different seasons, *International Journal of Industrial Entomology, Korea*, 17 (1): 157-163.
- 4) Chakrabarti, S. and Manna, B. (2008) Influence of temperature and relative humidity in infection of *Nosema bombycis* (Microsporidia: Nosematidae) and cross-infection of *N. mylitta* on growth and development of mulberry silkworm, *Bombyx mori*. *International Journal of Industrial Entomology, Korea*, 17 (2): 173-180.
- 5) Chakrabarti, S. and Manna, B. (2009) Studies on cross-infection of Microsporidian spores of non-mulberry silkworms to mulberry silkworm, *Bombyx mori* L. and its impact on economic parameters, *Indian Journal of Sericulture*, 48(2):162-168.
- 6) Chakrabarti, S. and Manna, B. (2009) Studies on infection and cross-infection of microsporidian spores of mulberry, tasar, eri and muga silkworm on economic parameters of silk to mulberry silkworm, *Bombyx mori* L. Current Trends in Parasitology (Edited by Veena Tandon, Arun K.Yadav, Bishnupada Roy, Panima Publishing Corporation, Bangalore Delhi) *Proceedings of National Congress of Parasitology, Shillong, India, Edited by V.Tandon, A.K.Yadav and B.roy, Nov.3-5, 2008, Paper 9 : 81-93.*
- 7) Chakrabarti, S. and Manna, B. (2008) Studies on cross-infection of Microsporidian spores of mulberry, eri and muga silkworms to tasar silkworm, *Antheraea mylitta* D. and its impact on economic parameters, *Indian Journal of Sericulture*. 47(1): 94 -100.
- 8) Chakrabarti, S. and Manna, B. (2008) Studies on cross-infection of Microsporidian spores of mulberry, eri and tasar silkworm to muga silkworm, *Antheraea assamensis* Ww. and a new approach for management of pebrine disease of in muga silkworm in Assam and West Bengal, India. *Zoological research in human welfare: Zoological Survey of India, Kolkata, 2008, Edited by Ramkrishna & Chatterjee: Paper 47: 447 – 460.*
- 9) Chakrabarty S., Mitra,P.,Hossain,Z., Saha, A.K.,Bajpai A.K. and Manna,B. (2010). Studies on immunological impact of some chemicals, botanicals, antibacterial proteins and live non-pathogenic bacteria in silkworm, *bombyx mori* L. against bacterial disease (Abstract) . 22nd Indian Congress of Parasitology to be held during Oct, 30 – Nov., 01, 2010 at University of Kalyani, Kalyani.
- 10) Chakrabarty S., Mitra, P.,Hossain,Z., Saha, A.K.,Bajpai A.K. and Manna,B. (2010). Microsporidiosis in mulberry silkworm, *bombyx mori* L.- a review (Abstract). National symposium on Recent advances in Sericulture Research held at Bangalore during 18th – 19th May,2010, p-32.

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

SI No.	Title of Project /Programme	Funding Agency	Amount	Date of sanction and duration
1	Study on the efficacy of newly developed bed disinfectant (Sericillin) in hot spot areas for the control of muscardine disease of silkworm, <i>Bombyx mori</i> L.	Central Silk Board	0.40 Lakhs	2010 1 year
2	Validation trial of technology for prevention against Gattine disease in silkworm <i>B. mori</i> L.	Central Silk Board	0.20 Lakhs	2010 2 year

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

- I am having doctoral degree in Zoology with specialization in Parasitology (Immunology) and have working experience in silkworm pathology for last 13 years. I have done Ph.D. on '*Studies on pebrine disease of silkworm in Assam*'. I was the Principle Investigator of a study entitled, '*Immunization of silkworm Bombyx mori L. against bacterial disease*' has just been concluded in March, 10. I have working experience in immunological methods and assays.
- Training on Molecular Biology at Seri-Biotech Research Laboratory, Kodathi, Bangalore from 15th – 24th Feb '10 on
 - Utilization of RAPD & ISSR markers for molecular Phylogenetic analysis
 - Extraction of cuticle protein HPLC purification & 2-D analysis of cuticle protein
 - SDS PAGE analysis of haemolymph protein
 - Basic principle of PCR, Cloning of PCR products, plasmid DNA isolation
 - Cloning of SSU-rRNA sequence
- Training on Molecular Biology at Seri-Biotech Research Laboratory, Kodathi, Bangalore from 20th – 22th May '10 on

Various molecular biology techniques

PART-VI: DECLARATION / CERTIFICATION

It is certified that

- 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.
- The same project has not been submitted to any other agencies for financial support.
- 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).
- Necessary provision for the project will be made in the Institute in anticipation of the sanction of the scheme.
- 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 intervene (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.

2. Signature of Executive Authority of
Institute with Seal
Date :

1. Signature of Project Co-ordinator
Date:

3. Signature of Principal Investigator
(Dr.N.Suresh Kumar)

4. Signature of Co-Investigator
(Dr.A.K.Saha)

5. Signature of Co-Investigator
(Dr.S.Sreekumar)

6. Signature of Co-Investigator
(Shri.N.B.Kar)

7. Signature of Co-Investigator
(Dr.Satadal Ckkraborty)

8. Signature of Co-Investigator
(Mrs.Chandana Maji)

9. Signature of Co-Investigator
(Dr.Debaraj)

10 Signature of Co-Investigator
(Dr.Ganashyam Singh)

11. Signature of Co-Investigator
(Dr.N.R.Rao)