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Impact of Front Line Demonstration on Muga Cocoon Yield at Farmers' Level in Assam, India

D. Mech[1], Rajesh Kumar[1*], N. I. Singh[1], D. Goswami[1], R. Das[1] and K. Giridhar[1]

[1]Central Muga Eri Research and Training Institute, Central Silk Board, Ministry of Textiles, Govt. of India, Lahdoigarh 785700, Jorhat, Assam, India.

Authors' contributions

This work was carried out in two districts of Assam, India viz., Dibrugarh and Golaghat. All the authors contributed equally in field activities for demonstration of technologies. Author DM designed the study, wrote the protocol and supervised the work. Authors RK and NIS performed the statistical analysis and editing part. Author DM wrote the first draft of the manuscript. Authors RK and NIS managed the literature searches and edited the manuscript. Author KG proof read the final manuscript before submission to journal. All authors read and approved the final manuscript.

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ABSTRACT

Front line demonstrations (FLD) of integrated technology package of muga culture were conducted at 10 adopted farmers' fields each in Golaghat and Dibrugarh districts in Assam State (India) during 2014-15. To demonstrate the production and economic benefit of adopting improved technologies, 200 g disease free laying (dfls) was brushed during *kotia* commercial crop (Oct-Nov) in each of the 20 adopted farmers' field. Impact assessment of FLD recorded higher yield as well as higher economic return as compared to the farmers' traditional practices. The demonstration of technologies registered higher yield of 66.8 cocoons per dfl with 41.9 per cent improvement as against 47.5 cocoons per dfl under traditional practices. Study also registered very narrow technology gap in the demonstration yield *i.e.*, 3.15 cocoons per dfl over the potential production.

**Corresponding author: E-mail: rajesh.ento@gmail.com;*

Extension gap of 19.5 cocoons per dfl is found to be wide but, mean technology index calculated only 4.5 per cent which prove the feasibility of technology packages at farmer's field. The improved technology packages also gave higher net return of Rs. 4855/-with higher benefit cost ratio 1.32 as compared to net return of Rs. 2045/- and benefit cost ratio 1.17 under traditional practice in 0.202 hectares of plantation. Findings of the present study in Golaghat and Dibrugarh districts of Assam indicated that FLD of integrated technology packages of muga culture have shown highly significant impact ($P \leq 0.05$) on cocoon production in terms of average cocoon yield per dfl and total cocoon yield against the traditional practices adopted by the farmers. Similarly, the comparative economic analysis of FLD and traditional practices of both the districts have found highly significant ($P \leq 0.05$) Net Return of FLD over that of traditional practices. The FLD of the integrated package is one of most effective tools for transfer of technology to enhance the productivity and hence, the integrated technology should be adopted in every potential pockets of muga culture for enhancing the productivity.

Keywords: Muga culture; Antheraea assamensis; technology gap; extension gap; technology index.

1. INTRODUCTION

Sericulture has been emerging as a gainful venture for sustainable income generation providing employment to the farmers with small land-holdings and the marginalized and weaker sections of the society. It is a farm-based, labour intensive and commercially attractive economic activity falling under the cottage and small-scale sector. It particularly suits rural-based farmers, entrepreneurs and artisans, as it requires low investment but, with potential of relatively higher returns. India produces four types of silks *viz*., mulberry, eri, muga and tassar and stands second in global raw silk production next to China. Among the four types of silks, muga silk is predominantly produced in the North Eastern region of India particularly in Assam. Muga silk is well known for its golden luster colour and its durability. It is the costliest silk among all types of silk and has high demand in the global market. However, the muga raw silk production is very low as compared to other types of silk and production of muga silk has been ranging from 102 MT (2002-03) to 158 MT (2014-15) during last decade.

Muga silkworm (*Antheraea assamensis*, Helfer) is a holometabolous insect endemic to the North Eastern region of India and it belongs to the family Saturniidae (Lepidoptera). This silkworm is reared completely in outdoor condition on two primary host plants *viz.*, Som - *Persea bombycina* and Soalu - *Litsea monopetala* (Family: Lauraceae). Presently, more than 13000 ha land area is covered under cultivation of muga host plantation and more than 34,000 families are actively involving in muga culture in Assam. In muga culture, mainly two crops *i.e., Jethua* (during Apr-May) and *Kotia* (during Oct-Nov) are considered as commercial crops to produce muga raw silk. Production and productivity of muga silk mostly depends on the knowledge and adoption of the latest technologies [1-6]. In the recent past, various improved technologies of muga culture were developed and recommended for the benefit of farmers. The recommended technologies like cultivation and management of muga host plants, production of disease free laying (dfl), early and late stages silkworm rearing, prophylactic measures against pests and diseases, improved mountage for cocoon spinning, etc. have been demonstrated at the farmer's field and impact of technology adoption has been studied [3]. However, the average cocoon yield in the demonstration sites ranged from 50-60 per disease free layings (dfls) which was far below the potential yield. The low production trend may be attributed to the low adoption or less effectiveness of the technologies. Frontline demonstration (FLD) introduced by Indian Council of Agricultural Research (ICAR) has been one of the most effective tools of extension to boost crop production. To analyze the impact of new technologies in the productivity of muga silk, the scientists of Central Muga Eri Research and Training Institute (CMER&TI), Jorhat, Assam (India) conducted FLD of integrated technologies with two newly evolved technologies in two major muga producing districts of Assam *viz.,* Golaghat and Dibrugarh during 2014 - 15 and data on cocoon production with economics were collected for impact analysis.

2. MATERIALS AND METHODS

Golaghat and Dibrugarh districts of Assam (India) were identified for conducting FLD of integrated technology packages of muga culture

during the year 2014-15. Ten farmers having with at least 0.202 hectare of muga host plants were selected in different locations from each district. The following integrated technology package was identified for the FLD to the farmers as per schedule.

(i) Timely pruning of host plants and application of FYM (@ 450 cft/0.405 hectare) and NPK doses (@ 40 Kg Urea + 56 kg SSP + 15 kg MOP/0.405 hectare) for production of quality leaf suitable for rearing of specific stages of silkworms.
(ii) Dusting of lime and bleaching powder (9: 1) in the field before the rearing.
(iii) Disinfection of the rearing field by spraying of 0.01 % Sodium hypochlorite solution 3 - 4 days before brushing of worms as pre-brushing care, repeating the spray of the solution to the worms along with the leaves once in every instar to check disease.
(iv) Biological control of uzi flies (*Blephirapa* sp.) infestation of the silkworms through release of hyperparasitoides (*Nesolynx thymus*) in the rearing field and use of insect traps.
(v) Use of disease free layings (dfls).
(vi) Brushing of young age silkworms on selected chawki plots under nylon nets to protect the tiny worms from pests and predators.
(vii) Use of improved mountages for spinning of mature worms to get uniform and quality cocoons.

Among above technologies, (iii) and (iv) are new inclusions in the FLD. Before conducting the demonstrations, average cocoon yield of the farmers under traditional practices for previous two years were collected and that has been considered as benchmark yield. Disease free layings @ 200 g per farmer along with nylon nets were provided free of cost for conducting rearing during *Kotia* commercial crop (Oct - Nov 2014). Monitoring of different activities at the demonstration field were also conducted regularly by the concerned scientists and farmers were provided required technical guidance [7] for brushing of worms, management of rearing, transferring of worms after attaining 3rd instars, etc. At the end of each demonstration, yield data were collected from muga farmers. The gross return, cost of production, net return, benefit cost ratio (BCR) were calculated using the prevailing market price of inputs and outputs along with labour cost. Technology gap, yield gap or extension gap and technology index were also calculated using the following formula suggested by Samui [8].

$$\text{Technology gap} = \text{Potential yield} - \text{Demonstration yield}$$

$$\text{Extension or Yield gap} = \text{Demonstration yield} - \text{Farmers Yield}$$

$$\text{Technology index (\%)} = \frac{\text{Technology gap}}{\text{Potential Yield}} \times 100$$

3. RESULTS AND DISCUSSION

3.1 Cocoon Yield

Cocoon yield under FLD and traditional practices in two districts are presented in Table 1. Average number of cocoon production per dfl in FLD and traditional practices was recorded as 66.7 and 47 in Golaghat, and 67 and 48 in Dibrugarh, respectively. The number of cocoon production per dfl under FLD in Golaghat district ranged from 65 to 69 against 45 to 50 cocoons under traditional practices (Table 3). Similarly, number of cocoon production per dfl under FLD in Dibrugarh district ranged from 63 to 70 against 46 to 50 cocoons under traditional practices (Table 5). The average number of cocoon yield of two districts was calculated as 66.8 per dfl under FLD with 41.9 per cent improvement over the yield of 47.5 cocoons per dfl under traditional practice (Table 1).

Findings of the present study in Golaghat and Dibrugarh districts of Assam indicated highly significant impact ($P \leq 0.05$) in FLD of integrated technology packages of muga culture on cocoon production in terms of average cocoon yield per dfl and total cocoon yield against the traditional practices adopted by the farmers (Tables 3, 5).

The earlier study conducted on assessment of impact of integrated technology intervention in muga culture showed the conformity with the present study [9]. They recorded production of 52 cocoons under demonstration of improved technology against the production of 29 cocoons per laying under traditional method. Study on adoption of improved technology package and its impact on production of muga cocoons conducted also recorded that the farmers adopted the technology package of muga culture and harvested 50 to 60 cocoons per dfl against 30 to 40 cocoons per dfl by the partial adopters and below 20 cocoons per dfl by nonadopters [3].

Table 1. Productivity, technology gap, extension gap, technology index of muga culture under FLD

Districts	Area under plantation (hectare)	DFL** brushed (g)	Av. cocoon yield (Nos/dfl)		Per cent increase	Potential yield (Nos/dfl**)	Technology gap (nos/dfl**)	Extension gap (nos/dfl**)	Technology Index (%)	Cocoon yield (Nos)	
			FLD*	Traditional practices						FLD*	Traditional practices
Golaghat	0.202	200	66.7	47	43.0	70	3.3	20	4.7	13340	9340
Dibrugarh	0.202	200	67.0	48	40.9	70	3.0	19	4.3	13400	9520
Mean	**0.202**	**200**	**66.8**	**47.5**	**41.9**	**70**	**3.15**	**19.5**	**4.5**	**13370**	**9430**

**FLD: front line demonstration, **DFL: disease free layings*

Table 2. Economics of improved technologies and traditional practices of muga culture under FLD

Districts	Cocoon yield (Nos)		Cost of production (Rs.)		Gross return (Rs.)		Net return (Rs.)		BCR***	
	FLD*	Traditional practices	FLD*	Traditional practices	FLD*	Traditional practices	FLD*	Traditional practices	FLD*	Traditional practices
Golaghat	13340	9340	15200	12100	20010	14010	4810	1910	1.32	1.16
Dibrugarh	13400	9520	15200	12100	20100	14280	4900	2180	1.32	1.18
Mean	**13370**	**9430**	**15200**	**12100**	**20055**	**14145**	**4855**	**2045**	**1.32**	**1.17**

**FLD: front line demonstration, **DFL: disease free layings, BCR: ***benefit cost ratio*

Table 3. Productivity, technology gap, extension gap, technology index of muga culture under FLD in Golaghat, Assam

Farmers	Area under plantation (hectare)	Dfls** brushed (g)	Av. Cocoon yield (Nos/DFL**)		Per cent increase	Potential yield (Nos/dfl)	Technology gap (nos/dfl)	Extension gap (nos/dfl)	Technology Index (%)	Cocoon yield (Nos)	
			FLD*	Traditional practices						FLD*	Traditional practices
1	0.202	200	67	48	39.6	70	3.0	19	4.3	13400	9600
2	0.202	200	69	46	50.0	70	1.0	23	1.4	13800	9200
3	0.202	200	65	48	35.4	70	5.0	17	7.1	13000	9600
4	0.202	200	66	46	43.5	70	4.0	20	5.7	13200	9200
5	0.202	200	67	47	42.6	70	3.0	20	4.3	13400	9400
6	0.202	200	65	46	41.3	70	5.0	19	7.1	13000	9200
7	0.202	200	67	45	48.9	70	3.0	22	4.3	13400	9000
8	0.202	200	66	46	43.5	70	4.0	20	5.7	13200	9200
9	0.202	200	68	45	51.1	70	2.0	23	2.9	13600	9000
10	0.202	200	67	50	34.0	70	3.0	17	4.3	13400	10000
Average	0.202	**200**	**66.7**	**47**	**43.0**	**70**	**3.3**	**20**	**4.7**	**13340**	**9340**
CD			**1.567**[#]							**313.427**[#]	

**FLD: front line demonstration, **DFL: disease free layings #: highly significant at P ≤ 0.05*

Table 4. Comparative economics of improved technologies and traditional practices of muga culture under FLD in Golaghat, Assam

Farmers	Cocoon yield (Nos/dfl)		Cost of production (Rs.)		Rate of Cocoon/ 1000 nos (Rs.)	Gross return (Rs.)		Net return (Rs.)		BCR***	
	FLD*	Traditional practices	FLD*	Traditional practices		FLD*	Traditional practices	FLD*	Traditional practices	FLD*	Traditional practices
1	13400	9600	15200	12100	1500	20100	14400	4900	2300	1.32	1.19
2	13800	9200	15200	12100	1500	20700	13800	5500	1700	1.36	1.14
3	13000	9600	15200	12100	1500	19500	14400	4300	2300	1.28	1.19
4	13200	9200	15200	12100	1500	19800	13800	4600	1700	1.30	1.14
5	13400	9400	15200	12100	1500	20100	14100	4900	2000	1.32	1.17
6	13000	9200	15200	12100	1500	19500	13800	4300	1700	1.28	1.14
7	13400	9000	15200	12100	1500	20100	13500	4900	1400	1.32	1.12
8	13200	9200	15200	12100	1500	19800	13800	4600	1700	1.30	1.14
9	13600	9000	15200	12100	1500	20400	13500	5200	1400	1.34	1.12
10	13400	10000	15200	12100	1500	20100	15000	4900	2900	1.32	1.24
Average	**13340**	**9340**	**15200**	**12100**	**1500**	**20010**	**14010**	**4810**	**1910**	**1.32**	**1.16**
CD								**470.140#**			

**FLD: front line demonstration, **DFL: disease free layings, ***benefit cost ratio, #: highly significant at P≤0.05*

Table 5. Productivity, technology gap, extension gap, technology index of muga culture under FLD in Dibrugarh, Assam

Farmers	Area under plantation (hectare)	Dfls brushed (g)	Av. Cocoon yield (Nos/dfl)		Per cent increase	Potential yield (Nos/dfl)	Technology gap (Nos/dfl)	Extension gap (Nos/dfl)	Technology index (%)	Cocoon yield (Nos)	
			FLD*	Traditional practices						FLD*	Traditional practices
1	0.202	200	69	48	43.8	70	1.0	21	1.4	13800	9600
2	0.202	200	67	46	45.7	70	3.0	21	4.3	13400	9200
3	0.202	200	63	47	34.0	70	7.0	16	10.0	12600	9400
4	0.202	200	66	48	37.5	70	4.0	18	5.7	13200	9600
5	0.202	200	64	48	33.3	70	6.0	16	8.6	12800	9600
6	0.202	200	68	49	38.8	70	2.0	19	2.9	13600	9800
7	0.202	200	68	46	47.8	70	2.0	22	2.9	13600	9200
8	0.202	200	70	46	52.2	70	0.0	24	0.0	14000	9200
9	0.202	200	67	50	34.0	70	3.0	17	4.3	13400	10000
10	0.202	200	68	48	41.7	70	2.0	20	2.9	13600	9600
Average	0.202	**200**	**67**	**48**	**40.9**	**70**	**3.0**	**19**	**4.3**	**13400**	**9520**
CD			**1.941#**							**388.109#**	

**FLD: front line demonstration, **DFL: disease free layings #: highly significant at p ≤ 0.05*

Table 6. Comparative economics of improved technologies and traditional practices of muga culture under FLD in Dibrugarh, Assam

Farmers	Cocoon yield (Nos/dfl)		Cost of production (Rs.)		Rate of Cocoon/ 1000 nos (Rs.)	Gross return (Rs.)		Net return (Rs.)		BCR***	
	FLD*	Traditional practices	FLD*	Traditional practices		FLD*	Traditional practices	FLD*	Traditional practices	FLD*	Traditional practices
1	13800	9600	15200	12100	1500	20700	14400	5500	2300	1.36	1.19
2	13400	9200	15200	12100	1500	20100	13800	4900	1700	1.32	1.14
3	12600	9400	15200	12100	1500	18900	14100	3700	2000	1.24	1.17
4	13200	9600	15200	12100	1500	19800	14400	4600	2300	1.30	1.19
5	12800	9600	15200	12100	1500	19200	14400	4000	2300	1.26	1.19
6	13600	9800	15200	12100	1500	20400	14700	5200	2600	1.34	1.21
7	13600	9200	15200	12100	1500	20400	13800	5200	1700	1.34	1.14
8	14000	9200	15200	12100	1500	21000	13800	5800	1700	1.38	1.14
9	13400	10000	15200	12100	1500	20100	15000	4900	2900	1.32	1.24
10	13600	9600	15200	12100	1500	20400	14400	5200	2300	1.34	1.19
Average	**13400**	**9520**	**15200**	**12100**	**1500**	**20100**	**14280**	**4900**	**2180**	**1.32**	**1.18**
CD								**582.164#**			

**FLD: front line demonstration, **DFL: disease free layings, #: highly significant at p ≤ 0.05*

The higher yield of cocoon under FLD was attributed due to full adoption of integrated technology package. An increase of cocoon yield of 7 to 15 per dfl was recorded in the present FLD than that of the earlier demonstration studied [3]. The higher increase in cocoon yield in the present FLD may be due to adoption of new technologies developed by CMER&TI *viz*., field disinfection technology through Sodium hypochlorite and biological control of uzifly through releasing hyperparasitoids in muga silkworm [1,2,6]. Similar impact of the FLD has been reported in pulse crops [10,11], which is in corroboration with the present findings.

3.2 Technology Gap

The technology gap in the demonstration yield over the potential yield was 3.3 and 3.0 cocoons per dfl in Golaghat and Dibrugarh districts, respectively (Table 1). The mean technology gap in the demonstration yield over the potential yield of two districts was calculated to be 3.15 cocoons per dfl which is very low. It is evinced that low technology gap as observed in the present study is due to the intervention of the integrated technologies through the FLD.

3.3 Extension Gap

The extension gap was 20 and 19 cocoons per dfl in Golaghat and Dibrugarh districts, respectively (Table 1). On an average, extension gap was observed to be 19.5 cocoons per dfl, which emphasized the need to educate the farmers for adoption of improved technology package of muga culture to reverse the trend of wide extension gap. Popularizing the integrated technology package among the farmers through FLD will certainly change such extension gap and production of muga silk will be increased to a large extent.

3.4 Technology Index

The technology index calculated as 4.7 and 4.3 per cent in Golaghat and Dibrugarh districts, respectively (Table 1). The mean technology index of two districts is calculated to be 4.5 per cent, which prove the feasibility of adoption of technology packages at farmers' level. The lower the value of technology index more is the feasibility of technology demonstrated [12]. Adoption of the demonstrated technology by the farmers, muga raw silk production can be reached to the potential level.

3.5 Economic

The inputs and output price of prevailing market during the study was taken for calculating the cost of production, gross return, net return and benefit cost ratio (BCR). Higher the production of cocoon under FLD, gave higher net return of Rs. 4810/- and Rs. 4900/- in Golaghat and Dibrugarh districts, respectively although the production cost of Rs. 15200/- is higher in comparison to traditional practices *i.e*., Rs. 12100/- per crop in 0.5 acre plantation. The average gross return of Rs. 20055/- and net return of Rs. 4855/- were recorded under FLD while the gross return of Rs. 14145/- and net return of Rs. 2045/- under traditional practice from the rearing of 200 dfls in 0.5 acre of plantation. The average BCR was calculated as 1.32 under FLD as compared to 1.17 under traditional practices (Table 2). The comparative economic analysis of FLD and traditional practices of both the districts (Golaghat and Dibruagarh) have found highly significant impact ($P \leq 0.05$) in Net Return of FLD (Tables 4, 6). The higher net return and higher BCR may be attributed due to the effectiveness of the technology package under FLD.

4. CONCLUSION

The result of FLD convincingly brought out that yield of muga cocoons in commercial crop can be increased with the intervention of recommended integrated technology packages at farmers' level. To maintain the sustainability of muga culture, it is quite important to increase the productivity of muga with limited resources. Calculated benefit cost ratio itself indicates the economic importance of muga culture and farmers shall be inspired for adoption of improved technologies. It can be inferred that FLD using the integrated technologies is one of the most effective tools for transfer of technology and it should be continued for enhancing the productivity. The recommended technology package need to be disseminated in every muga growing pockets through FLD to enhance the productivity of muga from 8 to 12 kg raw silk to 13 to 16 kg per hectare / crop.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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