PROJECT CODE : ***3617***

Identification of region specific bivoltine hybrids suitable for highly fluctuating and seasonally variable climatic conditions of Eastern and North-Eastern India (Phase-II).

April, 2017 to March, 2020

SUBMITTED BY

DR. V. LAKSHMANAN
SCIENTIST-D

SILKWORM BREEDING & GENETICS SECTION
CENTRAL SERICULTURAL RESEARCH & TRAINING INSTITUTE
BERHAMPORE – 742 101, WEST BENGAL

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**	: Identification of region specific bivoltine hybrids suitable for highly fluctuating and seasonally variable climatic conditions of Eastern and North-Eastern India (Phase-II)**.**
5.	**Category of the Project**	: Animal (A)
6.	**Specific Area**	: Silkworm Improvement
7.	**Duration**	**: 3 years (April, 2017 to March, 2020)**
8.	**Total Cost**	**: 4.20 Lakh**
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:

New bivoltine breeds developed / evolved under the project "AIB:3466: Development of region specific bivoltine breeds suitable for highly fluctuating and seasonally variable climatic conditions of Eastern and North-Eastern India" at six different locations, viz, CSRTI, Berhampore, RSRS, Kalimpong, RSRS, Koraput, RSRS, Jorhat, REC, Bhandara and REC, Shillong through shuttle breeding approach will be subjected for hybrid evaluation studies. Hybrids of all possible combinations will be prepared simultaneously at the six different locations utilizing the newly evolved bivoltine breeds / lines. Hybrid evaluation will be conducted simultaneously in the centres covering all the seasons of the year. Observation on rearing, cocoon and fibre parameters will be made. From hybrid test with all possible combinations, few promising hybrids from respective centres may be short-listed considering all economically important parameters. After completion of two years hybrid study, one or two new superior bivoltine hybrids specific to six respective locations may be identified.

11. (b) Aims and Objectives:.

The main aim and objective of the project is to identify new bivoltine hybrids with genetic plasticity to buffer against adverse climatic conditions of Eastern and North-Eastern India.

PART-II: PARTICULARS OF INVESTIGATORS

12. a) Name: : Dr.V.Lakshmanan
Date of Birth : 31-05-1965
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: : 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

c) Name: : 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

d) Name: : Dr.Ranjit Kar
Date of Birth : 01.09.1961.
Sex: : Male
Indicate whether Principal Investigator/ Co-investigator : Co- Investigator
Designation : Scientist-D
Department : RSRS,Kalimpong
Institute/University: Address : CSRTI, Berhampore

e) Name: : Dr.Bramha
Date of Birth : 07.05.1958.
Sex: : Male
Indicate whether Principal Investigator/ Co-investigator : Co- Investigator
Designation : Scientist-D
Department : RSRS, Koraput
Institute/University: Address : CSRTI, Berhampore

f) Name: : Dr.U.C.Bourah
Date of Birth : 28.07.1958
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 : 01.04.1962
Sex: : Male
Indicate whether Principal Investigator/ Co-investigator : Co- Investigator
Designation : Scientist-D
Department : REC, Bhandara
Institute/University: Address : CSRTI, Berhampore

h) Name: : Dr.Collin
Date of Birth : 01.03.1975.
Sex: : Male
Indicate whether Principal Investigator/ Co-investigator : Co- Investigator
Designation : Scientist-D
Department : RSRS Jorhat,
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.V.Lakshmanan	Scientist-D	3 (1+2)
Mr. N.B.Kar	Scientist-D	1
Dr.Chandrakanth	Scientist-B	3 (2+1)
Dr.Ranjit Kar	Scientist-D	2
Dr.U.C.Bourah	Scientist-D	1
Dr. Brahma	Scientist-C	2
Dr.Ganashyam Singh	Scientist-D	2
Dr.Collin	Scientist-C	1

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 form 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 hybrids capable of producing quality silk. However, the hot climatic conditions of India is not conducive to rear productive bivoltines. But it is a well established fact that hybrid combinations can thrive better particularly when subjected under various stress conditions better than pure breeds. Hence, it is logical to have bivoltine hybrids which can yield stable / better crops under 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 bivoltines and the most important aspect is that many quantitative characters such as viability and cocoon traits decline sharply when

temperature is high. The silkworm hybrids 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/ hybrids 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 identification of bivoltine hybrids 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 hybrids will be reared in three commercial seasons with adverse climate for two years. From these, selection of season specific better performing hybrids will be identified.

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 P_1 rearing to prepare multi x bi hybrid dfls for three commercial crop (June-July, August-September and November-December) is not successful as the P_1 bivoltine rearing to prepare multi x bi layings for aforesaid commercial seasons fall under unfavourable season [high temperature (>35^0 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 P_1 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.

The successful completion of the project will lead to the identification of robust bivoltine hybrids suitable to the West Bengal Conditions and these bivoltine hybrids can be reared in adverse seasons with relative ease and can be effectively utilized for the production of multivoltine x bivoltine hybrids throughout the year without any difficulty.

15.4 **Objective**

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

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 5^{th} instar.

Kato *et al*. 1989 subjected silkworm larvae to 25, 32 and 36 ^{o}C for early three and last three days of 5^{th} instar. Sensitivity to high temperature was found more pronounced at 36 ^{o}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 ^{0}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^{o}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 hybrids 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 conducible 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 x 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 x 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 x HTP2 a thermo-tolerant breed was developed by APSSRDI for summer rearing (Raju *et al*.2010). Thermo-tolerant hybrids, Dun 6 x Dun 21, Dun 6 x Dun 22, ATR 16 x ATR 29 and RSJ 3 x RSJ 1, RSJ 14 x 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 x 935 E (HSP1) and A3 x 961 B (HSP2) suitable for tropical climate with higher survival and better cocoon character.

Nobel Prize Laureate Norman E. Borlag (1968) has attempted on shuttle breeding approach in wheat improvement studies involving rain-fed areas of Chapingo and Toluca and the irrigated areas of Obregon, mainly to reduce the time taken to breed a new variety. However, the plants that survived and performed well under both locations were adapted well to wide range of conditions. Through this approach, thereby he has developed new early maturing and rust resistant wheat varieties which were broadly adapted to many latitude and elevations in Mexico. Shuttle breeding thereafter gained credence worldwide as a method to breed a new variety for wide adaptability. J.Nagaraju (2002) has suggested that shuttle breeding approach, the concept conceived and used successfully in wheat breeding programmes by Norman Borlaug, could be tried in silkworm breeding. One such attempt has been taken up by Lakshmanan, et. al (2008), wherein selected bivoltine silkworm genetic resources were shuttled between two different environment namely hilly area (SSBS, Coonoor) and plain area (CSRTI, Mysore).

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.

Rearing of Bivoltine hybrid with genetic plasticity to buffer against the adverse seasons (June, August and September) in Eastern and North-Eastern India still remains an unexplored challenge.

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 identification of robust bivoltine hybrids suitable to the West Bengal Conditions and these bivoltine hybrids can be reared in adverse seasons with relative ease and can be effectively utilized for the production of multivoltine x 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.V.Lakshmanan	Scientist-D	More than 20 years of experience in silkworm breeding
Mr. N.B.Kar	Scientist-D	More than 20 years of experience in reeling
N.Chandrakanth	Scientist-B	Adequate experience in silkworm breeding
Dr.Ranjit Kar	Scientist-D	Adequate knowledge in silkworm rearing
Dr. Bramha	Scientist-D	Adequate knowledge in silkworm rearing
Dr.U.C.Bourah	Scientist-D	Adequate knowledge in silkworm rearing
Dr.Ganashyam Singh	Scientist-D	Adequate knowledge in silkworm rearing
Dr.Collin	Scientist-C	Adequate knowledge in silkworm rearing

16.6 **List of Five Experts in India in Proposed Subject Area**: NA.

17. **Work Plan**:

17.1 **Methodology**:

1. Parental materials:

Five each new oval and dumbbell Bivoltine breeds developed at six different locations under the project AIB 3466 as detailed below, will be subjected for hybrid studies.

1) At CSRTI, Berhampore:

New oval bivoltine breeds	New dumbbell bivoltine breeds
BHP-1, BHP-2, BHP-3, BHP-4, BHP-5	BHP-6, BHP-7, BHP-8, BHP-9, BHP-10

2) At RSRS, Kalimpong:

New oval bivoltine breeds	New dumbbell bivoltine breeds
KPG-1, KPG-2, KPG-3, KPG-4, KPG-5	KPG-6, KPG-7, KPG-8, KPG-9, KPG-10

3) At RSRS, Koraput:

New oval bivoltine breeds	New dumbbell bivoltine breeds
Kora-1, Kora-2, Kora-3, Kora-4, Kora-5	Kora-6, Kora-7, Kora-8, Kora-9, Kora-10

4) At RSRS, Jorhat:

New oval bivoltine breeds	New dumbbell bivoltine breeds
Jor-1, Jor-2, Jor-3, Jor-4, Jor-5	Jor-6, Jor-7, Jor-8, Jor-9, Jor-10

5) At REC, Shillong:

New oval bivoltine breeds	New dumbbell bivoltine breeds
Shil-1, shil-2, Shil-3, Shil-4, Shil-5	Shil-6, Shil-7, Shil-8, Shil-9, Shil-10

6) At REC, Bhandara:

New oval bivoltine breeds	New dumbbell bivoltine breeds
Bhan-1, Bhan-2, Bhan-3, Bhan-4, Bhan-5	Bhan-6, Bhan-7, Bhan-8, Bhan-9, Bhan-10

Parentage:

Sl No	Breed	Parentage
1	BHP-1, KPG-1, Kora-1, Jor-1, Shil-1, Bhan-1	BHR-3 x Gen-3
2	BHP-2, KPG-2, Kora-2, Jor-2, Shil-2, Bhan-2	SK3C x Gen-3
3	BHP-3, KPG-3, Kora-3, Jor-3, Shil-3, Bhan-3	Gen-3 X MC4E
4	BHP-4, KPG-4, Kora-4, Jor-4, Shil-4, Bhan-4	Gen-3 x NBO-2
5	BHP-5, KPG-5, Kora-5, Jor-5, Shil-5, Bhan-5	KSO-1 x BHR-3
6	BHP-6, KPG-6, Kora-6, Jor-6, Shil-6, Bhan-6	Chinese (PN) x P5
7	BHP-7, KPG-7, Kora-7, Jor-7, Shil-7, Bhan-7	D6(P)N x SK6
8	BHP-8, KPG-8, Kora-8, Jor-8, Shil-8, Bhan-8	Dun-22 x D6(P)N
9	BHP-9, KPG-9, Kora-9, Jor-9, Shil-9, Bhan-9	Dun-22 x NB18
10	BHP-10, KPG-10, Kora-10, Jor-10, Shil-10, Bhan-10	Dun-22 x SK6

2. Hybrid evaluation

Hybrids of all possible combinations have to be prepared simultaneously at the six different locations utilizing the newly evolved bivoltine breeds / lines. Hybrid evaluation should be conducted simultaneously in the centres covering all the seasons of the year. Observation on rearing, cocoon and fibre parameters will be made.

3. Short-listing of promising hybrids

From hybrid test with all possible combinations, few promising hybrids from respective centres may be short-listed considering all economically important parameters.

4. Selection of hybrids

After completion of two years hybrid study, one or two new superior bivoltine hybrids specific to six respective locations may be identified.

17.2 **Organization of Work Elements**:

Name of Scientists	**Designation**	**Time**	**Organization of work elements.**
Dr. V.Lakshmanan	Scientist-D	60%	Principal Investigator will carry out the Panning and execution of the project
Shri.N.B.Kar	Scientist-D	25%	Co-Investigator will carry out the assessment of post cocoon parameters
N.Chandrakanth	Scientist-B	25%	Co-Investigator will assist in the experimental rearing, observation, data compilation, analysis etc
Dr.Ranjit Kar	Scientist-D	25%	Co-Investigator will carry conduct the rearing at RSRS / location
Dr. Bramha	Scientist-D	25%	Co-Investigator will carry conduct the rearing at RSRS / location
Dr.U.C.Bourah	Scientist-D	25%	Co-Investigator will carry conduct the rearing at RSRS / location
Dr. Ganashyam Singh	Scientist- D	25%	Co-Investigator will carry conduct the rearing at RSRS / location
Dr.Collin	Scientist-C	25%	Co-Investigator will carry conduct the rearing at his REC / location

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:**

Newly identified superior bivoltine hybrids will be submitted for race authorization and if authorized after large scale testing will be released for full scale commercial exploitation.

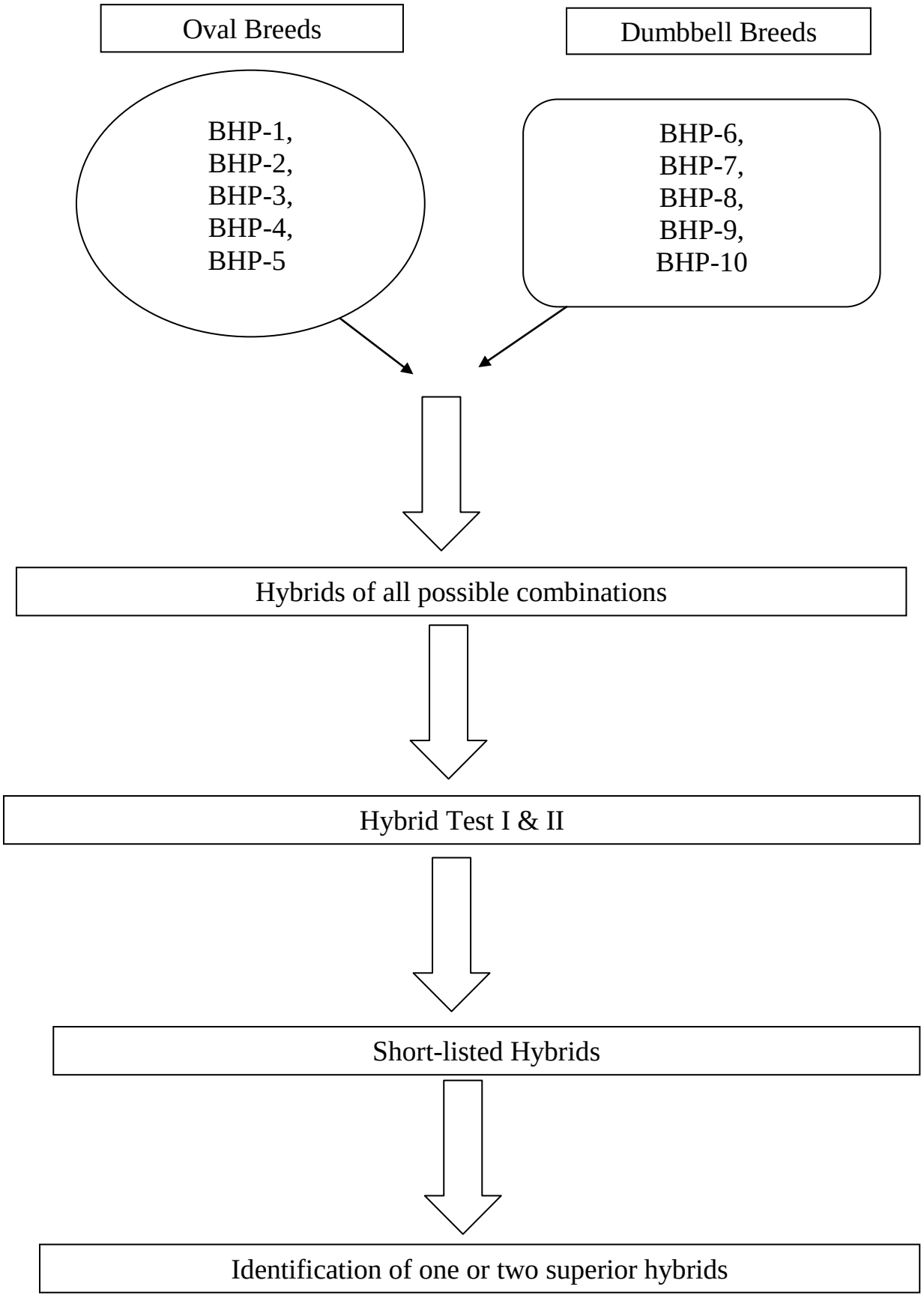
17.5 **Time Schedule of activities giving milestones**:

Sl. No.	**Milestone/ Activity**	**Expected Date of**		**Expected Outcome / visible / Measurable Indicators**
		Starting	**Completion**	
1.	Hybrid preparation	April 2017	June 2017	
2.	Hybrid evaluation	Aug 2017	April 2018	
3	Selection of hybrids	Aug 2018	March 2019	
4	Identification of hybrids	April 2019	December 2019	
5	Final report	January, 2020	March, 2020	

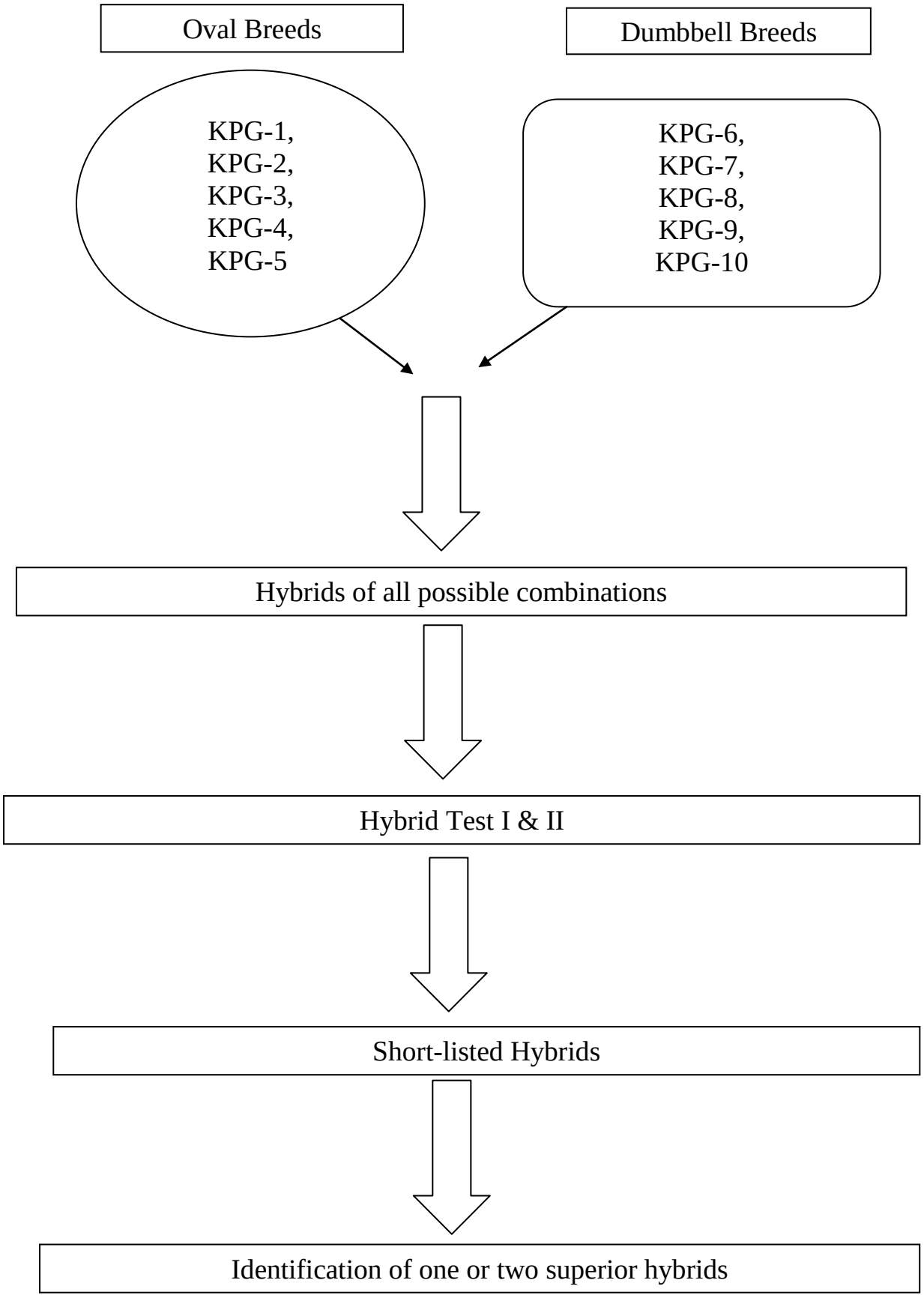
17.6 **Project Implementing Agency /Agencies** :

Name of the agency	Address of the agency	Proposed Research Aspects	Proposed Amount	Cost Sharing %
CSB	CSB, Bangalore Pin-560068			100%

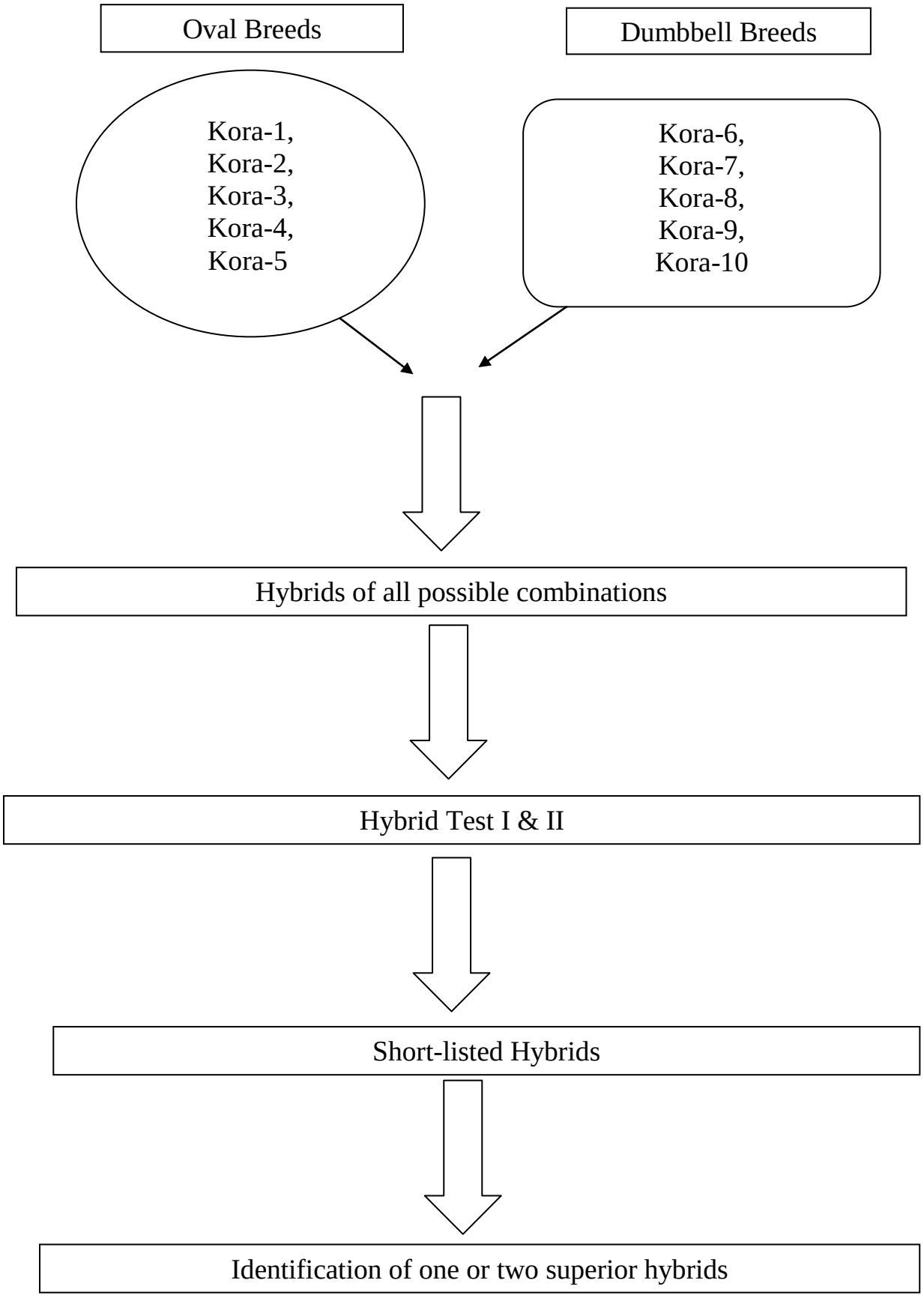
At CSRTI, Berhampore



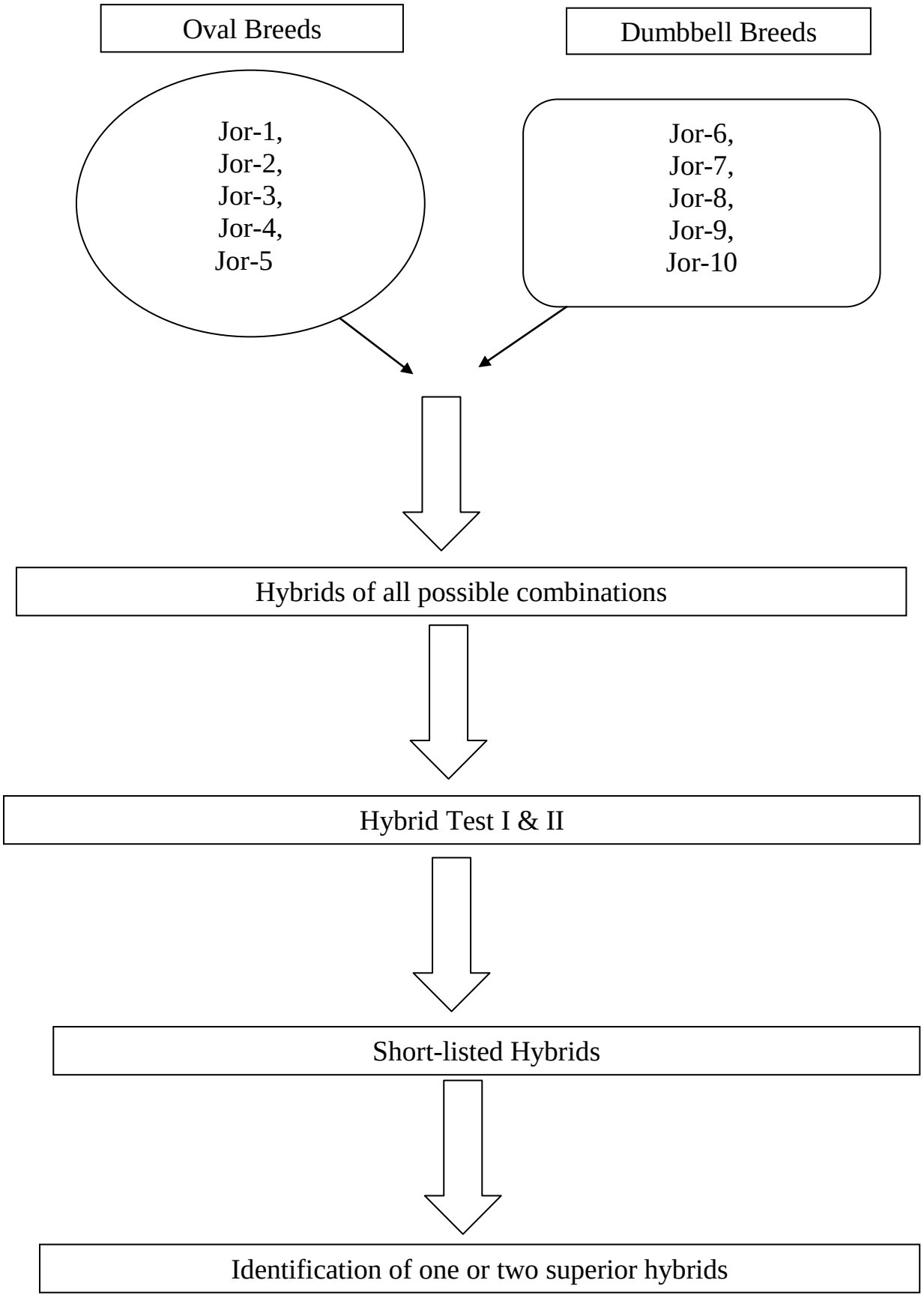
At RSRS, Kalimpong



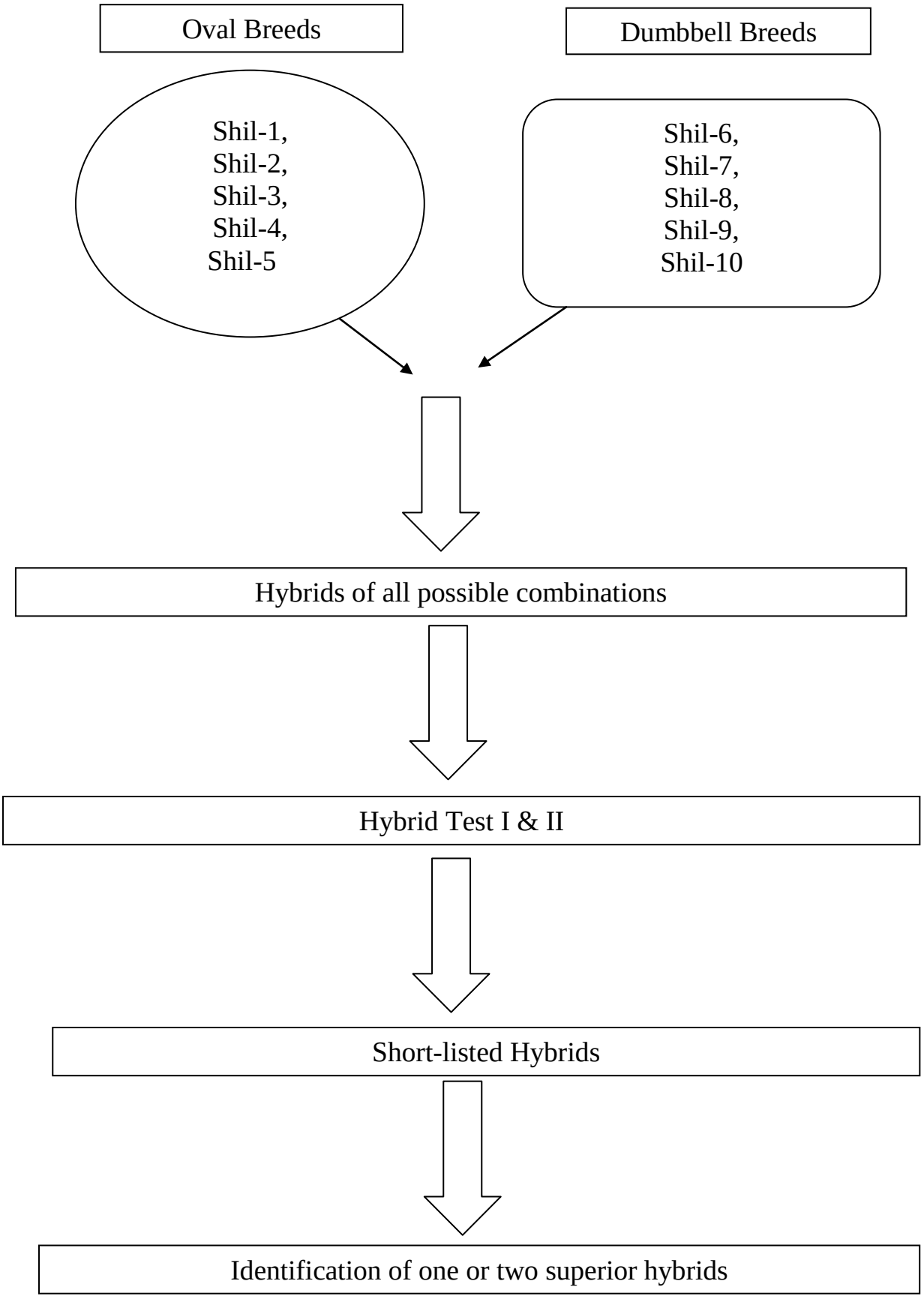
At RSRS, Koraput



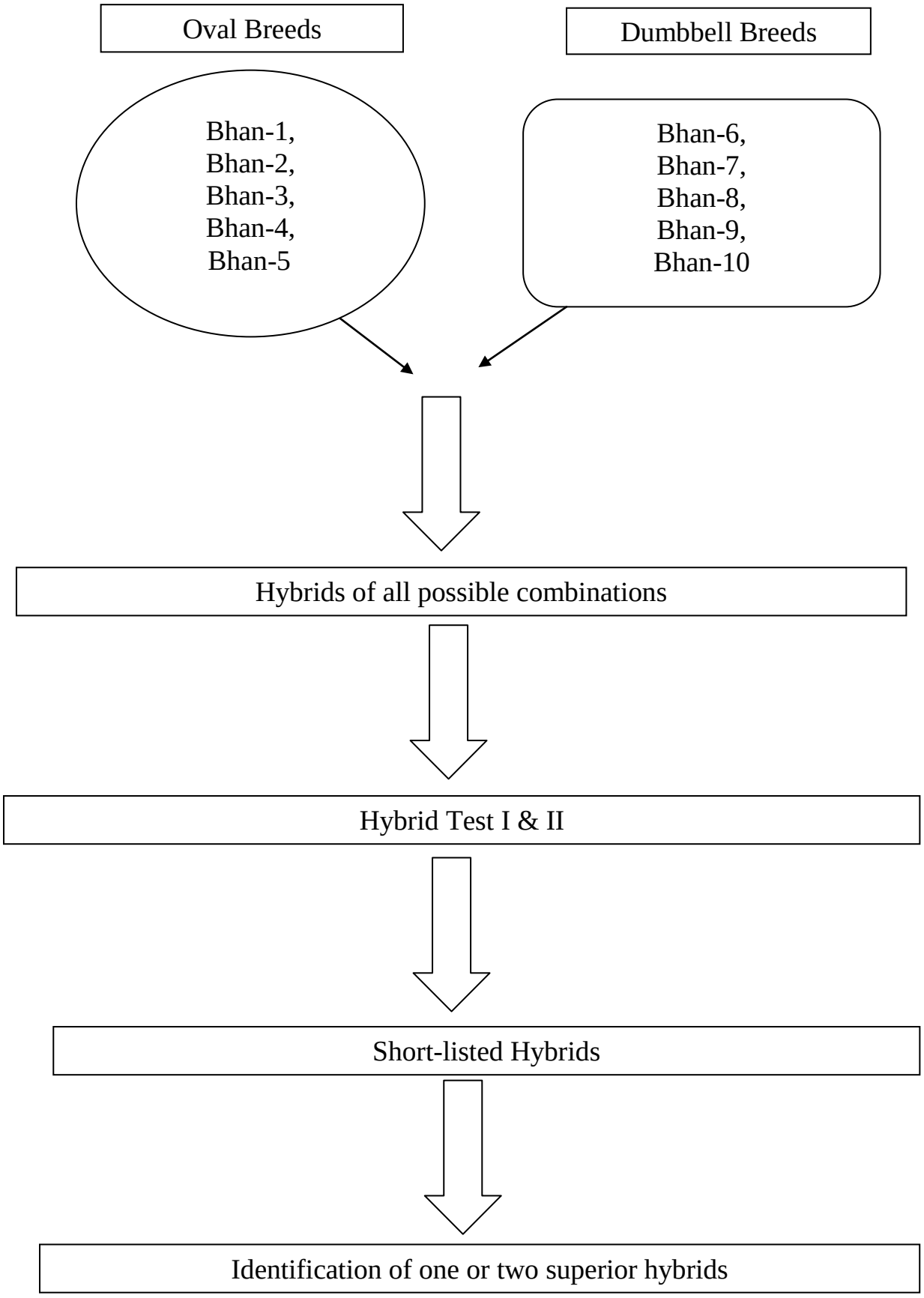
At RSRS, Jorhat



At REC, Shillong



At REC, Bhandara



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			
	2017-18	**2018-19**	**2019-20**	**Total**
A. Recurring				
1. Remuneration/salaries	-	-		
2. Consumables	1.00	0.80	0.40	2.20
3. Travel	0.30	0.30	0.20	0.80
4. Other costs	0.15	0.15	0.10	0.40
B. Non-recurring Permanent equipment	0.80*	-	-	0.80*
Grand Total (A+B)	**2.25**	**1.25**	**0.70**	**4.20**

*Refrigerators -2 Nos.

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. However, two number of refrigerators are required for conduct of grainage operations (preservation of male moths, etc) of experimental batches.

PART-VI : REFERENCES

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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.

Dandin, S.B.; Suresh Kumar, N, Basvaraja,H.K.; Mal Reddy, N.; Kalpana, G.V.; Joge, P.G.; Nataraju,B.; Balavenkatasubbaiah and Nanje Gowda, B. (2006). Development of new bivoltine silkworm hybrid, Chamaraja (CSR50 x CSR51) of *Bombyx mori* L.for tropics. *Indian J.Seric*.,**45(1)** : 21-29.

Das, S. K.; Moorthy, S. M.; Chattopadhyay, G. K.; Verma, A. K..; Ghosh, B.; Rao, P. R. T.; Mukherjee, S.; Sengupta, A. K. and Sarkar. A. (2005) Breeding strategies for high humidity and high temperature conditions of Eastern region. In: Mulberry silkworm Breeders Meet. Central Sericultural Research & Training Institute. Berhamporew-742101, West Bengal: 42-48.

Datta, R.K. and Nagaraju, J. (1987) Genetic engineering and tropical sericulture. *Indian Silk* 26(3): 9-12.

He, Y. and Oshiki, T.1984. Study on cross breeding of a robust silkworm race for summer and autumn rearing at low latitude area in China. J. Seric. Sci. Jpn., 53 : 320-324.

He Yi, Sima Yang hu, Jiang Da-xin, and Dai Ping (1991) Breeding of silkworm varieties For summer and autumn rearing "Xuhua and Qiuxing" and their hybrids. *Canye Kexue* **14(4)**: 200 – 207.

Huang, P.J; Chen, J.H; Hong, D.H and Chen, C.N.1979. Preliminary study on the inheritance of tolerance to high temperature in some silkworm strains. J. Agric.Assoc. China, 105.23-29.

Kato, M; Nagayasu, K; Ninagi, O; Hara, W and Watanabe, A.1989. Study on resistance of the silkworm Bombyx mori to high temperature. Proceedings of the 6th International Congress of SABRAO, (II):953-956.

Krishnaswami, S. and Narsimhanna, M. N. (1974) Large scale trials of bivoltine hybrids in Mysore state. Indian J. Genet. Pl. Breed. 34A: 229 – 236.

Krishna Rao, S. (1994) Bivoltine silkworm races evolved by KSSRDI In: Proc. Natl. Workshop on Silkworm Breeding held on 18 – 19 March, at university of Mysore. Pp. 119 – 130.

Lakshmanan, V., Suresh Kumar, N., Naseema begum, A., Pandya, R.K., Nirmal kumar, S. and Kamble, C.K. (2008). An attempt on shuttle breeding approach to import genetic plasticity in the bivoltine silkworm, Bombyx mori, L. Abstracts. Breeder's meet, CSRTI, Mysore, p49-51.

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Raju, P.J. (2010) Present scenario and future challenges of research and development in sericulture. Paper presented in workshop on state sericulture, technical compendium held by Ministry of Textiles, Orissa, Bhubaneswar on March, 24-26th 2010

Shao Yu-hua, Li Wei-bin, Xia-Jiang guo and Cao Jin ru (1990) Breeding of a new silkworm variety "Fangshan × Xing.Ming" for autumn rearing. Canye Kexue. 16(3): 74 – 79.

Shirota, T. (1992) Selection of healthy silkworm strain through high temperature rearing of fifth instar larvae. Rep. Silk. Sci. Res. Inst. 40: 33-40.

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.

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.

Tazima, Y and Ohnuma, A1995. Preliminary experiments on the breeding procedure for synthesizing a high temperature resistant commercial strain of the silkworm, Bombyx mori L. Silk Sci. Res. Inst. Jpn., 43:1-16.

Ueda, S., Kimura, R. And Suzuki, K. (1969) Studies on the growth of silkworm, *B. mori*. II. The influence of rearing condition upon the larval growth, productivity of silk Substance and eggs and boil off loss in cocoon shell. *Bull. Seric. Exp. Stn*. 23: 290 – 293.

Watanabe, K. (1928) Further studies on the voltinism in the silkworm, *Bombyx mori* L *Bull.Seric.Exp.Stn.Jpn.*, **7:** 285-303.

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

1. Full Name (in Block letters) : Dr.V.Lakshmanan (Principle Investigator)
2. Designation : Scientist-D
3. Department/ Institute/ University: CSR&TI, Berhampore
4. Address for Communication : Silkworm Breeding & Genetics Section, CSR&TI, Berhampore, Murshidabad, West Bengal-742101
5. Date of birth : 31.05.1965
6. Sex : Male
7. Education (Post Graduation onwards & Professional Career):

Name of the Univ	Class/ Dvn.	Degree	Year of passing
Bharathiar University	First	B. Sc . Zoology	1985
Bharathiar University	First	M. Sc. Zoology	1987
Bharathiar University	First	MPhil Zoology	1989
University of Mysore	--	Ph D	2014

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

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: 26
General articles:

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

SL. No.	YEAR	TOPIC OF PAPER/ BOOK	GIST OF PAPER/ BOOK	NAME OF JOURNAL/ MAGZINE/ PUBLISHER
1	2013	A new comprehensive evaluatory study of silk yield traits of genertic resources in the mulberry silkworm, *Bombyx mori*, L"..	Study brings out a comprehensive evaluation of silk yield traits of 31 bivoltine silkworm breeds which clearly depicts groupings on fitness, productivity, fibre and crop duration merits.	International Journal on applied bio-engineering. Vol 6(1): 44-54

2	2012	Evaluation of new bivoltine silkworm hybrids of *Bombyx mori*, L. for sub-tropical conditions.	Forty eight new bivoltine silkworm hybrids evolved under a breeding programme were evaluated and short-listed to five superior combinations.	International Journal of Science and Nature Vol 3(1): 129-136.
3	2012	Analysis of Heterosis in new double hybrid combinations in bivoltine silkworm, *Bombyx mori*, L.	Utilising 10 new bivoltine breeds and their 21 foundation crosses, a concise study on estimation of heterosis was made through which a superior double hybrid was identified.	International Journal of Science and Nature Vol 3(1): 197-204.
4	2012	Selection of breeding resource material from bivoltine strains of *Bombyx mori*. L.".	To initiate a breeding programme, 31 geographical races / breeds were evaluated of which 12 were selected in this study.	Indian Journal of Sericulture 51 (2): 100-108.
5	2011	Bivoltine silkworm breeds and hybrids for shorter larval duration for hilly areas.	Discusses on development of bivoltine silkworm breeds and hybrids of shorter larval duration	Journal of Sericulture and Technology Vol 2(2):146-149
6	2011	Modified multiple trait selection index for assessment of silk yield improvement in the silkworm, *Bombyx mori*, L.	Negative traits which are of economic importance needs to be evaluated in any breeding programme and one such effort is made in this study	Journal of Sericulture and Technology Vol 3(1):130-134
7	2010	Application of lime during moult and impact.	While restricting high humi dity in silkworm rearing through lime application, this paper discusses on avoiding some deleterious effects observed and suggests proper techniques	*Indian Silk*, 1(8): 10-11.
8	2008	An attempt on shuttle breeding approach to import genetic plasticity in the bivoltine silkworm, *Bombyx mori*.L,	Brings out some details on the shuttling approach adopted in a silkworm breeding programme between plain and hill climates.	Research paper Breeder's meet, 10th, June, 2008, CSRTI, Mysore, Pp-49-51.
9	2000	Genetic variation, correlation and path analysis in mulberry silkworm *Bombyx mori* (L).	Discusses on some details on genetic variation, correlation and path analysis studied with a group of silkworm breeds.	Sericologia, 40 (2): 211-223.
10	2000	Combining ability studies in Bivoltine silkworm, *Bombyx mori*. L.	Discusses on combing ability studies conducted in a silkworm breeding programme	Indian Journal of Sericulture, Vol.39 (2):127-130

11	2000	Synthesis of breeds with shorter larval duration and productive traits of Bivoltine silkworm, *Bombyx mori* L.**"**	Briefs on attempts made on development of silkworm breeds with shorter larval duration without compromising much on productivity merits.	Abstracts. Session IV: Silkworm Improvement, National Conference on Strategies for sericulture research and development in the new millennium, CSRTI, Mysore, p-26.
12	1997	Line x Tester analysis of combining ability in new genotypes of bivoltine silkworm, *Bombyx mori* (L).	Details on line x tester analysis made to identify superior breeds developed in a breeding programme	Indian Journal of Agricultural Sciences, 67(7):287-290.

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	Remarks
1	BAI (RP) 003: Maintenance of Multivoltine and Bivoltine Germplasm.	CSB	Continuous	3	As Principle Investigator (For Bivoltines)
2	AIB:3602: Development of Bivoltine breeds through marker assisted selection	CSB	Nov, 2016 to April, 2021	4	As Co-Investigator
3	AIB:3547: Develop-ment of high temperature and high humidity tolerant bivoltine breeds of silkworm (*Bombyx mori* L.)	CSB	July 2015– June 2017	3	As Co-Investigator

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

- Authorised one new bivoltine silkworm hybrid, SLD4 x SLD8 which is an outcome of a silkworm breeding programme undertaken by me as Principle Investigator, after its successful validation through nation wide Race Authorisation Test- Phase VIII (2005-2008).

- Developed two more new bivoltine hybrids, D2 x D13, a single hybrid and (D1 x D2) x (D13 x D11), a double hybrid as a principal investigator through shuttle breeding approach between a hill and plain environments.

- Identified one more double hybrid, (CSR2 x CSR50) x (CSR51 x CSR26), a superior bivoltine double hybrid over ruling "Chamaraja" double hybrid.

- Played an important and crucial role in the fixation of five new oval and five new dumbbell breeds derived through shuttle breeding approach (AIB:3466) at CSRTI, Berhampore, which are certainly superior in fitness merits under the highly fluctuating environmental conditions of West Bengal.

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

1. Full Name (in Block Letters) : N CHANDRAKANTH (Co-Investigator)
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: Nil

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, *Bombyx mori* 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, *Bombyx mori* 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 fluctuating and seasonally variable climatic conditions of Eastern and North-Eastern India- **AIB 3466**	Central Silk Board	Aug 2011 to Dec 2016	3 scientists from CSRTI, Berhampore and Sub unit incharges of 5 stations	10.00
4	Improvement of leaf quality and productivity through external application of seaweed extracts in mulberry (*Morus alba* 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 PROJECT COORDINATOR /PRINCIPAL INVESTIGATOR / CO-INVESTIGATOR(S)

1. Full Name (in Block letters) : MR. N. B. KAR (Co-Investigator).
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 Universityt	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

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 Approprite 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 4^{th} 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 P_1 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. RANJIT KAR (Co-Investigator)
2. Designation: Scientist -D
3. Department/ Institute/university: Central Sericultural Research and Training Institute
4. Address of communication: Central Sericultural Research and Training Institute, Berhampore –742101 (W.B.)
5. Date of Birth: 01.09.1961
6. Sex : Male
7. Education (Post Graduation onwards & professional career)**:**

Name of the university	**Degree Passed**	**Year of Passing**	**Subjects taken With Specialization**	**Class/Division**
Bidhan Chandra Krishi Viswavidyalaya	M. Sc. (Ag.)	1984	Agricultural Chemistry and Soil Science	3.41 OGPA out of 4.00
Bidhan Chandra Krishi Viswavidyalaya	Ph. D.	1991	Agricultural Chemistry and Soil Science	-

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

Year	Award	Agency	Purpose	Nature
Not applicable				

9. **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
Not applicable			

10. Memberships/Fellowships [Not required for in-house personnel]: Not applicable
11. Patents [Not required for in-house personnel]: Not applicable
12. Publications (Numbers only): 115

13. **Project(s) submitted/ being pursued/carried out by investigator:** 02

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

Developed soil test based recommendation for application of NPK fertilizers for mulberry, validated the technology successfully and subsequently popularized the same under ToT. Developed the technology for sulphur application for augmentation of mulberry productivity under sulphur-deficient soil, validated the same successfully and is being popularized under ToT. Cationic micronutrients, critical for mulberry productivity, have been diagnosed zone wise. Optimum foliar requirement of the same along with critical level of soil availability have further been estimated. Concentration of foliar spray for individual micronutrient has also been derived and the same is under validation at present. Standardized the farming practice in terms of enhanced carbon sequestration potential of mulberry as well as soil organic carbon stock and the same is presently under experimentation at regional level.

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

1. Full Name (in Block letters) : Dr. K.C. Brahma (Co-Investigator)
2. Designation : Scientist- C
3. Department/Institute/University : Central Silk Board
4. Address for Communication : Regional Sericultural Research Station,
   Central Silk Board, P.B. No:9,
   Koraput, Odisha
   Email: kcbrahma58@gmail.com
5. Date of birth : 07.05.1958
6. Sex : Male
7. Education (Post Graduation onwards & Professional Career):

Name of the University	Degree Passed	Year of Passing	Subjects taken with Specialization	Class / Division
Berhampore University	M. Sc.	1978	Zoology (Spl-Physiology & Biochemistry	1st Division
Berhampore University	Ph.D.	1984	Studies on factors influencing growth in male garden lizard, Calotes varsicolor.	

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

Year	Award	Agency	Purpose	Nature

9. 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

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

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

12. Publications (Numbers only):
    Books : Nil
    Research Papers, Reports : 70
    General articles : --

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

#	Title of the Project	Funding Agency	Duration		No. of Scientists / Associates working under the project	Total approved cost of the project
			From	To		
1.	**AIB-3466 DEVELOPMENT OF REGION SPECIFIC BIVOLTINE BREEDS FOR HIGH FLUCTUATING AND SEASONALLY VARIABLE CLIMATIC CONDITIONS OF EASTERN AND NORTH EASTERN INDIA(SHUTTLE BREEDING OF SELECTED BIVOLTINE BREEDS**	CSB	Aug, 2011	December, 2016	Collaborative	
2.	**AIB-3531:AUTHIRIZATION TRIALS OF SILKWORM HYBRIDS IN EASTERN AND NORTH EASTERN INDIA**	CSB	June, 2014	Dec, 2019	Collaborative	
3.	**BAR(RP)-021 SURVEY AND SURVEILLANCE AND MONITORING OF SILKWORM DISEASE IN SEED 7& COMMERCIAL CROPS IN EASTERN AND NORTH EASTERN INDIA**	CSB	April, 2016	Mar, 2019	Collaborative	
4	**PIB-3576 : EVALUATION OF NEW MULBERRY GENOTYPE FOR IMPROVEMENT IN PRODUCTIVITY AND QUALITY.**	CSB	June, 2016	July, 2020	Own	
5	**MOE3604 : YIELD GAP ANALYSIS IN MULBERRY LEAF AND COCOON PRODUCTION- A STUDY IN EASTERN GHAT HIGHLAND ZONES OF ODISHA.**	CSB	Dec., 2016	Nov., 2018	Own	
6	**AIB-3614-EVALUATION AND IDENTIFICATION OF SUITABLE PRODUCTIVE BIVOLTINE HYBRIDS FOR ODISHA.**	CSB	October, 2017	November, 2018	Own	

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

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

1. Name : GHAN SHYAM SINGH (Co-Investigator)
2. Designation : Scientist-D
3. Department/Institute/ University : Research Extension Centre, Bhandra, Lohardaga, Jharkhand
4. Address for Communication : Research Extension Centre, Bhandra, Lohardaga, Jharkhand
5. Date of birth : 01-04-1962
6. Sex : Male
7. **EDUCATIONAL QUALIFICATION:**

Name of the University	**Degree Passed**	**Year of Passing**	**Subjects taken with Specialization**	**Class / Dvn.**
G.B.Pant University of Agricuture & Technology Pantnagar	M.Sc.Ag.	1986	Plant Pathology	I
G.B.Pant University of Agricuture & Technology Pantnagar	Ph.D	1991	Major subject –Plant Pathology, Minor-Entomology and Plant Breeding Specialization-Seed technology	

8. Awards:

[Not required for in-house personnel]

Year	Award	Agency	Purpose	Nature
Not applicable				

9. 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
Not applicable			

10. Membership / Fellowship [Not required for in-house personnel]: Not applicable

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

12. Publications (numbers only): 35

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 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.

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

2. Signature of Principal Investigator
(Dr.V.Lakshmanan)

3.Signature of Co-Investigator
(Dr.N.Chandrakanth)

4. Signature of Co-Investigator
(N.B.Kar)

5.Signature of Co-Investigator
(Dr.Ranjit Kar)

6. Signature of Co-Investigator
(Dr.K.C.Brahma)

7. Signature of Co-Investigator
(Dr.U.C.Bourah)

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

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