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 & Training Institute,** Central Silk Board, Ministry of Textiles: Govt. of India, Berhampore - 742 101, West Bengal, India
2.	Status of the Institute(s)	:	NA
3.	Name(s) and designation of the Executive Authority of the Institute / University forwarding the application	:	Dr. S.NIRMAL KUMAR DIRECTOR
4.	Project Title	:	**PIB-3515:** **Evaluation of Newly Developed Triploid Mulberry Varieties under Irrigated condition**
5.	Category of the Project	:	Applied
6.	Specific Area	:	P – **P**lant I – **I**mprovement B - **B**reeding
7.	Duration	:	3 years (June, 2014 to March, 2017)
8.	Total cost:	:	**Rs.1.00 Lakh**
9.	Is the Project is 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	:	NA

11a. PROJECT SUMMARY:

In mulberry, triploids are regarded to have many superior traits like wider adaptability and higher leaf yield. Triploid mulberry varieties exhibit better rooting ability than diploids and tetraploids. The high yielding ruling variety, S-1635, is also a natural triplopid. The variety recommended for drought prone area, i.e. C-1730 is also a triploid. Recently, Tr-23, a triploid, was found to perform better than ruling variety.

Outcome of the previous project (PIB-3365), **15** new promising triploid varieties were developed by conventional breeding method by using promising tetraploid and diploids from the genetic resources of this Institute.

In the proposed project the newly developed 15 promising triploid mulberry varieties will be evaluated through **Primary Yield Trial (PYT)** for a period of two years to short list 5-6 better performing varieties for **Final Yield Trial (FYT).**

11b. AIMS AND OBJECTIVES:

Evaluation of newly developed triploid mulberry varieties under irrigated condition for better productivity and quality.

PART II: PARTICULARS OF INVESTIGATORS

12. NAME, DESIGNATION AND ADDRESS OF THE PROJECT CO-ORDINATOR: NA.

12 a) INVESTIGATORS

Name : Dr. P.K. Ghosh, Scientist-C
Date of birth : 06.06.1957
Sex : Male
Address **: Central Sericultural Research & Training Institute,** Central Silk Board, Ministry of Textiles: Govt. of India, Berhampore - 742 101, West Bengal, India

Name : Dr. M.K. Ghosh, Scientist-D up to 31.03.2016
Date of birth : 11.01.1959
Sex : Male
Address : CSRTI, Berhampore, West Bengal

Name : Mr. D Chakravarty, Scientist-D from 14.07.2016
Date of birth : -
Sex : Male
Address : CSRTI, Berhampore, West Bengal

Name : Dr. S.K.Dutta, Scientist-D
Date of birth : 20.04.1957
Sex : Male
Address : CSRTI, Berhampore, West Bengal

Name : Dr. Jalaja S. Kumar, Scientist-D up to 31.05.2016
Date of birth : 15.06.1962
Sex : Female
Address : CSRTI, Berhampore, West Bengal

Name : Mrs.Lalitha. N Scientist-C up to 31-10.2015
Date of birth : 26.11.1976
Sex : Female
Address : CSRTI, Berhampore, West Bengal

13. NO OF PROJECTS BEING HANDLED BY EACH INVESTIGATOR AT PRESENT

1. Dr. P.K. Ghosh : 03
2. Dr. M.K. Ghosh : 03
3. Dr. Jalaja S. Kumar : 01
4. Dr.S.K.Dutta : 02
5. Mrs.Lalitha .N : 03

14. PROPOSED RESEARCH FELLOWS: NA

PART III: TECHNICAL DETAILS OF PROJECT

15. INTRODUCTION:

The mulberry breeders at different Research Institutes have developed and released many varieties like Kanva-2, S-36, S-34, V-1 (for irrigated), S-13, S-34,MR-2, DD (for rainfed), Goshoerami, China White (for temperate) and Chack Majra (for Sub-Temperate Hills). Though these varieties have high potentiality to produce 30-70 mt. leaf/ hectare/year in their respective areas of release but in the field trial under irrigated condition of West Bengal they do not yield more than S-1635 ruling existing mulberry variety, which is a triploid. S-1635,a triploid variety was established as a top yielder for the Gangetic allouvial soil of West Bengal and was authorized for cultivation during the first phase of AICEM.

Triploids like Tr-4 and Tr-10 have been recommended in the hilly areas of Eastern India. In Japan five triploid varieties have been registered for releasing in the field. Triploid mulberry varieties are generally superior in feeding value in comparisons to their diploid counterparts (Sarkar, 1993). Triploids are also known to be tolerant to adverse abiotic stress (Filippovich and Strasnova, 1965).

It is evident from the research findings that the triploid mulberry is superior both in terms of quality and quantity and also suitable for the silkworm, *Bombyx mori* L. rearing (Das and Prasad, 1974).

Therefore, importance of the proposed project gains weight due to the fact that new high yielding triploid varieties need to be developed under the local prevailing conditions for better exploitation in this zone.

In the concluded project, **PIB-3365**, 15 progenies were identified as triploids and those triploids registered leaf yield to the tune of 578 to 982 g/plant/crop. Besides, stomatal frequency and guard cell size of the same ranged from 67 to 124 /mm^2 and from 325.79 to 406.39 μm^2, respectively.

Much attention towards polyploid breeding in mulberry was given in Japan during the first decade of 1900 when the existence of a large number of natural triploids and their significant contribution to the quality and quantity of silk production was realized. These findings opened up new vistas in the field of mulberry breeding throughout the world.

Among the naturally occurring polyploid species, a high degree of polyploidy was found in mulberry. The range of polyploidy varies from triploid (3x) to decosaploid (22x). In India two polyploid species, viz. tetraploid (4x, 2n=56) in *Morus laevigata* and hexaploid (6x, 2n=84) in *Morus serrata* are available in the natural habitat. Few other polyploids, viz. *Morus tiliafolia*, a hexaploid (6x, 2n=84), *Morus nigra*, a decosaploid (22x, 2n=308), *Morus cathyana* with tetraploid (4x, 2n=56), hexaploid (6x, 2n=84) and octaploid (8x, 2n=112) are available in Japan.

China is also rich in naturally occurring polyploids. In 1991, Jinhou *et al*. reported the existence of 60 triploids, 5 tetraploids, 46 hexaploids, 1 octaploid and 1 decosaploid forms.

15.1: DEFINITION OF THE PROBLEM

Utilization of genetic efficiency to develop suitable high yielding adaptive mulberry varieties for commercial exploitation.

15 a. ORIGIN OF THE PROJECT

Apart from the conventional breeding techniques used for development of high yielding mulberry, polyploid breeding was also attempted earlier in India, China and Japan. Triploid mulberry varieties are generally superior in feeding value in comparison to their diploid counterparts. In India, Tr-4 and Tr-10 have been recommended in the hilly areas of Eastern India. In Japan five triploid varieties have been registered for releasing in the field. S-1635, a triploid variety was established as a top yielder for the Gangetic alluvial soil of West Bengal. It is evident from the research findings that the triploid mulberry is superior both in terms of quality and quantity and also suitable for the silkworm, *Bombyx mori* L. rearing (Das and Prasad, 1974). Therefore, it is highly imperative to improve mulberry by developing triploid varieties.

In the concluded project, PIB-3365, 15 progenies were identified as triploids and those triploids registered leaf yield to the tune of 578-982 g/plant/crop. Besides, stomatal frequency and guard cell size ranged from 67 to 124 /mm^2 and from 325.79 to 406.39 μm^2, respectively

15 b. EXPECTED OUTCOME

Out come of the project is expected to shortlist 5-6 promising varieties capable of providing significantly higher leaf yield as compared to the ruling triploid variety, S-1635 which will be further tested through Final Yield Trial (FYT).

15.2: ORIGIN OF THE PROPOSAL/ RATIONALE OF THE STUDY

Mulberry leaves with superior quality and higher yield are the essential requirement for quality cocoon production. Although a large number of mulberry varieties are available in the field, high yielding varieties for commercial exploitation are very limited. On the other hand, introduction of new silkworm hybrids, more number of silkworm crops in a year, limitation of cultivated land, demand for production of high quality silk, etc. have further intensified the demand for superior mulberry varieties.

In polyploidy breeding, polyploids are regarded as superior in many characters. Yet due to increase in leaf coarseness, more hairiness of leaf, less leaf yield etc., mulberry tetraploids and its higher levels are found unsuitable for silkworm rearing.

On the other hand, triploid mulberry varieties exhibit better rooting ability than both diploids and tetraploids and possess high rate of growth and development. The leaf yield in

triploids is higher than tetraploids. The leaves of triploids are less hairy than tetraploids and palatable to the silkworm larvae.

In the concluded project, PIB-3365, 15 progenies were identified as triploids and those triploids registered leaf yield to the tune of 578-982 g/plant/crop. Besides, stomatal frequency and guard cell size of the same ranged from 67 to 124 /mm^2 and from 325.79 to 406.39 μm^2, respectively

In view of the above, the present project is proposed to evaluate the newly developed promising high yielding triploid mulberry varieties in terms of their productivity and quality through Preliminary Yield Trial (PYT).

15.3: RELEVANCE TO THE CURRENT ISSUES AND EXPECTED OUTCOME

Nowadays, horizontal increase of the sericulture industry is becoming a plateau and the expansion of the industry depends on the vertical improvement in terms of production of mulberry which will, in turn, per unit area to generate more income . Triploid breeding in mulberry has been found to be one of the effective technique to boost up the leaf productivity.

The expected out come of this PYT will be identification of 5-6 superior triploid mulberry varieties with significantly higher productivity as compared to the ruling one.

15.4 OBJECTIVES

Evaluation of newly developed triploid mulberry varieties under irrigated condition for better productivity and quality.

16. REVIEW OF STATUS OF RESEARCH AND DEVELOPMENT OF THE SUBJECT.

16.1 INTERNATIONAL STATUS

Triploid varieties are extensively cultivated in Japan, particularly in its northern parts, for their superior quality of leaves and cold and disease resistance (Sugiyama, 1959).

Osawa (1920), Seki (1951-1952) and Tojyo (1956) have so far reported 122 triploid varieties of mulberry from different parts of Japan. Triploids are usually produced by crossing diploids and artificially induced tetraploids. Besides, utilizing the induced tetraploids for higher yields and silkworm feeding; they may serve as a source of breeding material for the production of triploid varieties. Much attention towards polyploidy breeding in mulberry was paid in Japan during the first decade of 1900 when the existence of a large number of natural triploids and their significant contribution to the quality and quantity of silk production was realized (Osawa, 1920).

China is also rich in naturally occurring polyploids. In 1991, Jinhou *et al.* reported the existence of 60 triploids, 5- tetraploids, 46- hexaploids, 1-octaploid and 1-decasoploid.

The reason for the existence of such a large number of polyploids, especially triploids in mulberry, under natural conditions was postulated by a Japanese cytologist Osawa in 1920. According to him, there may be three possible mechanisms for natural occurrence of triploids: a)

crossing between diploid and tetraploid, b) formation of diploid gamete cells in diploid plants, caused by rapid lowering of temperature at the time of meiosis and , c) originally from triploid varieties.

Seki (1952) reported that the main cause for natural triploid formation was the crossings between diplodized gamete induced by low temperatures due to frost and normal haploid gamete.

In spite of the large natural assemblage, the natural triploids were not highly popularized commercially in the late stage in India due to low leaf yield and poor propagation ability.

In Japan, five triploid varieties viz. Shinkenmochi, Aobanezumi, Mitsushigeri, Yukimasari and yukiasahi have so far been registered for release in the field. Triploid mulberry varieties are generally superior in feeding value in comparison to their diploid counterparts (Dzhafarov and Gadzheiev, 1972).

Machii *et al.* (1997) suggested a model guideline for characterization and evaluation of mulberry genetic resources. Under the model proposed by them, the essential and optimal characters were broadly classified into these categories namely.

1. Primary characters which include the morphological parameters characterizing stem, leaf, petiole, flowers and seeds.
2. Secondary characters include sprouting, rooting and tolerance to biotic and abiotic stresses.
3. Tertiary characters include mostly the quantitative characters such as shoot weight, leaf weight and nutritional status, specially the nitrogen content of mulberry leaf.

An intensive review of mulberry evaluation in the temperate countries like China, Russia and Japan revealed that a number of mulberry varieties were developed by the breeders for temperate conditions which have potentiality to sprout and grow well immediately after cold spell. In Russia two mulberry varieties, Zimestojkij (Filippovich and Strasonova, 1965) and Ukranin-1 (Pryluckyj, 1969) were developed which are tolerant to cold and sustain almost growth during cooler months.

16.2 NATIONAL STATUS

Sikdar *et al.* (1965) developed a total of 33 triploids by using 2 female and 7 male tetraploids by controlled crossing with 18 selected diploid genotypes.

Das and Prasad (1974) evaluated the quality of 4 polyploid mulberry varieties viz., 2 tetraploids (T1 and T20) and 2 Triploids (Tr8 and Tr 10) against the diploid control. Chemical analysis revealed that protein content, total sugar content and minerals were distinctly higher in triploid varieties. The chemical superiority of the tetraploids could not be established. Overall performance of the variety Tr-10 (Triploid) has been found to be the best. Another notable feature of the polyploid leaf feeding has been a significantly lesser consumption of leaf showing the possibility of reducing the cost of cocoon production through their use.

According to Tikader *et al.* (1996) in a propagation study on diploid, triploid and tetraploid mulberry, maximum survival percentage was revealed in triploids (71.81%) followed by diploids (66.67%) and 59.17% in tetraploids.

Raghunath *et al.* (1993) opined that the induction of polyploidy is playing a vital role in the improvement of mulberry. The prime objective of mulberry breeding is to develop high productive genotypes with quality leaves in a shortest possible time at a reasonable cost. Since 1960, the Institute has developed a number of high yielding mulberry varieties namely S-1, S-1635, C-763, C-776, $BC_2$59, Tr-10, Tr-4 and C-1730 and recommended for different regions (Das *et al.,* 1970; Das and Prasad, 1974; Das, 1983; Sarkar, 2000). These genotypes are superior in quality with average leaf yield ranging between 30 and 40 mt/ha/year compared to 12-13 mt/ha/year of local cultivars (Das and Krishnaswamy, 1969; Annual Report, CSR&TI, Berhampore, 1997-1998).

The mulberry breeders at different Research Institutes have developed and released many varieties like Kanva-2, S-36, S-34, V-1 (for irrigated), S-13, S-34, MR-2, DD (for rainfed), Goshoerami, China White (for temperate) and Chack Majra (for Sub-Temperate Hills). Though these varieties have high yield potentiality to produce 30-70 mt. leaf/ hectare/year in their respective areas of release but in the field trial under irrigated condition of West Bengal they do not yield more than S-1635, the ruling existing mulberry variety.

According to Sarkar (2000), apart from the conventional breeding technique used for development of high yielding mulberry, polyploidy breeding and mutation breeding were also attempted earlier in India, China and Japan and in the erstwhile U.S.S.R. Out of these two techniques, polyploid breeding showed more promise and a number of varieties were developed in India.

16.3 IMPORTANCE OF THE PROPOSED PROJECT IN THE CONTEXT OF CURRENT STATUS

The mulberry breeders at different Research Institutes have developed and released many varieties like Kanva-2, S-36, S-34, V-1 (for irrigated), S-13, S-34,MR-2,DD (for rainfed), Goshoerami, China White (for temperate) and Chack Majra (for Sub-Temperate Hills). Though these varieties have high potentiality to produce 30-70 mt. leaf/ hectare/year in their respective areas of release but in the field trial under irrigated condition of West Bengal they do not yield more than S-1635 ruling existing mulberry variety.

Therefore, importance of the proposed project gains weight due to the fact that new high yielding triploid varieties need to be developed under the local prevailing conditions for better exploitation in this zone.

16.4 ANTICIPATED PRODUCTS, PROCESSES/ TECHNOLOGY, PACKAGES/ INFORMATION OR OTHER OUTCOME FROM THE PROJECT AND THEIR EXPECTED UTILITY:

1**). TECHNOLOGY TO BE EVOLVED**: Nil.

11). PRODUCTS TO BE DEVELOPED: Qualitatively superior new triploid, high yielding mulberry varieties.

111).EQUIPMENT FABRICATION/DESIGN TO BE EVOLVED: Not Applicable.

1V).OTHERS: Not Applicable.

16.5 EXPERTISE AVAILABLE WITH PROPOSED INVESTIGATION GROUP / INSTITUTION ON THE SUBJECT OF THE PROJECT:

Expertise on all the parameters envisaged to be studied is available within the investigating group as all the investigators possess sufficient experience in mulberry breeding.

17. WORK PLAN
17.1 Methodology

✓ ***Plantation:***

Fifteen selected genotypes along with S-1635 as check variety will be planted in Simple Lattice Design with 4 replications in 60 cm x 60 cm spacing. Each replication will contain **16** plants of each variety and the plantation shall be maintained as per recommended package of practices for irrigated conditions of West Bengal.

MATERIALS AND METHODS

15 identified triploids will be evaluated for two years through Primary Yield Trial (PYT)

No. of triploids	: 15+ 1 Check (S-1635)
Design	: Simple Lattice
Replication	: 4
Spacing	: 60cm x 60cm

The plantation shall be maintained as per recommended package of practices for irrigated conditions of West Bengal.

✓ ***Parameters to be studied*:**

Leaf yield and yield attributes of the genotypes shall be recorded for two years after completion of one year of establishment from the date of planting. Genotypes showing superiority over the check variety shall be short-listed for further evaluation under Final Yield Trial. Data will be recorded on the following parameters:

A: Growth and yield attributing characters-

1. Days to sprout after pruning (days)
2. Number of shoots per plant
3. Total shoot length (cm)
4. Length of the longest shoot (cm)
5. Internodal distance (cm)

6. Leaf shoot ratio
7. Total leaf yield (g/plant)

B: Disease and Pest incidence recording (PDI)

Major diseases and pest reactions will be studied in each crop season. Studies will be confined to foliar diseases only.

C: Studies on leaf quality parameters of the short listed varieties

1. Leaf Moisture Percentage (%)
2. Moisture Retention Capacity (MRC) up to 6 hour
3. Chlorophyll content (Arrnon, 1949)
4. Soluble Protein ((Lowry et.al.1951)
5. Soluble Sugar (Morris, 1948)

D: Bioassay study of the short listed varieties

Moulting Test (Benchamin and Anantharaman, 1990)

Leaf quality study will be restricted to 5-6 varieties primarily short listed on the basis of the leaf yield performance of the first year. On the day of 60-65 after pruning, leaf moisture, moisture retention capacity (MRC) up to 6 h, photosynthetic pigments, soluble protein, soluble sugar, and moulting test will be measured.

D: **Assessment of leaf quality through silkworm moulting test of the short listed varieties.**

Varieties found superior in leaf yield, will be subjected to moulting test to assess the palatability and quality of leaves with the recommended Multi x Bi hybrid. Rearing will be conducted with standard rearing practices with 3 replications. The newly hatched larvae will be given for nine feedings in the first instar considering four feeding per day against thirteen feeding for normal rearing. The curtailment of around 28% of the normal feed is done as suggested for moulting test for variety screening (Bernchamin and Anantharaman, 1990). The control set of rearing with normal feeding will be compared with the treatments. The number of moult out larvae and also 100 larvae weight will be compared with the control. Higher percentage of worms moulted out will be considered for selection of the varieties.

17.2: ORGANISATION OF WORK ELEMENTS

Sl. No.	Name of the scientist	Designation	Time	Organisation of work elements
1.	Dr. P. K. Ghosh	Scientist - C	60%	Transplantation and establishment of plantation Estimation of biochemical parameters. Data compilation and analysis
2.	Dr. M. K. Ghosh Mr. D Chakravarty	Scientist - D Scientist-D	20% 20%	Recording of growth and yield attributing parameters.
3.	Dr. S.K.Dutta	Scientist - D	10%	Recording of disease incidence.
4.	Dr. Jalaja S. Kumar.	Scientist-D	5%	Bioassay through moulting test
5.	Smt.N.Lalitha	Scientist-C	5%	Recording of pest incidence.

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

The short listed 5-6 promising triploid mulberry varieties will be further evaluated through Final Yield Trial.

17.5. TIME SCHEDULE OF ACTIVITIES GIVING MILESTONES

Sl. No.	**Milestone / Activity**	**Expected Date of**		**Expected Outcome / visible/ measurable indicator**
		Starting	Completion	
1	Establishment of plantation with 15 triploids along with check (S-1635)	June,2014	April, 2015	Promising triploids will be short listed in terms of yield and quality parameters.
2	Recording of data on leaf yield contributing traits and disease as well as pest scoring	November,2015	October, 2016	
3	Assessment of quality parameters (Biochemical)	November,2015	October, 2016	
4	Assessment of leaf quality through silkworm moulting test of the short listed varieties.	November,2016	December,2016	
5	Preparation of final report	February, 2017	March, 2017	

17.6 PROJECT IMPLEMENTING AGENCY/ AGENCIES:

Name of the Agency	Address of the Agency	Proposed Research Aspects	Proposed Amount	Cost Sharing %
CSB	CSB, Bangalore			100 %

PART IV: BUDGET PARTICULARS

18. **BUDGET (in Rupees):** Rs.1.50 lakh

[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.) [Rupees in Lakh]:

B. Recurring:

B1. Manpower: -

Sl.No.	Position	Nos.	Consolidated Emoluments	1st Yr	2nd Yr	3rd Yr	4th Yr	Total
	JRF/SRF/RA	Nil	NA	-		-		-
	HRA	NA	NA	-		-		-
	CCA	NA	NA	-		-		-
	Sub-total B1:	-	-	-		-		-

B2. Consumables: [Rupees in Lakh]:

Sl. No.	Item	1st Yr	2nd Yr	3rd Yr	Total
1.	Stationeries/ Office Contingencies.	0.05	0.05	0.05	0.15
2.	Research Operations (FYM, Fertilizers, Chemicals, Glassware's)	0.20	0.20	0.20	0.60
	Sub-total B2:	**0.25**	**0.25**	**0.25**	**0.75**
B3	Travel				
B4	Contingency	0.10	0.10	0.05	0.25
B5	Overhead charges	-	-	-	-
	Sub-total (B1+B2+B3+B4+B5):	**0.35**	**0.35**	**0.30**	**1.00**

PART VI: REFERENCES

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