Pro-forma for Submission of Concluded Research Project
(To be submitted separately for each project)

I. Project code and title:

MTS-3599: "*Study on Mulberry Sericulture Production in West Bengal: A Statistical Approach*"

II. Names of the Project Investigators (including coordinator in case of collaborative projects)

Investigator	Name	Designation	Time Spent (%)
Principal Investigator	Dr. Manjunatha. G. R	Scientist-B	60%
Co-Investigator	Mr. Shafi Afroz	Scientist-B	10%
Co-Investigator	Dr. S. Chanda	Scientist-D	10%
Co-Investigator	Dr. Dipesh Pandit	Scientist-D	10%
Co-Investigator	Dr. Tapati Datta Biswas	Scientist-D	10%

III. *Duration* (Date of Start - Scheduled Date of Completion):

1.5 year (November, 2016 – April, 2018)

IV. Name(s) of the Institute(s) and Address:

Central Sericultural Research and Training Institute, Central Silk Board, Ministry of Textiles. Govt. of India. Berhampore – 742101, Murshidabad, West Bengal

V. A list of Objectives/Goals (clearly indicating how far they have been achieved indicating the difficulties/reasons in case of achievement gap):

- To analyze the trends in mulberry cocoon production in West Bengal
- To estimate costs and returns of mulberry cocoon production
- To assess resource use pattern and resource use efficiency of sericulture farmers

VI. Introduction:

In India, marginal and small land holders are predominant and lack alternative sources of income and employment for their sustainable livelihood. In this regard, Government of India is encouraging regular income and employment oriented farming approaches, one such potential farming enterprise is sericulture (Roopa and Murthy, 2015). India is the second largest producer of raw silk in the world. Its production has shown a notable progress during 2014-15. The growth was around 8.4 per cent which is on the lower side in comparison with leading silk producing country like China (Anonymous, 2015).

Sericulture in India plays an important role in poverty alleviation. Compared to agricultural crops, sericulture provides year round employment and higher incomes to the rural farm families. It has generated employment for about 8.03 million farmers in 2014-15 as compared to 7.85 million in 2013-14 with a growth of 2.29%. Most of the beneficiaries are marginal farmers, women farmers and farmers belonging to the weaker section of the society (Anonymous, 2015). Micro level studies (Lakshmanan and Geetha, 2005) indicated that mulberry sericulture practiced on an acre generated employment of 506.20 mandays from leaf to cocoon stage of production.

Sericulture, a rural-agro based cottage industry occupies major chunk of silk production (75%). In India, it is practiced mainly in five traditional states. Amongst five, West Bengal ranks third and fourth in terms of mulberry silk production and total silk production, respectively.

Sericulture has historical background in case of West Bengal. The authenticated history is available from the beginning of 18^{th} century. Currently, West Bengal accounts for 14.5 per cent of the country's cocoon production in the vertex of the silk map (Anonymous, 2015). In the state, mulberry is cultivated in 2000 villages with plantation area of 37,883 acres (Anonymous, 2016). Though, West Bengal has historical background in the silk but Southern states of India are leading in mulberry raw silk. Thus, the study has been initiated to ascertain the trend in mulberry acreage, mulberry cocoon & raw silk production of the state. In addition, study was also taken-up to assess resource use pattern with respect to economic efficiency.

VII. Methodology Adopted:

The present study included selection of study area, sampling design, nature and source of data, collection of data, data editing and statistical tools.

7.1. Selection of study area

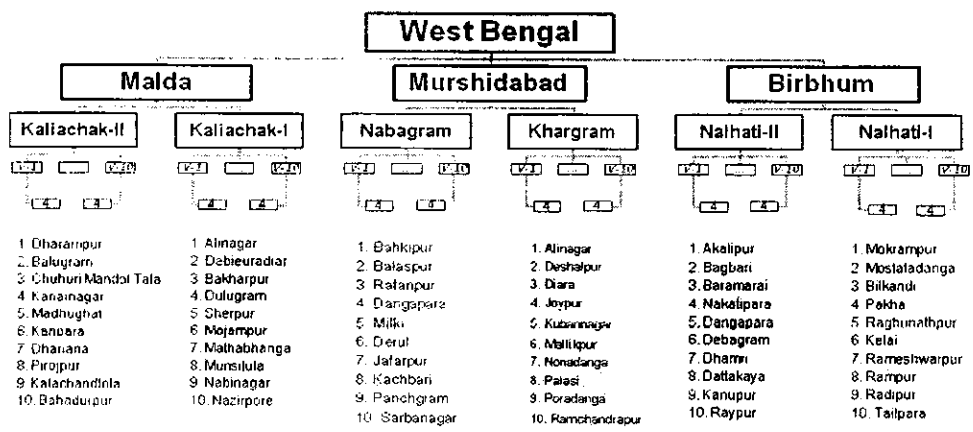
The study area comprised of traditional mulberry growing districts viz. Malda, Murshidabad & Birbhum of West Bengal. The districts were selected considering their contribution towards the growth of sericulture in the State. The study in these districts was hypothesized to represent the state as a whole.

7.2. Nature and source of data:

The study was based on *primary and secondary data*. The *primary data was collected using pre tested structured questionnaire (Annexure-I)* encompassing details of socio economic status of family, cropping pattern, variety of crop and breed reared, inputs used, technology adopted, cost and returns etc. from the respondents. The *secondary data was collected from 1989 to 2016 from authenticated sources (DoS, Govt. of WB)* to assess trends in area of mulberry, production of cocoon and raw silk of mulberry in the region.

7.3. Sampling design and collection of data:

Multistage purposive and random sampling design was adopted for the selection of districts, blocks, villages and sericulture farmers. Accordingly, three traditional districts (Malda, Murshidabad and Birbhum) were selected considering their contribution towards sericulture in the past decades. A total sample size of 240 respondents was considered from the study area (40 from each block). of these respondents were mentioned in *Annexure-II*.



7.4 Use of statistical tools:

The statistical analysis were performed using *MS excel, Systat 13 and R software*.

a) Parametric trend models: To trace the path of production process, different parametric trend models were used. Among the competitive trend models, the best model was selected based on maximum R^2 value, minimum RMSE (Root Mean Square Error) and significance of the parameters. Different trend models used were

Polynomial Model	$Y_t = b_0 + b_1 t + b_2 t^2 + b_2 t^3 + \ldots + b_k t^k$
Linear Model	$Y_t = b_0 + b_1 t$
Quadratic Model	$Y_t = b_0 + b_1 t + b_2 t^2$
Cubic Model	$Y_t = b_0 + b_1 t + b_2 t^2 + b_2 t^3$
Exponential Model	$Y_t = b_0 e^{(b_1 t)}$
Logarithmic Model	$Y_t = b_0 + b_1 \ln(t)$
Growth Model	$Y_t = e^{(b0 + b_1 (t))}$

b) Tabular analysis was performed to work out economics of mulberry and sericulture production. Both implicit and explicit cost was considered while working out economics. Economics includes estimation of standard cost concepts, gross returns and net returns. The details of standard cost concepts is given below.

- **Cost A1:** The actual expenses incurred in production by owner operator. The items included are wages of hired human labour, charges for bullock and machine labour, market rates of manures, seeds (cuttings/saplings), fertilizer, plant protection chemicals and other necessary inputs, depreciation of implements, machinery and farm buildings, irrigation charges, cess and other taxes, land revenue, amortized establishment cost for perennials, interest on working capital and fixed cost, processing and marketing costs.
- **Cost A2** = Cost A1+ rent paid for leased in land.
- **Cost B1** = CostA1+ interest on owned fixed capital (other than land). Building is one of the key requirement for the prosperous sericulture. In order to encourage capital formation in sericulture, this tendency needs to be strengthened. Hence, it is essential to consider the interest on the fixed assets while estimating the cost of mulberry cultivation /silkworm rearing/ reeling.
- **Cost B2** = Cost B1 + rental value of owned land (net of land revenue) + rent paid for leased land. The Commission of Agricultural Costs and Prices consider $1/6^{th}$ of the gross value of produce minus land revenue, taxes and cesses as the imputed value of the rent for the owned land. However, in the present study, the opportunity cost of land was considered for estimating the rental value. The

rainfed paddy was the 'next best alternative' crop for the land devoted for mulberry in the traditional region.

- **Cost B=Cost B2**
- **Cost C1** = Cost B1+ imputed value of family labour at the rate of attached farm labour wherever available or else the wage rate of the casual labour. If the family labour does the skilled jobs like tractor driving, harvesting of mulberry leaves, feeding, bed cleaning, and reeling of cocoon, the ruling wage rate was considered.
- **Cost C2** = Cost B2+ imputed value of family labour
- **Cost C3** = Cost C2 + 10 per cent of Cost C2 towards the managerial functions performed by stakeholders.
- **Cost C= Cost C3**

c) Data Envelopment Analysis:

It is a non parametric and deterministic measure of efficiency. It is an alternative approach to stochastic production function and is devoid of assumptions pertaining to distribution or functional form. *Cost efficient input oriented constant returns to scale model was employed to assess efficiency of sericulture farms.* The analysis was performed using software designed by *Coelli* which encompasses technical efficiency, allocative efficiency and cost/ economic efficiency. The term ***technical efficiency*** indicates the ability of the farm to produce maximum output from a given set of inputs, whereas ***cost efficiency*** requires achieving the lowest possible cost, given the current prices and firms output. Sericulture farms were considered as decision making units (DMUs). Farms aim at minimizing usage of inputs in general and labour in particular to attain desired level of output. To ascertain efficiency, production frontier was constructed in DEA approach based on linear programming. The term envelopment is derived from production frontier which envelops the set of observations. *For each DMU, sericulture output (cocoon yield), human labour (mandays), dfls and mulberry leaves fed and their corresponding unit prices (input category) were considered in the calculation of cost- DEA efficiency score*. The best DMU operates at 100 percent technical efficiency (efficiency score =1) and the DMU with lower technical efficiency (score <1) works at a percentage less than 100. ***Allocative efficiency*** or otherwise called as pricing efficiency relies on cost of inputs. It is related to cost of inputs in relation to output, and equilibrium condition is attained when marginal cost equates average revenue. DMU's allocative efficiency is with regard to the allocation of inputs vis-a vis its price for a given level of output, so as to minimize the cost of production. *The cost efficiency refers to the product of technical and allocative efficiencies expressed in percentage*.

7.5 Definition of terms and concepts used:

- ✓ Planting material: Cuttings /saplings are the planting material used in mulberry cultivation. It was valued at current market rate.
- ✓ Cost of dfl: The cost of dfl was calculated at the actual price paid by farmers plus the incidental costs incurred on its procurement.
- ✓ Cost of mulberry leaf: The actual quantity of mulberry leaf consumed for the silkworm was multiplied by the imputed cost of leaf (per kg). In case of shortage, purchased leaves at prevailing market price was considered.
- ✓ Cost of disinfectants: It was the cost of all the chemicals used to disinfect the rearing house after every rearing process. The actual purchase price of all the chemicals was considered for cost accounting disinfectants.
- ✓ Human labour: Human labour was valued at the prevailing wage rate on per man-day basis. The cost of family labour was imputed at the prevailing wage rate. The man-day equivalents of women and child labour were worked out using respective wage ratios.
- ✓ Cost of paraffin paper or news paper: the actual purchase price of the news paper (Rs. 10 - 12 per kg) was considered.
- ✓ Apportioned cost of rearing house and depreciation charges of rearing equipments: Investment made on rearing house was apportioned over its useful life years. The rearing equipments comprised of rearing stands, mountages and leaf cutting knives. The depreciation charges were worked out using *straight line method.* The life span refers to average expected life of the asset as furnished by the farmers.

$$\text{Annual depreciation} = \frac{\text{Purchase value} - \text{Junk value}}{\text{Life span of the asset}}$$

- ✓ Land rent: Net returns foregone from the land utilized for cultivation of paddy crop was considered as the opportunity cost of land. The average land rent prevailing was ~Rs. 4000 to 5000 per bigha (3 bigha=1 acre).
- ✓ Land revenue: The actual payment made to the government was considered. It was apportioned to actual area under mulberry crop. The average land revenue paid was ~Rs. 70 per bigha per year.
- ✓ Apportioned establishment cost: The establishment cost was apportioned over life span of the sericulture/ moriculture unit.

- ✓ Interest on working capital: This was computed at the rate of 12 per cent per annum on the total variable cost. It included cost of dfls. mulberry leaf, human labour, hired charges of mountages, disinfectants and disinfestations, news paper, cocoon picking (harvesting) cost and marketing cost.
- ✓ Interest on fixed capital: The opportunity cost of fixed capital was worked out considering the interest rate charged by commercial banks on long term loans. The rate of interest considered in the present study was 8 per cent, as prevailing interest for fixed deposits are nearly 8 percent at Banks.
- ✓ Cocoons: The main product of sericulture is quality cocoons. The cocoons are valued at market price to work out gross returns.
- ✓ Gross income: The gross income realised from silk cocoon production consisted of the value of total cocoons produced and the value of other items (litter or fodder sale), if any.
- ✓ Net income: The net income from silk cocoon production was estimated by deducting the total cost of cocoon production from the gross income.
- ✓ Marketing cost: This included the cost of transportation of cocoons to the market, the market fee and other incidental expenses incurred in marketing of cocoons.
- ✓ DFLs: disease free layings, each dfl consists of 300 to 400 eggs.
- ✓ Organic manure: Total quantity of organic manure applied per year per acre was ascertained and then apportioned for each rearing season considering five rearings per annum. Its valuation was done at prevailing price per tonne.

VIII: Observations / Results duly indicating the output in terms of adding to knowledge; know-how / new packages/ practices / processes /products / innovations developed and their utility and advantages; etc.,

The results of the study are presented under the following subheads:

8.1 Estimation of trend for mulberry acreage and cocoon & rawsilk production

8.2a General characteristics of the sample respondents

8.2b Distribution of farmers based on mulberry area (total land holding size)

8.3 Operation wise labour use pattern in establishment & maintenance of mul.garden

8.4 Establishment cost of mulberry garden

8.5 Cost of cultivation of mulberry

8.6 Operation wise labour use pattern in silkworm rearing (per crop)

8.7 Cost & returns of cocoon production for marginal and small farmers

8.8 Efficiency of sericulture farms by Data envelopment analysis

8.1. Estimation of trend for mulberry acreage and cocoon & rawsilk production:

The results of trend analysis (**Table 8.1**) showed that mulberry acreage followed a trend of 3rd degree polynomial. It has recorded negative growth at the rate of 1.38 percent per annum. Cocoon and raw silk production exhibited exponential growth with positive CGR of 2.35 & 3.72, respectively.

Table 8.1: Trends for mulberry acreage, cocoon & raw silk production in West Bengal during 1989 -2016

Particulars	Model	R^2	Trend	CGR
Mulberry Area	$y = 4.7314x^3 - 28433x^2 + 6E+07x - 4E+10$	0.78	**Cubic**	-1.38**
Cocoon Production	$y = 9E-17e^{0.0232x}$	0.95	**Exponential**	2.35**
Raw silk production	$y = 2E-29e^{0.0365x}$	0.86		3.72**

*** Significant at 1%*

Inference: The results in Table 8.1 reflected that the mulberry area in West Bengal over the years has recorded declining trend while cocoon & raw silk production shown significantly increasing trend. It is because of vertical growth in productivity of mulberry & cocoon. Vertical growth may be attributed for technological interventions. In this regard, impact assessment of technologies developed in this region is inevitable.

8.2a. General characteristics of the sample respondents:

The details of general characteristics of sericulture farmers in the study area are presented in Table 8.2a. The perusal of table indicates that 44.44 percent of the respondents lie in the age group of 30-40 years. Another 33 percent of sample farmers fall in the age group of below 30 years. This result clearly indicates that majority of farmers involved in sericulture activity belongs to young - middle age group. The age factor is considered as pivotal in technology adoption. Since, majority of farmers belong to young-middle age group, adoption of technology should not be constrained by this factor in the study area. With regard to occupation, 84.45 percent of farmers were engaged in sericulture and agriculture activities and hardly 15.55 percent of farmers engaged in sericulture activity alone. Agricultural crops are grown for food purpose and sericulture is carried out for income generation. In terms of literacy, 71 percent of farmers have possessed education over and above higher primary. This

clearly indicates the existence of literacy level among sample farmers. This factor will give a further fillip for technology adoption. Average size of the family in study area was found to be five. Greater the size of family, larger will be the supply of family labour towards sericulture and agricultural operations as both of them are labour intensive. Average area under mulberry was found to be 0.78 acre. The major factor limiting the size of holding under mulberry in the study area would be the supply of labour force. Local, S1 and S1635 are the ruling mulberry varieties in the study area. The average age of mulberry garden was found to be 17 years. With regard to sericultural breeds, farmers were found to rear all the three types of breeds/hybrids such as Mutivoltine×Multivoltine (N×M12w), Multivoltine × Bivoltine (N× (SK6×SK7)) (locally called as hybrid) and Bivoltine ×Bivoltine (SK6×SK7) (locally called as F1).

8.2b Distribution of farmers based on mulberry area (total land holding size):

Table 8.2a: General characteristics of sample respondents

Sl. No.	Particulars	West Bengal [n=240]
1	**Age of the respondent (average)**	
A	<30	80 (33.33)
B	30-40	**107 (44.44)**
C	40-50	21 (8.88)
D	50-60	21 (8.88)
E	>60	11 (4.44)
2	**Occupation**	
A	Sericulture	37 (15.55)
B	Sericulture & Agriculture	**203 (84.45)**
3	**Education**	
A	Illiterates	43 (17.77)
B	Primary school	27 (11.11)
C	Higher Primary	**91 (37.77)**
D	High school	48 (20.00)
E	College	31 (13.33)
4.	**House type**	
A	Kuccha (Paat kadi)	48 (20.00)
B	Mixed	**126 (52.50)**
C	Pucca	66 (27.50)
5.	**Average family size**	5.30 [2-13]
6.	**Type of family**	
A	Joint family	69 (28.88)
B	Nucleus family	**171 (71.11)**
7.	**Average area under mulberry (Acre)**	0.78 [0.25-2.5]
8.	**Avg. age of the mulberry gardens**	17 [7-50]
9.	**A. Mulberry varieties**	Local, S1 & S1635
	B. Spacing	Layering/ 2'×2'
10.	**Silkworm breeds & DFLs rearing capacity**	N x M12w N x (SK6 x SK7) *or Hybrid* SK6 x SK7 or F1

Note: ( ) indicates the percentage contribution to the total and [ ] indicates the range of the particular item

Table 8.2b: Distribution of farmers based on mulberry area

#	Classification farmers	Avg. mul. acerage (acres)	No. of farmers	% farmers
1	Marginal (<2.5 acre)	0.66 (0.25-1.00)	204	85
2	Small (2.5-5 acre)	1.50 (1.01-2.50)	36	15
	Total		**240**	**100**

The distribution of land holding for mulberry cultivation in the study area is given in the **Table 8.2b**. From this table, it could be concluded that majority of the farmers practicing mulberry cultivation belonged to marginal category (85%) and rest were belonged to small category (15%). This clearly indicates that mulberry is practiced on a small scale due to labour constraint. This calls for research and development related to suitable mechanization of various operations in sericulture.

8.3 Operation wise labour use pattern in establishment & maintenance of mulberry garden:

Establishment and maintenance of mulberry garden for optimum bio-mass production is most critical for the profitability of sericulture enterprise. Sericulture is a labour intensive enterprise. Its profitability depends on efficiency of labour use. The information on operation wise labour requirement to establish and to maintain mulberry garden is detailed in **Table 8.3**. On an average, establishment of mulberry garden required human labour of around 50 and 90 mandays in case of marginal and small farms, respectively.

Table 8.3: Operation wise labour use pattern in mulberry cultivation

#	Particulars	Establishment			Maintenance (II Year onwards)		
		*Marginal farmers	**Small farmers	%	*Marginal farmers	**Small farmers	%
1.	**Land digging**	-	-	-	10	16	13.11
2.	**Ploughing (Hr)**	2	3	3.33	-	-	-
3.	**Manure application**	5	9	10.00	5	8	6.56
4.	**Transplanting/ gap filling**	5	9	10.00	2	2	1.64
5.	**Weeding**	20	36	40.00	33	54	44.26
6.	**Fertilizer Appln.**	3	6	6.67	6	9	7.38
7.	**Irrigation**	12	21	23.33	12	19	15.57
8.	**Spraying**	5	9	10.00	8	14	11.48
9.	**Bullock pairs (levelling/ ploughing)**	2	3	3.33	-	-	-
Total		**50**	**90**	**100%**	**74**	**122**	**100%**

0.66 acres & ** 1.50 acres

With respect to machine labour (2 hours) & bullock labour (3 pair days) was essential to perform cultural and intercultural operations. Human labour was essential to perform

operations such as weeding, irrigation, land digging, planting/ gapfilling, application of FYM and fertilizers, application of plant protection chemicals etc. The machine & bullock labour was employed to perform land preparation operations and intercultural operations. Weeding and irrigation activities were considered as highly labour intensive operations in moriculture demanding 20 and 36 mandays of labour on marginal (0.66 acre) and small farms (1.5 acre), respectively. Similarly, on an average, for the maintenance of mulberry garden (2nd year onwards), 74 and 122 mandays was required.

8.4 Establishment cost of mulberry garden:

The details of cost incurred by farmers in establishing mulberry garden are presented in **Table 8.4.** It was found that farmer had incurred Rs. 37,244 and Rs. 71,916 towards establishment of mulberry garden on 0.66 & 1.5 acre, respectively.

Table 8.4: Establishment cost of Mulberry

#	Particulars	*Marginal Farmers		% to total cost	**Small farmers		% to total cost
		Qty.	Value (Rs.)		Qty.	Value (Rs.)	
A.	**Variable Cost**						
	I. Labour Cost						
i	Human Labour (mandays)	**50**	**12500.00**	**33.56**	**90**	**22500.00**	**31.29**
	a) Hired Labour (mandays)	20	5000.00	13.42	36	9000.00	12.51
	b) Family Labour (mandays)	30	7500.00	20.14	54	13500.00	18.77
ii	Bullock Labour (Pairs)	**3**	**1500.00**	**4.03**	**4**	**2000.00**	**2.78**
	a) Hired Bullock Labour (Pairs)	1	500.00	1.34	2	1000.00	1.39
	b) Own Bullock Labour	2	1000.00	2.68	2	1000.00	1.39
	II. Material/ Input Cost						
	FYM (ton)	3	3000.00	8.05	7	7000.00	9.73
	Fertilizers (kg)	190	1430.00	3.84	380	2860.00	3.98
	Planting material (No.)	7200	720.00	1.93	15990	1599.00	2.22
	Plant Protn.Chemicals (L)	1.5	225.00	0.60	2.5	375.00	0.52
	Irrigation Charges (Hrs.)	10	3200.00	8.59	25	8000.00	11.12
	Interest on working capital@12% per annum		2709.00	7.27		5320.08	7.40
	Total Variable cost (TVC) [I + II]		**25284.00**	**67.89**		**49654.08**	**69.04**
B.	**Fixed Cost**						
	land revenue		140.00	0.38		245.00	0.34
	Depreciation		1110.00	2.98		1230.00	1.71
	Interest on fixed capital @ 8% per annum		710.40	1.91		787.20	1.09
	Rental value of land		10000.00	26.85		20000.00	27.81
	Total Fixed cost (TFC)		11960.40	32.11		22262.20	30.96
	Total establishment cost (A+B)		***37244.40***	***100.00***		***71916.28***	***100.00***
C.	**Returns (sale of leaf/cocoon production)**		18200.00			38350.00	
	Net establishment cost (A+B-C)		***19044.40***			***33566.28***	

0.66 acres and ** 1.50 acres

The net establishment cost mainly depends on cocoon yield (2 crops) and to some extent on sales of mulberry leaves. In estimation of establishment cost both variable and fixed expenses were considered. Among the variable expenses, the expenditure on human labour was found to be highest at Rs. 14,000 and 24,500 (~35%) in case of marginal and small farms, respectively. The other major item of expenditure was on plant nutrition which amounted to Rs. 4,430 in case of marginal and Rs. 9,860 (~12%) in case of small farms. The expenditure incurred on irrigation at Rs. 3,200 and Rs. 8,000 (~11%) in case of marginal and small farms. respectively was considered as imperative as it decides the production of leaf during off seasons. The opportunity cost of capital at 12 percent rate of interest came at Rs. 2,709 (marginal farmers) and Rs. 5,320 (small farmers). This indicates the extent of working capital invested in mulberry cultivation.

8.5 Cost of cultivation of mulberry:

Table 8.5: Maintenance cost of Mulberry [2nd year onwards]

#	Particulars	*Marginal Farmers		% to total cost	**Small Farmers		% to total cost
		Qty.	Value (Rs.)		Qty.	Value (Rs.)	
I	**Material Costs/ Input costs**						
	Human Labour (hired mandays)	40	10000	21.12	65	16250	18.95
	Bullock Labour (hired Pairs)	1	500	1.06	2	1000	1.17
	FYM(tonnes)	3	3000	6.34	7	7000	8.16
	Fertilizers (kg)	310	2330	4.92	620	4660	5.43
	Gap filling planting material (Nos.)	605	60	0.13	805	80	0.09
	PPC (L)	2	300	0.63	2.5	375	0.44
	Irrigation Charges	14	4480	9.46	31	9920	11.57
	Interest on working capital@12% per annum		2480.4	5.24		3928.5	4.58
	land revenue		140	0.30		245	0.29
	Depreciation		1110	2.34		1230	1.43
	Apportioned establishment cost		2285.33	4.83		3356.63	3.91
	Amortised establishment cost		952.22	2.01		1678.31	1.96
II	**Cost A_1**		**27637.95**	**58.37**		**49723.44**	**57.98**
	Interest on fixed asset (8% per annum)		710.4	1.50		787.2	0.92
	Rental Value of owned land		10000	21.12		20000	23.32
III	**Cost B**		**38348.35**	**80.99**		**70510.64**	**82.22**
	Imputed family labour	34	8500	17.95	57	14250	16.62
	Imputed own Bullock labour	1	500	1.06	2	1000	1.17
IV	**Cost C**		**47348.35**	**100.00**		**85760.64**	**100.00**
	Returns						
	Mulberry leaves or Output (kg)		7700			17890	
	Cost per kg of mul. Leaf (Cost A1)		**3.63**			**2.78**	
	Cost per kg of mul. Leaf (Cost B)		**5.03**			**3.94**	
	Cost per kg of mul. Leaf (Cost C)		**6.21**			**4.79**	

**0.66 acres and ** 1.50 acres*

Table 8.5 shows the total cost incurred by marginal (~0.66 acre) & small farmers (~1.5 acre) in mulberry cultivation and the details are presented as per standard cost concepts

(as mentioned in methodology). The total cost incurred in cultivation of mulberry was Rs. 47,348 and Rs. 85,760 on 0.66 and 1.5 acre per year, respectively. In the total cost, cost A1 accounted for ~ 58% percent, Cost B accounted for ~81 [= 58 + 23] per cent and 100 per cent being shared by Cost C, as it contains all costs. Among Cost A1, the cost on hired mandays shared (~20 %) a major chunk [Rs 10,000 (marginal farmers) and Rs. 16,250 (small farmers)] of the total cost followed by 10 percent on irrigation charges, 6-8 percent on FYM, 5 percent on Fertilizers etc. On an average, the productivity of mulberry was found to be 7.7 and 17.89 tons per 0.66 and 1.5 acre per year (5 crops), respectively. The cost incurred per kg of mulberry was found to be at Rs. 3.63 (as per Cost A1), Rs. 5.03 (as per Cost B) and Rs to 6.21 (as per Cost C) in case of marginal farmers whose mulberry had 0.66 acre. Similarly, the cost incurred per kg of mulberry was found to be at Rs. 2.78, 3.94 and 4.79 in case of small farmers whose mulberry had 1.50 acre. The result reflected that the scale of economies was visible as cost incurred for maintenance of mulberry is nearly 20 % higher in marginal farmers as compared to small farmers.

8.6 Operation wise labour use pattern in silkworm rearing (per crop):

The information on operation wise labour use pattern in silkworm rearing [~200 (small farmers) & ~400 dfls (marginal farmers) per crop] is detailed in **Table 8.6**. On an average, for silkworm rearing with rearing capacity of 200 to 400 dfls per crop, 33 to 59 mandays was found to be necessary. Mandays were required to perform operations such as harvesting of leaves, chopping, feeding, bed cleaning, etc in each instar. Forth and Fifth instars were considered as highly labour intensive demanding 25 and 36 per cent mandays, respectively to total labours necessary as per capacity of rearing.

Table 8.6: Operation wise labour use pattern in silkworm rearing (per crop)

#	Particulars	DFLs reared	
		200	**400**
1.	Disinfection	2 (6.06)	4 (6.77)
2.	I Instar (4 days)	2 (6.06)	4 (6.77)
3.	II Instar (3 days)	2 (6.06)	4 (6.77)
4.	III Instar (4 days)	3 (9.09)	5 (8.47)
5.	IV Instar (4-5 days)	8 (24.24)	14 (23.72)
6.	V Instar (6-7 days)	12 (36.36)	21 (35.59)
7.	Ripened larvae transformed to Chandrikes	2 (6.06)	4 (6.77)
8.	Harvesting & Grading Cocoon	2 (6.06)	4 (6.77)
Total		**33**	**59**

( ) indicates the percentage contribution to the total

8.7 Cost & returns of cocoon production for marginal and small farmers:

Table 8.7 shows cost of cocoon production for marginal and small farmers considering five rearings per year. Standard cost concepts was used. The total cost incurred towards cocoon production was Rs 1, 23,053 (marginal farmers) and Rs. 2,00,926 (Small farmers). The gross returns from cocoon production was Rs. 1,81,203 in case marginal farmers and Rs. 3,14,466 in case small farmers. The cost A1 (Input costs) constituted to nearly 60 percent of the total cost (Cost C) and rest (in cumulative mode) is accounted by Cost B (78 %) and C (100%). The cost A1 component included cost of human labour, dfls, mulberry leaves, disinfectants and opportunity cost of working capital. The Cost B included the cost A1, interest on fixed asset and rental value of owned rearing room. Likewise, Cost C included the cost B and imputed family labour. In the cost A1, the major expenditure was on mulberry leaves which came to around 23 percent [Rs. 27,637 (marginal farmers) and 49,723 (small farmers)]. The second major cost component was hired human labour which came to nearly 13 per cent (Rs. 15,000 (marginal farmers) and 27,000 (small farmers)] reflecting its labour intensive nature. The other items of expenditure included interest on working capital ~ ~6 percent, disease free layings (~4%) and disinfectants (~3%). In case of Cost C, imputed family labour accounted for nearly 22 percent (Rs.26250 and 47250 in case of marginal and small farmers, respectively) of the total cost, revealing the greater reliance on family members. Thus, it could be concluded that sericulture being a labour intensive enterprise could be made profitable through reduced reliance on human labour or in other words through necessary mechanization. The research efforts should aim at development of technologies which reduces reliance on human labour and consequent drudgery.

Further, the gross returns mainly depend on cocoon yield (of MxB, BxB and MxM hybrids). The benefit cost ratio (BCR) is presented as per cost concepts. It was observed that BCR was highest over Cost A1 (1: 2.46 and 2.64) followed by Cost B (1: 1.87 and 2.05) and Cost C (1: 1.47 and 2.58, in case of marginal and small farmers, respectively). The cocoon yield was highest in case of MxB followed by BXB and MxM as study region had two favourable [*Aghrayani (Nov.) and Falguni (Feb.)]* and three unfavourable seasons [*Baisakhi (Apr.), Shravani/ Jaitha (June-July) and Ashiwina (Sept.)*]. Moreover, the majority of farmers were preferred rearing of MxB silkworm hybrids in all five seasons as risk is not as much of compared to BxB hybrids.

Table 8.7: Cost and Returns of cocoon production

#	Particulars	*Marginal Farmers			**Small Farmers		
		Qty.	Value (Rs.)	% to total cost	Qty.	Value (Rs.)	% to total cost
I	**Material Costs/ Input costs**						
	Human Labour (Hired Mandays)	60	15000.00	12.19	108	27000.00	13.44
	DFLs (Nos.)	850	4450.00	3.62	1600	7825.00	3.89
	Mulberry leaves (Kg)	7700	27637.95	22.46	17890	49723.44	24.75
	Disinfectants		3800.00	3.09		4700.00	2.34
	Electric Charges		1216.00	0.99		2000.00	1.00
	Marketing fee		750.00	0.61		1000.00	0.50
	Interest on working capital@12% per annum		7910.39	6.43		13949.84	6.94
	Rearing house revenue		150.00	0.12		240.00	0.12
	Depreciation		12604.00	10.24		14638.00	7.29
II	**Cost A1**		**73518.34**	**59.75**		**121076.29**	**60.26**
	Interest on fixed asset (8% per annum)		18285.12	14.86		25600.00	12.74
	Rental Value of owned rearing house		5000.00	4.06		7000.00	3.48
III	**Cost B**		**96803.46**	**78.67**		**153676.29**	**76.48**
	Imputed family labour (Mandays)	105	26250.00	21.33	189	47250.00	23.52
IV	**Cost C**		**123053.46**	**100.00**		**200926.29**	**100.00**
	Returns						
	Cocoon or Output (kg)		435.00			839.92	
	Yield per 100 DFLs		45.79			42.00	
	Cost per kg of cocoon (Cost A1)		169.01			144.15	
	Cost per kg of cocoon (Cost B)		222.54			182.97	
	Cost per kg of cocoon (Cost C)		282.88			239.22	
	Gross returns		181203.68			314466.67	
	BCR (Cost A1)		**1: 2.46**			**1: 2.64**	
	BCR (Cost B)		**1: 1.87**			**1: 2.05**	
	BCR (Cost C)		**1: 1.47**			**1: 1.58**	

*0.66 acres and ** 1.50 acres

8.8 Efficiency of sericulture farms by Data envelopment analysis:

The result of efficiency analysis (Table 8.8) clearly indicates that 70 percent of farms were found to be economically efficient and rest were found to be relatively inefficient. The inefficiency might be due to technical inefficiency or allocative inefficiency. Thus, conclusion could be drawn 1) farmers are found to be slightly allocatively inefficient *i e.*, few of farmers were not found to be price efficient not following the rule of MVP (Marginal Value product) = MIC (Marginal Input Cost) while allocation of scarce capital resources and 2) farmers were found to be technically inefficient indicating their inability to convert input into desirable output in an efficient manner that means farmers needs adoption skills. The economic efficiency score of 0.9-1.0 was observed in case of 10 percent of the sample farmers and 20 percent of farmers were found to have efficiency score of 0.8-0.9.

Table 8.8. Frequency distribution of *sericulture farmers* based on technical, allocative and economic efficiency

Range of efficiency score	Technical efficiency (No.)	Allocative efficiency (No.)	Economic efficiency (No.)
0.0-0.1	-	-	-
0.2-0.3	3	-	3
0.3-0.4	9	-	18
0.4-0.5	3	3	18
0.5-0.6	12	6	18
0.6-0.7	3	18	66
0.7-0.8	39	81	42
0.8-0.9	75	15	48
0.9-1.0	96	117	27
Mean efficiency score (n=240)	**0.83**	**0.84**	**0.70**

IX. Discussion:

Tracing of trend in area under mulberry and sericulture production will provide better insight about the possible development in silk sector. Hence, attempt was made to ascertain trend in mulberry cultivation and sericulture produciton in the state. The result clearly indicated that area under mulberry cultivation had shown declining trend and sericulture production had shown increasing trend signalling the apparent influence of technological interventions in the field of moricultrue and sericulture. Intensive cultivation is the sole cause for negative growth in mulberry cultivation. Similar trend was observed by Sharad and Shekhar (2008) in case of raw silk production for country as a whole indicating the influence of high yielding mulberry varieties and silk worm breeds. Manjunatha *et al.* (2015) had also observed similar kind of growth in cocoon production for the state.

As per the cost concepts, the total cost incurred per kg of mulberry was found to be Rs. 3.63 and Rs. 6.21in case of marginal and small farms, respectively. The average variable cost of mulberry leaves came to Rs. 2.78 and Rs. 4.79 across marginal and small farms. The total cost per kg of coccon came to Rs. 169 and Rs. 283 and total variable cost per kg of coccon came to Rs. 144 to Rs. 239in case of marginal and small farms, respectively. This clearly reflects the existence of scale economies. The returns per rupee of investment was higher on large holding compared to farms with small holdings. Similar kind of results was found by Lakshmanan *et al.*, (1997).

The efficiency analysis of sericulture farms revealed that 70 percent of farms were found to be economically efficient and rest were found to be relatively inefficient. The inefficiency might be due to technical inefficiency or allocative inefficiency. The possible reasons for inefficiency are 1) allocative inefficiency among farmers due to the violation of

marginal principle (MVP=MIC) in allocation of resources 2) technical inefficiency indicating the inability of farmers to convert input (human labour (mandays), dfls and mulberry leaves fed) into desired level of output (cocoon yield). Kainga *et al.*, (2013) supported the similar way of results in case of banana and plantain production.

X. Inference / Recommendations:

- The trend analysis using time series data for 29 years, cubic trend with negative CGR and exponential trend with positive CGR was observed for mulberry acreage and cocoon & raw silk production, respectively in West Bengal. Vertical growth in productivity of mulberry & cocoon was due to intervention of technologies. Hence, social impact assessment of these technologies is indispensible.

- Estimated the cost incurred per kg of mulberry (ranged from Rs. 3.63 to 6.21 and Rs. 2.78 to 4.79) while, in case of per kg of cocoon (ranged from Rs. 169 to Rs. 283 and from Rs. 144 to Rs. 239) for marginal farmers (whose mulberry had 0.66 acre) and small farmers (whose mulberry had 1.50 acre), respectively. *These cost estimates will serve as basis for Govt. intervention through support price in the event of price crash*. In estimation of cost per kg of mulberry and cocoon production, labours cost had made a significant role, so that, suitable efforts on mechanization in sericulture are necessary. Economies of scale were visible both in mulberry and cocoon production. *It can be improved further through formation of multipurpose seri. farmers co-operatives*.

- The efficiency analysis indicated that their exists economic inefficiency to an extent of 30 percent in sericulture. The labours utilized, land holding, rearing skills, type of varieties grown and type of breeds reared are considered as major factors responsible for inefficiency. *To improve economic efficiency*, research efforts should focus on *mechanization of operations to reduce dependency on human labour* which is scarce. Since the *level of literacy and age of respondents were found to be satisfactory* which facilitates extension personal to disseminate technologies for their effective adoption.

XI. Applications made for patenting / commercialization if any:

Not Applicable

XII. References

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XIII Papers Published (*Paper presented*)

Manjunatha, G.R., Afroz, S., Pandit, D. and Trivedy, K. 2018.Trend analysis of mulberry silk production in West Bengal. *National seminar on "Emerging areas of sericulture issues, Challenges and Industrial Application for sustainable development and eco – restoration-2018". Pp-19.*

XIV. Summary:

As India is predominant of marginal and small land holder's and lack of alternative income source and employment for their sustainable livelihood. The Govt. of India is encouraging regular income and employment oriented farming approaches, one such potential farming enterprise is sericulture (Roopa and Murthy, 2015). Thus, a study on mulberry sericulture in West Bengal has taken with following objectives:

- To analyze the trends in mulberry cocoon production in West Bengal
- To estimate costs and returns of mulberry cocoon production
- To assess resource use pattern and resource use efficiency of sericulture farmers

To accomplish the objectives, both primary and secondary data was elicited from suitable source. The time series data on mulberry acreage, cocoon and raw silk production of West Bengal for 29 years (1989 to 2016) was collected from DOT (S), Govt. of West Bengal. The primary data pertaining to cost & returns on mulberry and cocoon production was elicited from districts (Malda, Murshidabad and Nadia) of state using pre tested structured questionnaire. A total of 240 sample size was considered for the study under muti-stage purposive random sampling design.

Trend and compound growth rate (CGR) were estimated for mulberry acreage, cocoon and raw silk production in the state using time series data during 1989-2016. It was found that cubic trend with negative CGR and exponential trend with positive CGR for mulberry acreage and cocoon & raw silk production, respectively. Vertical growth in productivity of mulberry & cocoon was due to intervention of technologies. Hence, social impact assessment of these technologies is indispensible.

Worked out the cost incurred per kg of mulberry (ranged from Rs. 3.63 to 6.21 and Rs. 2.78 to 4.79) while, in case of per kg of cocoon (ranged from Rs. 169 to Rs. 283 and from Rs. 144 to Rs. 239) for marginal farmers (whose mulberry had 0.66 acre) and small farmers (whose mulberry had 1.50 acre), respectively. The total cost incurred in cultivation of mulberry was Rs. 47,348 and Rs. 85,760 while, in case of cocoon production was Rs 1,23,053 and Rs. 2,00,926 per 0.66 and 1.5 acre per year, respectively. Economies of scale were visible both in mulberry and cocoon production.

From the data envelopment analysis (DEA), observed economic inefficiency to an extent of 30 percent in sericulture. The labours utilized, land holding, rearing skills, type of

varieties grown and type of breeds reared are considered as major factors responsible for inefficiency.

Future Scope of the study:

- Output of the study may be utilized for developmental project in sericulture by the Govt.
- Cost estimates will serve as basis for Govt. intervention through support price in the event of price crash
- Study can be conducted for other regions giving due consideration for integrated components such as intercropping, animal husbandry and reeling activities.
- Efforts should be made on cocoon market under the ambit of NAM (National Agril. Market)

Glimpses during Data Collection:

XV. Budget utilized (Summery):

#	Items	Total (in Rupees)
1	Non-recurring	**63,349**
2	Consumables	**5,000**
3	Travel	*
4	Other costs	**98,28**
Grand total		**78,177**

**Office vehicle used by the staff of REC Mothabari/ Kamnagar/ Investigators of the project during the survey. Further, travel under this project was made for data collection in the survey/study/visit of other projects/ routine prog. of the institute also which is not incurred separately. Thus, the difference is observed form proposed / allotted budget Rs. 2.00 lakh.*

XVI Certificate:

Certified that the Project work has been carried out and financial expenditure incurred for executing the Project are in accordance with the declaration / certification submitted at the time of submission of the Project Proposal and sanction obtained from time to time thereafter as per the revision made.

Signature of the

Principal Investigator

Dr. Manjunatha G R
Scientist-B, PMCE Divn.

Co-Investigator (s)

Mr. Shafi Afroz
Scientist-B, Extension & Pub. Divn.

Dr. S. Chanda
Scientist-D, Entomology Section.

Dr. Dipesh Pandit
Scientist-D, PMCE Divn.

Dr. Tapati Datta Biswas
Scientist-D, Extension & Pub. Divn.

Signature (with comments, if any) of Director / Executive authority

The project has been concluded without any deviation of milestones and obtained the results as per the objectives proposed. From the study, it is observed that the estimation the growth rate in sericulture (mulberry area & cocoon production), cost & returns of cocoon production and economic efficacy of sericulture farms was studied for study region. The results found that the negative growth rate in case of mulberry area while, positive growth in case cocoon and rawsilk production. It was because of vertical growth in productivity of mulberry and cocoon and raw silk production due to intervention of technologies. So that, impact assessment of these technologies on the society is indispensible. Further, study indicated that the cost and returns from sericulture are benefitted for small farmers compare to marginal farmers. The economic inefficiency of sericulture farms was nearly 30 per cent. This inefficiency can be managed through the efforts on suitable mechanization development and a proper resources use pattern in labor usage, feed, silkworm hybrids usage, etc. On the whole, this study is an updated reference for further investigations for the study region. The outcomes of the study may be utilized for developmental project in sericulture by the Government.

28-8-18

DIRECTOR I/c
CSR&TI, BERHAMPORE
निदेशक / Director (Offg. Charge)
केन्द्रीय रेशम उत्पादन अनुसंधान एवं प्रशिक्षण संस्थान
Central Sericultural Research & Training Institute
केन्द्रीय रेशम बोर्ड/Central Silk Board
Berhampore-742101
Murshidabad (W.B.)

Comments of the 48th RAC of CSR&TI Berhampore::

Observations/ Suggestions of RAC	Action taken
An effort may be taken up to study which technology has played a prominent role in vertical growth.	A project in the form of concept note proposal entitled "*Study on impact assessment of mulberry sericultural technologies in West Bengal*" submitted to CO. Bangalore for necessary action. (No. CSB/CSRTI/BHB/PMCE/R-29/2018-19/ 4668 dt. 09.08.2018)
Studies may be taken-up for other regions giving due consideration for integrated components such as intercropping, animal husbandry and reeling activities.	Noted for future compliance

CENTRAL SERICULTURAL RESEARCH & TRAINING INSTITUTE,
CENTRAL SILK BOARD, GOVT. OF INDIA.
BERHAMPORE, MURSHIDABAD, WEST BENGAL

STUDY ON MULBERRY SERICULTURE PRODUCTION IN WEST BENGAL : A STATISTICAL APPROACH (MTS-3599)

Interview schedule

Investigator: ..... Date of investigation:.....

I General Information cum socio-economic characteristics:

1. Identification

1	Name of the farmer		2	Sex	M		F
3	Village		4	Block			
5	District		6	Age			
7	Mobile/ Phone #		8	Type of Family	Nuclear		Joint
			9	Family nos. involved in sericulture	M	F	Childers

2. Education:

Illiterate	Primary	Middle	Secondary	Higher Secondary	Graduate & above

3. House

No house	Hut	Kutcha house	Mixed house	Pucca house	Mansion

4. Land

No land (lease)	< 1.0 acre	1-5 acre	5-10acre	10-15 acre	15-20 acre

5. Land details

Mulberry garden	Agriculture	Pond	Household	Fallow	Total

6. Cropping pattern:

Season	Crop	Dry/ Irrigated	Area (ha)	variety	Main Yield/ha	Value (Rs)	By product Yield /ha	Value	Total value (Rs)
Kharif									
Rabi									
Summer									

COST OF CULTIVATION FOR MULBERRY

Variety: Unit rates:

Area: Male:

Spacing: Female:

Year of planting: Bullock Pair: Rs/day

Irrigated/ Rainfed Tractor: Rs/hr

Economic life: Gestation period: Yield stabilization year (range):

Method of irrigation: Drip/Furrow/Flooding Method: Plot system/ Traditional

a) ESTABLISHMENT COST

1. Labour use in different operations: M =Man, W =Woman and BP =Bullock Power

Sl. No.	Name of the Operation	No. of Times	Family			Hired			Machine Hours
			M	W	BP	M	W	BP	
1	Ploughing								
2	Manuring								
3	Opening ridges and Furrows								
4	Transplanting								
5	Intercultivation/ Earthing up								
6	Weeding								
7	Fertilizer application								
8	Irrigation								
9	Others								
Total									

2. Input use during establishment:

Sl. No.	Input	Quantity	Rate (Rs.)	Amount (Rs.)
1	Cuttings/ saplings			
2	Manure			
3	Fertilizer a.			
	b.			
	c.			
4	Bio-Fertilizer			
5	Irrigation			
6	Drip material			
7	Electricity charges			
8	Others Specify			
Total				

b) Annual/ Maintenance Cost:

1. Labour use in different operations:

Sl. No.	Name of the Operation	No. of Times	Family			Hired			Machine Hours
			M	W	BP	M	W	BP	
1	Ploughing								
2	Replacement/gap filling								
3	Pruning and training								
4	Manuring								
6	Intercultivation/ Earthing up								
7	FYM application								
8	Fertilizer application								
9	Weeding								
10	PPC application								
11	Irrigation								
12	Watch and ward								
13	Harvesting								
14	Loading and unloading								
16	Others								
Total									

M = Man, W = Woman and BP = Bullock Power

2. Input used:

Sl. No.	Input	Quantity	Rate (Rs.)	Amount (Rs.)
1	Planting material (gap filling)			
2	Manure/ FYM			
3	Fertilizer a.			
	b.			
	c.			
4	Bio-Fertilizer			
5	Growth Regulators			
6	PPC			
7	Weedicides			
8	Irrigation			
9	Electricity charges			
10	Transportation charges			
11	Others if yes, Specify			
Total				

3. Gross returns:

Sl. No.	Particulars	Quantity	Rate (Rs.), if leaf sold	Amount (Rs.)
1	Main product: Leaf Yield (1 Mon = 40 Kg)			

COST OF SILKWORM REARING

Breed/ Hybrid: Cross Breed/ Biovoltine / F1 (Multi x Bi)/ Hybrid (Multi x Multi)

Method of feeding: Shoot/ Leaf

1. Fixed cost component (per acre):

Sl. No.	Items	Unit	Quantity	Life	Rate (Rs.)	Amount (Rs.)	Present value (Rs.)
1	Rearing house						
2	Chawki rearing boxes						
3	Rearing plates/ dala						
4	Chandrikes						
5	Stand						
6	Uzyfly net						
7	Hygrometer						
8	Wax paper/ paraffin sheet						
9	Sponge rubber/ foam pad						
10	Ant wells						
11	Gunny cloth/ Basta						
12	Knives						
13	Wooden plank						
14	Bucket						
15	Sprayer						
16							

2. Variable cost component: Cost involved in rearing of DFLs

Sl. No.	Items	Unit	Quantity	Rate (Rs.)	Amount (Rs.)
1	DFLs/ Chawki DFLs (F1 / Hybrid)	Nos.			
2	Formalin	Lts			
3	Lime dust	kgs			
4	Bleaching powder	kgs			
5	Vijetha/Labex/Sericillin	kgs			
6	Labour per leaf harvest	Mandays			
7	Number of harvest reqd.	Nos.			
8	Disease control	Rs.			
9	Labour: I instar (4 days) II instar (3 days) III instar (4 days) IV instar (4-5 days) V instar (6-7 days)	Mandays			
10	Transfer of ripened worms (pakka palu) from trays to chandrikes	Mandays			
11	Watch and ward	Mandays			
12	Harvesting of cocoons	Mandays			
13	Transportation	Rs.			
14	Electricity charges (per month)	Rs.			
15	Marketing charges	Rs.			
16	Purchase of leaves from outside	Rs.			
				Total	

a) Yield and returns:

Sl. No.	Particulars	Quantity	Rate (Rs.)	Amount(Rs.)
1	Main product: Cocoon yield (Kgs)			
2	By-products a. Crop waste/fodder(Kgs) b. Manure (tons)			
3	Sale of leaves outside			
	Gross return (Rs.)			