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Research Note

AN ECONOMIC ANALYSIS OF YIELD GAPS AND CONSTRAINTS IN COTTON IN DHARWAD DISTRICT*

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Introduction

Cotton is the chief source of fibre that sustains the huge Indian textile industry. Karnataka ranks third in area and fifth in production of cotton in India with about 7.47 lakh hectares under its cultivation and 5.02 lakh bales of output. The area under high yielding varieties of cotton in the state is increasing, while the yields obtained are not showing appreciable increase. This is causing concern to the researchers as well as policy makers in the State. The general notion is that the farmers are not fully exploiting the available technology in cotton production and that, therefore, there is a large gap between the potential productivity and the actual productivity.

The International Rice Research Institute (IRRI) has pioneered a technique to estimate the yield gaps (Gomez, 1977; De Datta *et al.*, 1978; Gomez *et al.*, 1979). A close look at the IRRI type gap analysis revealed that the technique is inadequate to capture the role of socio-economic constraints conditioning the yield gaps. A fresh approach is, therefore, attempted in the present study to overcome this deficiency. The objectives of the study are to (1) examine the extent of gap in the attainable cotton yield and (2) identify the constraints responsible for the gap.

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Methodology

Sampling design

The study was based on the data from 120 randomly selected farmers growing cotton in Dharwad district, besides the relevant data from 30 demonstration plots for the crop year 1987-88. This district was purposively selected as it is one of the major cotton growing districts in Karnataka. The sampled farmers' data were collected by personal interview. Two *talukas* (Nargund and Navalgund) having higher percentage of their total area under cotton in the district were chosen at the primary level. Five villages from each of the selected *talukas* having higher proportion of cotton area were chosen at the secondary level. Random sampling technique was adopted for the selection of farmers at the tertiary level. The relevant demonstration data were obtained from the Extension Education Unit of the University of Agricultural Sciences, Dharwad.

Analytical frame

The yield gap is defined as the difference between the potential yield (productivity at research stations) and the actual yield. The yield gap is conceptually divided into two components namely, yield gap-I and yield gap-II. The former was calculated as the difference between the potential yield and the potential farm yield (productivity on demonstration plots) while the latter was computed as the difference between the potential farm yield and the actual yield. The preliminary analysis revealed that the size of yield gap-I was very small (around 5 per cent) while that of yield gap-II was quite substantial. Hence, the emphasis was given to yield gap-II in the present study. The input gap for an input in question was obtained by deducting the amount of input used at the farmers' field from the amount of the respective input used at the demonstration plots: 'F' and 't' test was applied to test the difference in mean values of yield and those of inputs between the demonstration plots and the farmers' fields.

For delineating the influence of biological and socio-economic factors on yield gap, Cobb-Douglas type production function was used. The index of the realised potential farm yield of cotton was considered as the dependent variable in the model, while a set of biological and socio-economic constraints were included as explanatory variables. The estimating model for the current purpose was specified as follows :

$$\ln Y = \ln A + \sum_{i=1}^{6} bi \ln X_i + \sum_{i=7}^{13} b_i X_i$$

where,

Y=realised potential farm yield index

X_1=expenditure on seeds (Rs/ha)

X_2=expenditure on plant nutrients (Rs/ha)

X_3=expenditure on plant protection chemicals (Rs/ha)

X_4=expenditure on labour (Rs/ha)

X_5=education of the respondents (years of schooling)

X_6=age of the respondents (years)

X_7=soil type dummy, value one for deep black soils and zero otherwise

X_8=irrigation dummy, value one for irrigated crop and zero otherwise

X_9=sowing time dummy, value one for timely sowing and zero otherwise

X_{10}=spacing dummy, value one for right spacing adopted and zero otherwise

X_{11}=method of fertilizer application dummy, value one for ring method of fertilizer application and zero otherwise

X_{12}=credit access dummy, value one for easy access to credit and zero otherwise

X_{13}=participation dummy, value one for participation in extension education methods and zero otherwise

The important constraints (independent variables : x_i's) that were assumed to prevent farmers from exploiting the potential farm yield were partly biological and partly socio-economic factors. The dependent variable (Y) was defined as the ratio of the actual yield to the potential farm yield expressed in percentage. This ratio, therefore, indicated the portion of the realised potential farm yield.

Results and Discussion

The data presented in Table-1 clearly brings out the fact that the productivity of cotton on the farmers' fields is far below the potential farm yields. The mean difference between the potential farm yield and the actual yield was significant ($P<0.01$). The estimated gap of 42.42 per cent indicated the possibility of increasing cotton output at least by one-third of the present level if the technology now available to the farmers is fully adopted. The yield gap is often attributed to the biological constraints like sub-optimal input use (Fale *et al.*, 1985; Rao and Prasad,

Table 1. Estimated yield (inputs) levels and yield (input) gaps in cotton

Particulars	Demonstration (n=30)	Farms (n=120)	Gap
I. Yield (kg/ha)	2547.84	1467.04	1080.80** (42.42)
II. Inputs (Rs/ha)			
1. Seeds	335.29	298.27	37.02 (11.04)
2. Plant nutrients	1944.97	1366.49	578.48** (29.74)
3. PP chemicals	1833.53	1528.44	305.09** (16.63)
4. Labour	2136.66	1595.59	541.07** (25.32)

Figures in parentheses are respective percentage gaps
** $P<0.01$

1981). The size of input gaps was found to be high for all inputs except seeds. This reinforces the conviction that the yield gap is basically attributable to sub-optimal input use. However, the influence of socio-economic factors on the yield gap should not be over-looked.

The estimated regression parameters are presented in Table 2. The significant coefficient of multiple determination implied that more than 92 per cent of the variation in the realised potential farm yield was explained by the variations in the independent variables incorporated in the model.

Biological constraints

The study revealed that the sub-optimal use of seeds, plant protection chemicals and spacing (dummy) had insignificant influence on the realised potential farm yield. The high and statistically significant elasticity coefficients of plant nutrients and labour implied that a substantial portion of the untapped potential farm yield in cotton could be effectively exploited by applying higher doses of these inputs, particularly, plant nutrients. The case for such a policy is fairly strong. But there are obvious hurdles in its implementation. Majority of the farmers felt that they were already using adequate quantities of plant nutrients. Those who thought otherwise, had no adequate means to acquire the needed nutrients. In such a context what is needed is a more liberal credit policy on the one hand and a more vigorous campaign of

Table 2. Estimated coefficients of realised potential farm yield function

Particulars	Value of Estimated Coefficients
1. Intercept	0.7029
2. Seeds	0.0040 (0.0750)
3. Plant nutrients	0.2837** (0.0579)
4. PP chemicals	0.1474 (0.0931)
5. Labour	0.2686** (0.0697)
6. Education	0.1005* (0.0432)
7. Age	—0.0154 (0.0421)
8. Soil type	0.0988** (0.0285)
9. Irrigation	0.0856* (0.0370)
10. Sowing time	0.1405** (0.0453)
11. Spacing	0.0953 (0.0560)
12. Method of fertilizer application	0.0785* (0.0344)
13. Credit access	0.0987** (0.0344)
14. Participation	0.1164** (0.0345)
15. Coefficient of multiple determination (R^2)	0.92**
16. Number of observations	120
17. Adjusted coefficient of multiple determination ($\bar{R}^2$)	0.91

Figures in parentheses are standard errors
** $P<0.01$
* $P<0.05$

extension activities on the other. Further, majority of the farmers complained about acute labour shortage during the peak seasons. Therefore, labour availability, particularly during the peak seasons, acted as a barrier to the fuller exploitation of the untapped potential farm yield.

The positive and significant coefficients of soil type (dummy) suggested that the cotton crop grown on black soil gave higher productivity as compared to that grown on other types of soils. Around 39 per cent of the farmers were found to grow cotton on other types of soils. It is therefore, advisable for the farmers of black soil area to devote more area to cotton. This would considerably help in reducing the yield gap. Irrigation (dummy) showed a remarkable influence on the dependent variable. The present findings lent further support to the view that irrigation is a crucial factor in removing or minimising the yield gap.

Non-adoption of recommended agronomic cultural practices was bound to influence the potential farm yield and therefore the yield gap. In certain cultural practices, the method and time lag involved in adopting the operation could produce a noticeable difference in output. This contention was strongly supported by the findings of the present study. The time of sowing and method of fertilizer application (dummies) were found to positively and significantly condition the realised potential farm yield. This implied that the yield gap is dependent not only on the level of inputs used—particularly seeds and fertilizers—but also on the time and methods of application.

Socio-economic constraints

The exploitation of the potential farm yield in cotton was found to be positively and significantly conditioned by the level of education, credit access (dummy) and participation (dummy). This strengthened the view that easier availability of credit and better exposure of the farmers to new technology coupled with an improvement in their educational level would help them in exploiting the potential farm yield to a considerable extent and thereby reducing the yield gap. The age of the respondents was found to exert a negative but non-significant influence on the dependent variable.

Conclusion and Policy Implications

The study clearly revealed the existence of a wide gap in the attainable yield of cotton in the study area. The sub-optimal input use, particularly plant nutrients and labour were found to be the most important constraints in exploiting the attainable yield. Intensification of extension activities along with the liberal credit policy would go a long way in closing or minimising the yield gap in cotton. The farmers of black soil area should be educated and encouraged to devote more area to cotton in order to exploit the inherent favourable properties of black soils for cotton production. Key management practices like time of sowing, method of fertilizer application and balanced use of nutrients have been found to be crucial in conditioning the potential farm yield exploitation.

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