PPS -3598

ARSENIC CONTAMINATION IN MULBERRY SERICULTURE OF BENGAL PLAIN AND ITS ALLEVIATION THROUGH APPLICATION OF ZINC IN SOIL

DURATION

NOVEMBER, 2016 - OCTOBER, 2019

Monica Chaudhuri – *Coordinator*

Investigators

Vijay V, Kar R, Mahesh R and Das GC

CENTRAL SERICULTURAL RESEARCH AND TRAINING INSTITITE
CENTRAL SILK BOARD
MINISTRY OF TEXTILES (GOVERNMENT OF INDIA)
BERHAMPORE-742101, WEST BENGAL

PROFORMA – I (To be filled by applicant)

PART I: GENERAL INFORMATION

1.	Name of the Institute / University / Organization submitting the Project Proposal	Central Sericultural Research and Training Institute, Berhampore-742101, West Bengal
2.	Status of the Institute(s)	Not applicable
3.	Name(s) and designation(s) of the Executive Authority of the Institute / University forwarding the application	Director
4.	Project Title	Arsenic contamination in mulberry sericulture of Bengal plain and its alleviation through application of zinc in soil
5.	Category of the Project	Applied
6.	Specific Area	Plant and Environmental Science
7.	Duration	3 years (November, 2016 – October, 2019)
8.	Total cost	**Rs. 16. 35 Lakhs**
9.	Is the Project single institutional or multi-institutional	Single institutional
10.	If the Project is multi-institutional, please furnish the following: Name, Designation and Address of the Project Co-ordinator.	Not applicable
11.	Project Summary	Groundwater from many tube wells, especially with the depth of 20-80 meter below ground level (mbgl), in the Eastern part of the river Bhagirathi/Hoogly river are highly contaminated with arsenic (> 0.05 ppm) (http://www.soesju.org/arsenic/wb.htm; http://maps.wbphed.gov.in/arsenic/index.html). Agricultural soils of sericulturally important districts (Murshidabad, Malda and Nadia) falling under this area are also in the trap of arsenic contamination from the arsenic loaded groundwater as a source of irrigation affecting soil quality. As per SOES report, out of 26, 14 and 17 blocks of Murshidabad, Malda and Nadia districts, groundwater arsenic contamination in Jalangi, Kaliachak-II and Karimpur-I is reported to be maximum (50.9, 57.5 and 27.5 % of samples studied having the said contamination) with >50 µg/L arsenic and the maximum concentration of arsenic found in these blocks are 2040, 1904 and 1363 µg/L, respectively. For ascertaining the ill effect of arsenic on sericulture, if any, the present study is proposed. For this purpose, the blocks, namely: Jalangi of Murshidabad; Kaliachak-II of Malda; and Karimpur-I of Nadia, which are reported to have high degree of arsenic contamination in groundwater, are selected for further studies. Wherein, from each block, arsenic load in irrigation water of randomly selected 30 tube wells (based on

		source of irrigation water, *i.e.* tube well depth 20-80 mbgl) and soil from respective mulberry field and few plant species from the adjoining fields will be surveyed. Based on the findings, three fields/sites will be selected, as “High”, “Moderate”, and Low/No level of arsenic (As) contamination, to study the *in situ* affect of As contamination, as well as the extent of bio-magnification of As, if any, in the groundwater-soil-plant and silkworm system. Such effect will be ascertained by periodic monitoring of arsenic load in irrigation water-soil-mulberry (root, shoot and leaf)-silkworm (‘V’ instar) samples from the three sites. Upon ascertaining the extent of bio-accumulation of naturally existing soil arsenic in mulberry and silkworm, if any, alleviation of the contaminant through application of zinc (Zn) in soil will be formulated through laboratory incubation and pot experiments, using the field soils (High and Moderate), subject to the soil of these fields being found to be Zn-deficient. Subsequently, alleviation of arsenic contamination by graded doses of Zn treatment in the selected fields will be studied.

PART II: PARTICULARS OF INVESTIGATORS

12.	Name: Date of birth Sex Indicate whether Principal Investigator / Co-investigator Designation Department/Institute / University: Address	Vijay V 10.04.1983 M Principal Investigator Scientist-B CSR&TI, Berhampore (WB)
	Name: Date of birth Sex Indicate whether Principal Investigator / Co-investigator Designation Department/Institute / University: Address	Ranjit Kar 01.09.1961 M Co-investigator Scientist-D CSR&TI, Berhampore (WB)
	Name: Date of birth Sex Indicate whether Principal Investigator / Co-investigator Designation Department/Institute / University: Address	Mahesh R 25.05.1985 M Co-investigator Scientist-B CSR&TI, Berhampore (WB)
	Name: Date of birth Sex Indicate whether Principal Investigator / Co-investigator Designation Department/Institute / University: Address	Gopal Chandra Das 01.05.1961 M Co-investigator Scientist-C CSR&TI, Berhampore (WB)
13.	No of Projects/ Programmes being handled by each investigator at present: Vijay V Ranjit Kar Mahesh R Gopal Chandra Das	 01 01 01 01
14.	Proposed Research Fellow	One (01)

PART III: TECHNICAL DETAILS OF PROJECT

15. Introduction		
15.1	Definition of the Problem	Arsenic (As) is present in soils in various forms with varying degree of bioavailability, toxicity, and mobility (Sanyal *et al*., 2015). Arsenic contaminated groundwater, when used for irrigation, helps entry of arsenic into the food-chain *via* the soil-plant-animal continuum. As of now, no such information, pertaining to As toxicity in sericulture, is available in the literature. Thus, widespread arsenic contamination in sericulturally important districts like Murshidabad, Malda and Nadia of West Bengal (Ray and Shekhar, 2009; Kundu *et al.*, 2013; Sanyal *et al*., 2015; GWYBWBA and N-CGWB, 2016) is of great concern as arsenic is highly toxic.
15.2	Origin of the Proposal / Rationale of the Study	As per the available report, 12 districts of West Bengal covering 111 blocks are suffering from ground water arsenic contamination (Sanyal *et al*., 2015; SOES, 2012). Among these districts, Murshidabad, Malda and Nadia are sericulturally important and 49 blocks of these three districts are already contaminated with groundwater arsenic (Rahaman *et al.*, 2012). Where level of contamination reached 10 to 250 times higher than that of safe limit of 50µg/L (Chatterjee *et al.*, 2013). Majority of the fertile alluvial soils of this area are in the trap of arsenic contamination, with gradual build-up from the arsenic loaded groundwater as a source of irrigation affecting the soil quality *vis-à-vis* crop production (Sanyal and Dhillon, 2005; Das, 2012). Accumulation of arsenic in soil environment expedites the possibility and extent of arsenic accumulation in the economic produce and other parts of different crops (Ghosh *et al*., 2002; Das *et al*., 2013; Biswas *et al.*, 2013), which, in turn, is expected to influence soil-plant-animal continuum (Sanyal *et al*., 2015). In mulberry-sericulture of the three districts as mentioned above, there is every chance of introduction of arsenic into the food-web of silkworm. As no report is available on the mobilization of arsenic in the soil-mulberry-silkworm continuum, the present study is proposed to investigate extent of arsenic load in soil and its subsequent transmission into mulberry plants, if any, as well as silkworm. Reports (Garai *et al*., 2000; Das, 2007; Das *et al.*, 2016) are available on the reduction of extractable arsenic in soil and arsenic build-up in plants by the application of zinc. Thus, attempt will also be made to develop an appropriate technology to mitigate the arsenic pollution in mulberry sericulture, based on zinc-arsenic interactions in soil.

15.3	Relevance to the Current Issues and Expected outcome	In mulberry-sericulture of the three districts as mentioned above, there is every chance of introduction of arsenic into the food-web of silkworm. The present study is proposed to investigate the extent of arsenic load in irrigation water, soil and its subsequent transmission into mulberry plant as well as silk worm. Based on the preliminary field studies, attempt will be made to develop an appropriate technology to mitigate arsenic pollution in mulberry sericulture by the application of zinc in soil, which is deficient in zinc.
15.4	Objectives	• To investigate the extent of arsenic load/accumulation in irrigation water-soil-mulberry plant-silkworm larva continuum under mulberry vegetation. • To formulate dose of zinc for alleviating arsenic pollution in mulberry sericulture by application of zinc in soil wherein it is deficient. • To validate the efficacy of laboratory findings by conducting the appropriate field trials.

16	**Review of literature**
16.1	REVIEW OF STATUS OF RESEARCH AND DEVELOPMENT ON THE SUBJECT : Arsenic (As) contamination in West Bengal was first reported in late eighties (Chakraborty and Saha, 1987). Subsequently, intensive use of As contaminated groundwater for irrigation purpose in the Bengal delta basin of India has become one of the world's most important disasters (SOES, 2012; Rahaman *et al.*, 2012). Groundwater arsenic contamination in arsenic affected districts in West Bengal ranges between 0.05 to 3.7 mg/L. Studies on arsenic load in soils of affected areas in West Bengal revealed that the total and Olsen extractable As (i.e., the labile soil As pool amenable to plant uptake) in the soils varied from 8.40 to 24.3 and from 2.90 to 15.8 mg As kg^{-1}, respectively (Sanyal *et al.*, 2012; Sanyal *et al.*, 2015). Several researchers have worked on accumulation of arsenic in various crops, mainly focusing on their economic produce consumed by humans and/or animals. In general, As accumulation by the plant parts followed the order: root > stem > leaf > economic produce (Sanyal *et al.*, 2012; Kundu *et al.*, 2012; Das *et al.*, 2013; Majumder *et al.*, 2013; Sanyal *et al.*, 2015). However, potato tuber, despite being an underground part (a modified stem), contained relatively lower amount of arsenic (Adak and Mandal, 1999). Das *et al.* (2013) reported 80.8% yield reduction in *boro* rice at a rate of more than 60 mg kg^{-1} As. At harvest, the As accumulation in root, stem, leaf and grain was 30.6, 13.5, 10.2 and 7.98 mg kg^{-1}, respectively, at 60 mg kg^{-1} As application. The As accumulation by the plant parts was observed to increase with the increase of added As. Das *et al.* (2016) studied arsenic content in various plants grown on soils having Olsen extractable arsenic in soil 1.26–4.21 mg

	kg^{-1} and found that arsenic content in leaves (at harvest) of cauliflower, pointed gourd and jute was 12.2, 4.33 and 5.86 mg kg^{-1}, respectively. Kundu *et al.* (2012) reported that, wheat cultivars differed in their leaf arsenic concentration (2.37 to 3.21 mg kg^{-1}), which differed across the sites and year of experiment. Majumder *et al.* (2013) reported that As content of jute leaf attained the highest concentration (3.72 mg kg^{-1}) on the 35th day after sowing on farmers field with average soil arsenic content of 13 mg kg^{-1}, and continuously decreased with the increase in crop age. Sinha *et al*. (2011) noted that As content of sesame leaves grown on arsenic contaminated farmer's field (with total and extractable arsenic 19.17 and 5.30 kg ha^{-1}, respectively) and irrigated from shallow tube well water (0.32 mg As L^{-1}) was 2.9 to 4.5 mg kg^{-1}. Work done by Saibur *et al.* (2006), cited in Das *et al.* (2013), on As toxicity symptoms, reported that rice leaf number and width of leaf blade decreased with As toxicity. Arsenic toxicity also induced chlorosis symptoms in the youngest leaves of rice seedlings by decreasing chlorophyll content. Das *et al.* (2013) reported that in *boro* rice, the arsenic toxicity symptoms in leaf and root were observed with treatment above 40 mg kg^{-1} As. In leaf, the symptoms were reddening of tip, followed by lateral expansion towards the leaf blade, and further proceeding from the margin of the leaves to their midribs, which appeared 25 days after sowing. After 40 days of sowing, As poisoning led to yellowing of these leaves. The total chlorophyll content of rice leaf reduced significantly from 20 mg As kg^{-1} with the senescence at an accelerated rate, the latter setting in from 40 mg As kg^{-1} application. At panicle initiation stage, the (chlorophyll 'a'/chlorophyll 'b') ratio decreased up to 60 mg As kg^{-1} application, whereas beyond this, it registered inconsistent trends. As regards the root symptom, extensive reduction in the root vigour, followed by the yellowing of roots when exposed to 60 mg As kg^{-1} was observed. Though the pot culture experiment revealed distinct visual symptoms of arsenic poisoning in different plant parts, no such visual symptom was observed in the field experiment (Das *et al*., 2013). Regarding mitigation of As bioavailability in soil-plant systems, Sanyal *et al*. (2015) suggested application of appropriate inorganic amendments, like zinc/iron salt, which can be used as remedial option for arsenic contamination in soil where these micronutrients are deficient. Das *et al.* (2016) found that application of zinc (@ 20 kg $ZnSO_4$ / ha) in soil decreases arsenic release in soil solution of the given soils, which tends to bind arsenic electrostatically in the soil matrix, thereby helping to mitigate the toxicity of arsenic to some extent (moderating effect) in the soil-plant system. Fayiga *et al.* (2007), cited in Das *et al.* (2016), reported negative impacts of addition of zinc on plant As uptake. Interaction of zinc (Zn) and As and the period of soil submergence were studied by Garai *et al.* (2000) for the As-affected soils of West Bengal. Such an interaction study showed the soil As content to increase with the progress of submergence up to 35 days in the presence of graded concentrations of Zn. However, Das *et al.* (2005) showed that the amount of As content in soil decreased significantly with the application of graded levels of Zn as $ZnSO_4$. Das *et al.* (2005) reported that the accumulation of arsenic in rice root, stem, leaves and grains might be significantly decreased with the application of zinc or by management of irrigation water or both. A field study, examining lowland rice (*boro* paddy), revealed that the extractable arsenic in soil and arsenic build-up

	in plants was drastically reduced by zinc application (Garai *et al*., 2000). Laboratory experiments conducted to reduce the arsenic contamination in soils using zinc revealed that the amount of 0.5 M $NaHCO_3$ extractable arsenic content in soil was significantly decreased due to zinc-arsenic electrostatic attraction facilitating compound formation (Das, 2007). Addition of organic manure is an important mitigation option in moderating the heavy metal toxicity in soil-plant system, including arsenic toxicity (Mukhopadhyay and Sanyal, 2004; Ghosh *et al*., 2012; Sanyal *et al*., 2015). NAS (1977), cited in Eisler (1988), reported that low doses (< 2 µg/daily) of arsenic increases viability and cocoon yield in silkworm caterpillars. Nevertheless, as of now no report is available on bio-accumulation of arsenic in mulberry plants and its economic produce (*i.e.*, leaf in case of sericulture). Therefore, the proposed study is important to ascertain the effect of arsenic contamination in mulberry sericulture.	
16.2	IMPORTANCE OF THE PROPOSED PROJECT IN THE CONTEXT OF CURRENT STATUS	Mulberry sericulture in the districts of Murshidabad, Malda and Nadia are practiced in soils which fall into the arsenic affected belt of West Bengal, and thus, it deserves attention towards evaluation of the extent of arsenic contamination, not only in soil but also in mulberry leaf and silk worm too. Soils of these districts are mostly neutral in reaction, and thus, contamination through highly toxic species of arsenic, *i.e.*, As (III), is very much likely (Sanyal, 1999; Sanyal *et al.*, 2015). The situation warrants development of an efficient technology for mitigating arsenic pollution in soil-mulberry-silkworm continuum.
16.3	ANTICIPATED PRODUCTS, PROCESSES/TECHNOLOGY PACKAGES, INFORMATION OR OTHER OUTCOME FROM THE PROJECT AND THEIR EXPECTED UTILITY	Information will be generated on the extent of arsenic toxicity in soil-mulberry-silkworm continuum and an efficient technology is expected to be standardized in terms of alleviation of this toxicity.
16.4	EXPERTISE AVALABLE WITH PROPOSED INVESTIGATION GROUP/INSTITUTION ON THE SUBJECT OF THE PROJECT	Investigators are having expertise in Soil Science, Mulberry Nutrition, Mulberry Cultivation, Rearing Technology and Silkworm pathology.

17. Work Plan:

17.1 Methodology:

Step 1: Field Survey:

i. **Selection of study area/plot:** Thirty farmers will be randomly selected from each of the three study areas (Jalangi of Murshidabad; Kaliachak of Malda; and Karimpur of Nadia), based on their source of irrigation water, *i.e.*, tube well depth 20-80 mbgl (http://www.soesju.org/arsenic/wb.htm; http://maps.wbphed.gov.in/arsenic/index.html). A preliminary survey through laboratory testing of arsenic loading in irrigation water and soil samples from the selected 90 farmers will be done using rapid arsenic test Kit and HG-AAS. On the basis of the survey results, maximum, medium and low/no arsenic affected field will be selected.

ii. **Monitoring of field:** Arsenic (As) accumulation in the selected maximum, medium and low/no arsenic affected field will be monitored over one year. In the year, during each crop season, periodic sampling and testing of irrigation water-soil-mulberry (root, shoot and leaf)-silkworm ('V' instar) will be undertaken.

Step 2: Laboratory experiment:

i. **Incubation study:** To ascertain Zn-As interactions in the selected maximum and medium arsenic affected field soils, an incubation study will be conducted in a factorial randomized block design experiment, taking the soil samples (5 g each) from the selected experimental fields, and subjecting them to three concentrations of Zn, namely 0, 2.5 and 5.0 mg Zn/kg. The soil samples will be maintained at a moisture content equivalent to just-saturation stage. The incubated soil samples will be kept inside an incubator at 30°C for different periods of 10, 25 and 35 days. At the end of each period, the appropriate soil samples will be extracted with 0.5 M $NaHCO_3$ (pH 8.5) for extractable As, and DTPA-TEA extractable available The As and Zn contents in the soil extracts will be measured by the appropriate analytical methods (Das *et al.*, 2016).

ii. **Pot-culture experiment:** Soils from the selected maximum and medium arsenic affected fields will be used for pot-culture experiment (each treatment to be replicated thrice) in glasshouse. For the control pot, soil from low/no arsenic affected field will be used. The same age sapling of S1635 will be planted in each pot. The potted plants will be treated with three doses of Zn (0, 10, and 20 kg/ha zinc) in the form of zinc sulphate as basal application. The Zn will be applied along with standard doses of N, P, K fertilizers after 200th day (180 days after planting + 20 days after 1st pruning) of plantation. The soils in the pots will be irrigated with As free water and will be maintained at the field capacity of the soil with the help of a tensiometer. The As uptake and accumulation parameters will be measured periodically at the 225th day (*i.e.*, 45th day after 1st pruning) and 245th day (65th day after 1st pruning, *i.e.*, on the day of harvest) of plantation. (Das *et al.*, 2013).

Step 3: Field Trail:

To validate the findings from the laboratory incubation and pot-culture studies, a field experiment will be conducted (in a randomized block design mode) in the selected field with maximum As-contamination. The crop will be grown following the standard packages of practices (*i.e.*, fertilizer dose, etc.). The crop will be treated with three doses of Zn (0, 10, and 20 kg Zn/ha/yr) in the form of zinc sulphate as basal application. The Zn will be applied along with fertilizers in 5 splits/yr (*i.e.*, at each crop season). Periodic observations, namely, growth parameters, yield, etc., will be recorded during the field experiments. In addition, soil and plant samples at each crop season will be collected to monitor the As accumulation in different plant parts, subjected to different Zn treatments. Soil, plant (root, shoot, leaf) and silk worm larva ('V' instar) samples will be analyzed by the methods described earlier (Mogren *et al*., 2012; Das *et al.*, 2016).

17.2 ORGANISATION OF WORK ELEMENTS:		
Name of the Scientist	Project Capacity	Work Component
Kanika Trivedi	Executive authority	Scrutinizing project proposal in terms of its viability towards appropriate execution and evaluation of final outcome in terms of its viability as technology package
Monica Chaudhuri	Coordinator	Coordination among nested units and DOS with the purpose to generate information on arsenic

		status in mulberry sericulture in arsenic contaminated districts of West Bengal and also to develop the management packages for mitigating the same.
Vijay V	Principal Investigator	Project preparation/formulation, literature review, execution of experiments, analysis of samples, data compilation and analysis, interpretation of results and submission of final report
Kar R	Co-Investigator	Project preparation/formulation, literature review, execution of experiment, analysis of samples, data compilation and analysis, interpretation of results and submission of final report
Mahesh R	Co-Investigator	Execution of agronomic activities related to the study.
Das GC	Co-Investigator	Execution of field survey and experimentation under Karimpur-I and Jalangi block of Nadia and Murshidabad district, respectively, in association with the Department of Sericulture, Government of West Bengal
#	JRF	Assisting the principal investigator for undertaking all sorts of work for successful implementation of the project. Collection of samples and appropriate processing of the same for evaluation of arsenic status and analytical works.

17.3	PROPRIETARY / PATENTED ITEMS, IF ANY, EXPECTED TO BE USED FOR THIS PROJECT	Not applicable
17.4	SUGGESTED PLAN OF ACTION FOR UTILIZATION OF THE EXPECTED OUTCOME FROM THE PROJECT	Specific information will be generated regarding arsenic status in soil, mulberry leaf as well as silkworm larva (V-instar). Subsequently, dose of zinc application to soil will be standardized in respect of its decontamination effect on arsenic in the food-web of silkworm.

17.5. TIME SCHEDULE OF ACTIVITIES GIVING MILESTONES				
Sl No.	Milestone / Activity	Expected Date of		Expected outcome/ visible / measurable indicators
		Starting	Completion	
Step-1	i. Selection of study area/plot	November,2016	April, 2017	Out of 90 sites in the selected blocks, 3 sites (Maximum, Minimum and Low/No arsenic contaminated) will be selected for further study.

	ii. Monitoring of arsenic accumulation in the 3 selected fields (Maximum minimum and low/no arsenic contaminated) and samples	April,2017	March, 2018	Provide information on periodic/crop wise variation of arsenic build-up in the selected sites and respective samples.
Step-2	i. Incubation study	April,2017	September, 2017	Zn-As interactions in the selected soils will be ascertained.
	ii. Pot-culture experiment	April,2017	March, 2018	i. Effect of the soil arsenic on growth parameter of potted plants and arsenic uptake by the same will be studied. ii. Effect of Zn (0, 10, and 20 kg Zn/ha) treatment in that soil will be ascertained.
Step-3	i. Field trial	April, 2018	August, 2019	Findings from the laboratory incubation and pot-culture studies will be validated in appropriate field experiments.
	ii. Final Report preparation	September, 2019	October, 2019	Submission of Report

PART IV: BUDGET PARTICULARS

18. BUDGET (in rupees): [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.):

Sl. No.	Item	1st year	2nd year	3rd year	Total
01	FIAS-100 compatible with Aanalyst 200 (Make: Perkin Elmer); IEEE cable; GPIB card; Syngistix Software; EDL Driver Assembly for EDL Lamp; EDL-As; Argon gas cylinder as well as regulator.	11,00,000=00	-	-	11,00,000=00
02	Tensiometer with Accessories	50,000=00	-	-	50,000=00
	TOTAL	**11,50,000=00**	**-**	**-**	**11,50,000=00**

B. Recurring:

B1. Manpower:

Sl. No.	Position	1st year	2nd year	3rd year

1	JRF	The JRF provided under the Soil Testing Project (PPS 3600) may be utilized for analysis of arsenic etc. (CO let. no.CSB-31/2(BER-NP)/2013-14-RCS Dt. 24.10.2016)

B2: Consumables:

Sl. No.	Item	1st year	2nd year	3rd year	Total
01	Chemicals, Kits, Outsourcing, Fertilizers & manure	1,50,000=00	1,50,000=00	1,00,000=00	4,00,000=00
02	Glassware & plastic wares	10,000=00	10,000=00	-	20,000=00
	Sub-total B2:	**1,60,000=00**	**1,60,000=00**	**1,00,000=00**	**4,20,000=00**

Other Items:

Sl. No.	Item	1st year	2nd year	3rd year	Total
B3	Travel	5,000=00	5,000=00	5,000=00	15,000=00
B4	Contingency	20,000=00	20,000=00	10,000=00	50,000=00
B5	Overhead charges	-	-	-	-
	Sub total (B3+B4+B5)	**25,000=00**	**25,000=0**	**15,000=0**	**65,000=00**
	Total (**B1+B2+B3+B4+B5**)	**1,85,000=00**	**1,85,000=00**	**1,15,000=00**	**4,85,000=00**

Total (A+B) = Rs. 16,35,000 (Sixteen lakh thirty five thousand only)

PART V: EXISTING FACILITIES

19. AVAILABLE EQUIPMENTS AND ACCESSORIES TO BE UTILIZED FOR THE PROJECT:

[Should be provided separately for each of the Institute]

Sl. No.	Name of the Equipment/ Accessory	Make	Model	Funding Agency	Year of Procurement
01	Atomic Absorption Spectrometer	Perkin Elmer	AAnalyst 200	CSB	2009

PART VI: REFERENCES

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PART VII: BIODATA OF INVESTIGATORS

INVESTIGATOR-I

1. Full Name (in Block letters) : Dr. VIJAY V
2. Designation : Scientist-B
3. Department/Institute/University : Mulberry Pathology Section, Central Sericultural Research and Training Institute, Berhampore (WB)
4. Address for Communication : Mulberry Pathology Section, Central Sericultural Research and Training Institute, Central Silk Board, MoT, Govt. of India, Berhampore-742101, Murshidabad (D), West Bengal
5. Date of Birth : 10.04.1983
6. Sex : Male
7. Education (Post-Graduation onwards & Professional Career):

S.No.	Institution/Place	Degree Awarded	Year	Field of Study
1.	The American College, Madurai Kamaraj University, Madurai (TN)	M.Sc.	2006	Immunology & Microbiology
2.	Bharathiar University, Coimbatore (TN)	Ph.D.	2015	Biotechnology

8. Honors/Awards: Not applicable
[Not required for in-house personnel]
9. Positions 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 (Numbers only):
Books: 0 Research Papers: 1 Reports: 0 General articles: 0 Patents: 0
Others: Proceedings – 1; Abstract – 1; GenBank submissions – 5

13. Project (s) submitted/ being pursued/ carried out by investigator: 01

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

INVESTIGATOR-II

1. Full Name (In Block Letters): DR. RANJIT KAR
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.

INVESTIGATOR-III

1. Full Name (In Block letters) : Dr. Mahesh R
2. Designation : Scientist-B
3. Department/Institute/University
   Address for communication : Agro-Physio-Farm Management,
   Central Sericultural Research & Training Institute,
   Berhampore - 742 101
   Dist. Murshidabad, West Bengal
4. Date of birth : 25.05.1985
5. Sex : Male
6. Education (Post Graduation onwards & Professional Career):

Name of the University	Degree Passed	Year of Passing	Subject taken with specialization	Class/ Division
Tamil Nadu Agricultural University	M.Sc (Ag)	2009	Agriculture (Agronomy)	1st
Tamil Nadu Agricultural University	Ph.D (Ag)	2016	Agriculture (Agronomy)	1st

Memberships/fellowship: -

1. Life member in Valarum Velanmai – Tamil Magazine
2. Life member in Trends in Bio science – Journal
3. Annual member in Madras Agricultural science Journal

Patents: (Not required for in-house personnel)

Publications (Number only):

Book	:	1nos
Technical bulletin	:	4nos
National article published	:	3nos
Articles in the proceeding of national conferences	:	5nos
Book chapters	:	5nos
Training attended	:	1nos
Leaflets	:	1nos
International Magazines	:	2nos
Conferences attended (National)	:	7nos
Abstract published	:	6nos
Newspaper cuttings published	:	3nos

INVESTIGATOR-IV

1. Full Name (In Block Letters): Mr. GOPAL CHANDRA DAS
2. Designation: Scientist -C
3. Department/ Institute/university: Central Sericultural Research and Training Institute
4. Address of communication: Central Sericultural Research and Training Institute, Berhampore –742101, Murshidabad, W.B.
5. Date of Birth: 01.05.1961
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**
Calcutta University	M. Sc. (Zoology)	1983	Entomology	1st Class

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): 12
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)**

Outcome of the Project: Four Hybrids Selected & recommended for commercial exploitation from two projects concluded during 2005-2008:

i. On farm trials of evolved bivoltine and multivoltine congenic breeds and their hybrid performances at farmers' level **[AIB-3349 (**2005-2007**)] (Co-I)**

ii. MSRAP-Phase VII: as a Zonal Coordinator, conducted trial in 20 test centers in Eastern and North Eastern zone **[AIE-3243 (**2005-2008**)]**

Hybrids recommended for commercial exploitation:

i. Two multi x bi hybrids [MCon1 x BCon4 & MCon4 x BCon4] recommended for favorable season with yield potential of 45-50 kg/100 dfls having 18% yield gain over the ruling M x B hybrid.

ii. Two Multi x Multi hybrids [MCon1 x MCon4 & N x MCon4] recommended for unfavorable Season with yield potential of 30-35 kg/100dfls having 12 % yield gain over ruling hybrids.

PART VIII: 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.
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/ competent authorities and the same would be conveyed to the Department of Biotechnology before implementing the project.
g) It is agreed by us that any research outcome or intellectual property right(s) on the invention(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.
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 to 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 Project Coordinator

Date:

2. Signature of Executive Authority of Institute with Seal

Date:

3. Signature of Principal Investigator

Date:

4. Signature of Co-Investigator

Date: