ORIGINAL RESEARCH PAPER

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YIELD GAP IN MULBERRY AND COCOON PRODUCTION UNDER RAINFED AND IRRIGATED CONDITIONS IN CHAMARAJANAGAR DISTRICT, KARNATAKA STATE

KEY WORDS: Mulberry, cocoon, rainfed farmers, irrigated farmers, yield gap.

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ABSTRACT

An investigation has been conducted to know the extent of yield gap existed in mulberry and cocoon production among rainfed and irrigated sericulture farmers in Chamarajanagar district of Karnataka state, India, in order to find the ways to reduce the gap and improve upon the productivity of sericulture. In mulberry production, potential yield, potential farm yield and actual yield of farmers varied considerably between rainfed and irrigated conditions. Yield gap-1, yield gap-2 and index of yield gap were very narrow under rainfed condition when compared to irrigated condition with fewer gaps among big farmers over medium and small farmers. Similarly, index of realized potential yield and index of realized potential farm yield were also better with rainfed farmers over irrigated farmers being higher yield realization among big farmers as compared to medium and small farmers. In silkworm cocoon production, potential yield was same for both rainfed and irrigated conditions. Potential farm yield and actual yield of farmers were higher with irrigated farmers over rainfed farmers. The variation existed in yield gap-1, yield gap-2 and index of yield gap were less under irrigated condition over rainfed condition with least gap among big farmers as compared to medium and small farmers. Similarly, index of realized potential yield and index of potential farm yield were superior under irrigated farmers over rainfed farmers with higher yields among big farmers over medium and small farmers.

INTRODUCTION

Silk has been intermingled with the life and culture of the Indians. India has a rich and complex history in silk production and its silk trade dates back to 15th century. Sericulture industry provides approximately 8.25 million persons in rural and semi-urban areas in India. (Anonymous, 2018). In India, there are two ways for increasing silk production. One way is to expand the area. It cannot be done beyond certain extent, as sericulture competes with food crops. The second alternative is to increase the production per unit area by applying better methods of mulberry cultivation and rearing practices.

During 1960s and 1970s, silk productivity in India was ranging between 14 to 20 kg/ha. However, a significant leap in productivity was observed in the eighties and nineties, when it reached a yield level of 100 kg/ha/year during 2016-17. Sericulture technology has been changing at rapid pace and extension network has been established at national, state and village levels to educate the sericulturists. In spite of this, a wide gap exists between the available technology and its adoption by farmers. The challenge to bridge the gap will largely depend upon the professional competence of the extension administrators, policy makers, and the extension workers to come out with right answers to the farmers' problems in the field.

The yield gap analysis is a potent research technique that has been introduced in the 1970s, developed by the International Rice Research Institute (IRRI), Philippines. It is extensively used to measure and analyze determinants of the yield gaps. The first attempt to conceptualize yield gap was made by Gomez (1977). The concept of yield gap provides the information base in this regard. This approach has gained widespread popularity among researchers, administrators and policy makers. The findings of such research have many implications for policy formulation which are aimed at alleviating the constraints causing the yield gaps.

In the study on yield gaps and constraints in bivoltine cocoon production in Mandya District of Karnataka showed that the magnitude of the yield gap was 30.01% in small farms and 45.56% in large farms, which means that approximately 30-45% cocoon yield could be increased with the technology package adopted by the demonstration/identified farmers (Vijaya Prakash and Dandin, 2005). As per Anil Kumar Yadav (2008), the potential yield of silk cocoon recorded at the Research Stations was estimated at 75 kg/100 DFLs, while the actual yield realized by the farmers was found to be 65.63 kg/100 DFLs.

A wider total yield gap was observed in mulberry leaf production (47.46%) under irrigated condition compared to silkworm rearing (mainly multivoltine) and cocoon production (14.46%). In the case of mulberry, yield gap-I was higher (33.40%) compared to yield gap-II (9.92%) and yield gap-III (12.42%). Thus, yield gap in mulberry is mainly due to variation in climatic factors and water resources. Yield gap in silkworm rearing which is the crucial part of sericulture is mainly due to uncertain factors (9.24%), indicating that silkworms are sensitive to environmental factors (Mattigatti et al., 2009, 2010). Keeping this in view, a study has been undertaken to know the extent of yield gap existed in mulberry and cocoon production among the rainfed and irrigated farmers in Chamarajanagar district of Karnataka state, India to find the ways and means to reduce the gap for enhancing the productivity.

METHODOLOGY

The investigation has been conducted in Chamarajanagar district of Karnataka, State, India. Karnataka state has 70,958 ha of mulberry of which the crop occupies 1,103.97 ha in Chamarajanagar district. The district has four taluks with a total geographical area of 5,69,901 ha. It is located in the southern tip of Karnataka state and lies between the North latitude 11° 40' and 12° 06' and East longitude 76° 24' and 77° 46'. The district chiefly comprises red sandy loam soil, in addition to having black cotton soil in some pockets. The district receives an average annual rainfall of 791 mm. Altogether, 2821 farmers are practicing sericulture both under rainfed and irrigated conditions in as many as 254 sericultural villages (Department of Sericulture, Govt. of Karnataka).

The district was purposively selected for the study as it has both rainfed (187.47 ha) and irrigated (916.50 ha) mulberry. However, Chamarajanagar and Gundlupet taluks have both irrigated and rainfed areas, while Kollegal and Yelandur taluks posses only irrigated areas.

A total of 240 farmers, 120 each under rainfed (Chamarajanagar and Gundlupet taluks) and irrigated (Kollegal and Yelandur taluks) conditions comprising 60 farmers in each taluk were considered for the study. The selection of villages and number of farmers interviewed for collection of data in each taluk depends on the mulberry area and number of farmers practicing sericulture. The study was formulated based on the preliminary field survey and in consultation with Technical Staff of the State Department of Sericulture in different taluks of the Chamarajanagar district.

The information pertaining mulberry and cocoon yields among the

farmers of the rainfed and irrigated conditions was collected through formal discussion using interview schedule. Further, both under rainfed and irrigated conditions, classifications of respondents were categorized into three groups namely big, medium and small land holding based on mulberry holding size as mentioned below:

Category	Rainfed condition		Irrigated condition	
	Area under mulberry (Acres)	No. of farmers	Area under mulberry (Acres)	No. of farmers
Medium farmers	0.80 to 1.61	91	0.84 to 1.94	75
Big farmers	>1.62	21	>1.95	33

Computation of yield gaps

Yield gap refers to the difference between the potential yield and actual farm yield. The yield gaps were quantified using tabular analysis. Some of the concepts (Gomez, 1977) used in the study are furnished hereunder:

a) Yield Gap-I

$$\text{Yield gap - I} = \frac{(\text{Potential yield} - \text{Potential farm yield})}{\text{Potential yield}} \times 100$$

Yield Gap-I is hypothesized to be caused by either the environmental differences between experimental station and farmers' fields or by non-transfer of technologies.

b) Yield Gap-II

$$\text{Yield gap - II} = \frac{(\text{Potential farm yield} - \text{Actual yield})}{\text{Potential farm yield}} \times 100$$

Yield gap – II is hypothesized to be caused by biological and socio-economic constraints; biological constraints stern from the non-application of essential production inputs and the socio-economic constraints from the social or economic conditions that prevent farmers from using the recommended technology.

c) Index of yield gap:

Refers to the percentage of yield potential unrealized i.e.,

$$\text{Index of yield gap} = \frac{(\text{Potential yield - Actual yield})}{\text{Potential yield}} \times 100$$

d) Index of realized potential yield: Refers to the percentage of the yield potential achieved. Thus,

$$\text{Index of realized potential yield} = \frac{\text{Actual yield realized}}{\text{Potential yield}} \times 100$$

Therefore, Index of potential yield realization = (100 – index of yield gap)

Full potential yield index (100) = Index of potential yield realization + Index of yield gap

e) Index of realized potential farm yield: Ratio of actual yield to potential farm yield, expressed in percentage. Thus,

$$\text{Index of realized potential farm yield} = \frac{\text{Actual yield realized}}{\text{Potential farm yield}} \times 100$$

Potential yield refers to the yield which is obtained in the experimental station. The yield is considered to be the absolute maximum production of the crop possible in the given environment, which is attained by the best available methods and with the maximum inputs in trials on the experimental station in a given season.

Potential farm yield is the yield obtained on the demonstration plots on the farmers' fields in the study area. The conditions on demonstration plots closely approximate to the conditions on the cultivators' fields with respect to infrastructural facilities and environmental conditions. Average of 10 farmers who obtained highest yield in the study area for rainfed and irrigated conditions separately was considered for potential farm yield.

Actual yield refers to the yield realized by the farmers on their farms under their management practices.

(a) Improved practice is defined for this study as the level of each factor anticipated to give the potential yield and is fixed for all the farms in the region.
(b) Farmers' practice is what the farmers had done in the crop season under study.

The analysis of data was carried out adopting the statistical tools like percentage and mean.

RESULTS AND DISCUSSION

Yield gap in mulberry production

Yield gap is the difference between the potential yield and the actual yield of farmers producing units is caused by biophysical and socio-economic constraints. The purpose of yield gap analysis is to identify the major bio-physical constraints responsible for the yield gap and to determine the contribution of each factor to the gap and to identify the possible socio-economic constraints impending the adoption of improved technology (Jain and Singh, 1987).

Potential yield (4800 and 24,000 kg/acre/year), potential farm yield 4375 and 21,773 kg/ac/year and actual yield of farmers (3942 and 18,181 kg/acre/year) varied considerably both under rainfed and irrigated conditions. The actual yield of mulberry was more with big farmers when compared to medium and small farmers both under rainfed and irrigated conditions. The yield gap-1 between rainfed and irrigated conditions were very narrow i.e., 8.854 and 9.279%, while broader variation was observed in yield gap-2 (9.889 and 16.50%), respectively. In yield gap-2, the gap was very little among big farmers over medium and small farmers. Index of yield gap too was wider between rainfed and irrigated conditions with values of 17.87 and 24.25% with less variation among big farmers as compared to medium and small farmers, respectively (Table 1). Kumaresan et al. (2004) observed that the magnitude of yield gap-I in mulberry was substantially more (24.22%) in Chitradurga district and farm potential yield was 24.58% in Kolar district. Further, opined that 25% of mulberry leaf could be increased with the technology package adopted by the demonstration farmers.

The index realized potential yield was higher under rainfed farmers (82.13%) over irrigated farmers (75.75%) and was better with big farmers when compared to medium and small farmers. Similar situation too exist with respect to index of realized potential farm yield with higher values being under rainfed condition (90.11%) over irrigated condition (83.50%) with better values among big farmers over medium and small farmers (Table 1). According to Venkataramana et al. (2003), leaf yield in Telangana Region of Andhra Pradesh was 30,371 kg/ha during 1998-99 and 31,526 kg/ha during 1999-2000, as compared to the benchmark yield of 20,772.80 kg/ha/year with the adoption of the full packages for mulberry production. The gap existed between the potential and actual yield of mulberry yield was very wide due to ignorance and non-adoption of improved recommended technologies.

Table 1: Yield gap in mulberry production under rainfed and irrigated conditions

No.	Particulars	Rainfed (n=120)	Irrigated (n=120)
1	Potential yield (kg/acre/year)	4800	24000
2	Potential farm yield (kg/acre/year)	4375	21773

3	Actual yield of farmers (kg/acre/year)	Small (n=8)	3600	Small (n=12)	16388
		Medium (n=91)	3949	Medium (n=75)	18084
		Big (n=21)	4278	Big (n=33)	20071
		Mean	**3942**	**Mean**	**18181**
4	Yield gap- 1 (%)	8.854		9.279	
5	Yield gap -2 (%)	Small (n=8)	17.71	Small (n=12)	24.73
		Medium (n=91)	9.737	Medium (n=75)	16.94
		Big (n=21)	2.217	Big (n=33)	7.817
		Mean	**9.889**	**Mean**	**16.50**
6	Index of yield gap (%)	Small (n=8)	25.00	Small (n=12)	31.72
		Medium (n=91)	17.73	Medium (n=75)	24.65
		Big (n=21)	10.87	Big (n=33)	16.37
		Mean	**17.87**	**Mean**	**24.25**
7	Index of realized potential yield (%)	Small (n=8)	75.00	Small (n=12)	68.28
		Medium (n=91)	82.27	Medium (n=75)	75.35
		Big (n=21)	89.13	Big (n=33)	83.63
		Mean	**82.13**	**Mean**	**75.75**
8	Index of realized potential farm yield (%)	Small (n=8)	82.29	Small (n=12)	75.27
		Medium (n=91)	90.26	Medium (n=75)	83.06
		Big (n=21)	97.78	Big (n=33)	92.18
		Mean	**90.11**	**Mean**	**83.50**

5.4.2 Yield gap in cocoon production

Potential yield of cocoons (60 kg/100 DFLs) did not vary between rainfed and irrigated conditions, while potential farm yield differ between rainfed (50.34 kg/100 DFLs) and irrigated conditions (56.30 kg/100 DFLs). Actual yield of farmers was more under irrigated condition (53.44 kg/100DFLs) and less under rainfed condition (45.74 kg/100 DFLs) with higher cocoon yield among big farmers when compared to medium and small farmers. Yield gap–1 was wider between irrigated and rainfed conditions with 6.163 and 16.10%, respectively. Similarly, yield gap-2 also varied between irrigated and rainfed conditions with fewer gaps in irrigated farmers (5.080%) when compared to rainfed farmers (9.141%) and extent of yield gap was less with big farmers over medium and small farmers (Table 2).

According to Vilas Kulakarni (1993), the difference existed between the yield gap-I (between experiment/research station yield and potential farm yield in demonstration plots) and yield gap-II (between potential farm yield in demonstration plots and actual yield at farmers' level) were 30.26 and 19.62 %, respectively, in respect of bivoltine (NB_4D_2) cocoon production in Mandya district under irrigated condition. The reason for yield gap-I was attributed for the environmental conditions and other infrastructural facilities available in the multi-locational trials and yield gap-II was attributed for non-adoption of recommended package of practices. Vijaya Prakash (2006) recorded the average cocoon productivity of 42.76 kg/100 DFLs as against the laboratory yield of 61.09 kg/100 DFLs with PM x NB_4D_2 and 75.0 kg/100 DFLs with PM x CSR_2 with the latter yield levels being achieved by a few progressive farmers.

Index of yield gap was least with irrigated condition (10.93%) over rainfed condition (23.77%) with lesser values being with big farmers as compared to medium and small farmers. Higher index of realized potential yield was registered for irrigated condition (88.92%) over rainfed condition (76.23%) with variation among three categories of farmers being better values with big farmers as compared to medium and small farmers. Index of realized potential farm yield was higher with irrigated farmers (94.92%) when compared to rainfed farmers (90.86%) and these values were also differed considerably among the three groups of farmers with more yields being in big farmers as compared to medium and small farmers (Table 2).

The current results are in corroboration with the studies conducted by Lakshmanan (2007) where the total yield gaps between bivoltine and cross-breed races were estimated to be 23.18 and 19.52%, respectively. The index of potential yield realization was to the tune of 87.5% for bivoltine and 92.86% for cross-breed cocoon production. The magnitude of yield gap-I was estimated to be 12.50 and 7.14% and yield gap-II was 12.21 and 13.32% for bivoltine and cross-breed, respectively.

Similar results were also observed by Anil Kumar Yadav (2008), where yield gap-I was found to be 2.26 % and yield gap-II was found to be 11.00 and 9.91 % in Kolar and Chikkaballapur districts, respectively with an overall gap of 10.46%. The variations existed in the yield levels could be attributable to non-adoption of recommended package of practices. The overall index of yield gap was estimated at 12.49%, the index of realized potential yield was 87.51% and the index of potential farm yield was 89.54%.

AS per Choudhury et al. (2017), the farmers adopting the technologies in full could harvest the highest cocoon yield i.e., 56.5 kg/100 DFLs, whereas the farmers of partial and non-adopters harvested an average of 45.0 and 24 kg/100 DFLs. In this regard, farmers should be educated to adopt the improved technologies to obtain higher yields along with crop stability. Further, the demonstrations should be continued with the adopted farmers repeatedly over a period of time for sustenance of technology adoption.

Table 2: Yield gap in cocoon production under rainfed and irrigated conditions

No.	Particulars	Rainfed (n=120)		Irrigated (n=120)	
1	Potential yield (kg/100 DFLs)		60		60
2	Potential farm yield (kg/100 DFLs)		50.34		56.30
3	Actual yield of farmers (kg/100 DFLs)	Small (n=8)	44.25	Small (n=12)	50.97
		Medium (n=91)	45.96	Medium (n=75)	53.42
		Big (n=21)	47.00	Big (n=33)	55.93
		Mean	45.74	Mean	53.44
4	Yield gap- 1 (%)	16.10		6.163	
5	Yield gap -2 (%)	Small (n=8)	12.09	Small (n=12)	9.467
		Medium (n=91)	8.698	Medium (n=75)	5.115
		Big (n=21)	6.635	Big (n=33)	0.657
		Mean	9.141	Mean	5.080
6	Index of yield gap (%)	Small (n=8)	26.25	Small (n=12)	15.05
		Medium (n=91)	23.40	Medium (n=75)	10.97
		Big (n=21)	21.67	Big (n=33)	6.780
		Mean	23.77	Mean	10.93
7	Index of realized potential yield (%)	Small (n=8)	73.75	Small (n=12)	84.50
		Medium (n=91)	76.60	Medium (n=75)	89.03
		Big (n=21)	78.33	Big (n=33)	93.22
		Mean	76.23	Mean	88.92
8	Index of realized potential farm yield (%)	Small (n=8)	87.90	Small (n=12)	90.53
		Medium (n=91)	91.30	Medium (n=75)	94.88
		Big (n=21)	93.37	Big (n=33)	99.34
		Mean	90.86	Mean	94.92

CONCLUSION:

Thus from the study, it can be inferred that considerable yield gaps existed in respect of mulberry and cocoon production among the three categories of farmers (small, medium and big) both under rainfed and irrigated conditions in Chamarajanagar district of Karnataka state. Hence, suitable strategies need to be undertaken for the improvement of yield levels to reduce the gap for sustainable sericultural productivity.

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