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Factors contribution to productivity of BT cotton: A production function analysis – with special reference to Coimbatore district

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Abstract
Agriculture is the backbone of Indian economy. It provides employment to more than 60 per cent of the population directly and indirectly and the area of cultivation occupied almost 43 per cent of India's total geographical area. In the context of Indian agriculture, cotton occupies a place of prominence. Moreover, the contribution of Cotton to total agricultural income of the country is 30 per cent. With the increasing demand for cotton due to fast industrialization in India and abroad, there is a need for increasing the level of output and the productivity of cotton. This has resulted in the introduction of high yielding varieties and one such high yielding variety is the Bt cotton. It is established that when compared to other high yielding varieties, the Bt cotton has the advantage of higher productivity. The main objective of the is to understand the factors contribution to productivity of Bt cotton in Coimbatore district. The data were collected with the help of a pre tested questionnaire from 511 farmers who were selected by adopting the stratified random sampling technique.

Keywords: Bt Cotton, Production Function, Productivity Analysis, Cotton Growers

1. Introduction

1.1 Preamble

Agriculture plays an essential role in the process of economic development of less developed countries like India. Besides providing food to nation, agriculture releases labour, provides saving, contributes to market of industrial goods and earns foreign exchange. Agricultural development is an integral part of overall economic development. In India, agriculture was the main source of national income and occupation at the time of Independence. Agriculture and allied activities contributed nearly 50 percent to India's national income. Around 72 percent of total working population was engaged in agriculture. These confirm that Indian economy was a backward and agricultural based economy at the time of Independence. After 61 year of Independence, the share of agriculture in total national income declined from 50 percent in 1950 to 13.70 percent in 2012-13 [1]. But even today more than 60 percent of workforce is engaged in agriculture [2]. In spite of this, it is also an important feature of agriculture that is to be noted that growth of other sectors and overall economy depends on the performance of agriculture to a considerable extent. Because of these reasons agriculture continues to be the dominant sector in Indian Economy.

1.2 BT Cotton and Indian Farmers

In India, cotton contributes 30% to agricultural gross domestic product. With over 20 million acres [3], the country has the largest cotton area in the world. The area under cotton in India has grown considerably in recent years. Likewise, yield levels have increased significantly, from around 120 kg of lint per acre in the early 2000s, to over 200 kgs. The Cotton Advisory Board (CAB) of India estimated an all-time record cotton production of 5.27 million tons with the area soaring to a record high of 23.8 million acres in 2007-08. As a result, India has been able to improve its position in world cotton trade from the third largest importer in 2002-03 to the second largest exporter after the US in 2007-08. This significant increase in cotton area and production in India is attributed to better returns realized by farmers during the last few years, which are largely due to the introduction and rapid spread of Bt cotton technology. The first three Bt cotton hybrids were commercially approved in India in 2002 for central and southern cotton-growing states [4].

3. Need for the study

India is one of the major cotton producing countries, ranking third after U.S.A. and China. Cotton accounts for 30 per cent of agricultural gross domestic product [5]. in India and has the largest cotton area of 20 million acres [6]. It provides a livelihood to more than 60 million people in India by way of support in the agriculture sector. The ever increasing demand for cotton at the Indian level and at the global level has resulted in the innovation of High Yielding Varieties and one such variety that has been introduced is the Bt cotton. However, the studies carried out in the Indian context on Bt cotton indicated the various problems associated with raising of Bt cotton [7]. These include the higher damage caused by insects, higher use of chemical fertilizers etc. The studies, has a resulted could also come out the lower level of income of the farmers. Added with this, the immense role played by middlemen in the purchase of the cotton produce from the farmers also results in the reduction of the farmer's income from cotton [8]. Hence, it becomes pertinent to understand in the context of Coimbatore a district which has a higher level area under cotton more specifically under Bt cotton.

Bt cotton has been one of the first genetically modified (GM) crop technologies with a wide distribution in developing countries. In India and China, in particular, the area under Bt cotton has increased sharply over the last couple of years, reaching 25 million acres in 2007 [9]. Most of the Bt cotton growers in these countries are small-scale farmers; a number of recent studies [10] has shown that they benefit considerably from adopting the technology in terms of reductions in pesticide use and higher effective yields [11]. Nonetheless, there

are concerns with respect to the development of benefits over time. Pest populations might eventually become resistant to Bt, especially when refuge strategies are not enforced, as is often the case in smallholder agriculture. Moreover, secondary pests that are not controlled by Bt might turn into primary pests [12]. Both factors could potentially entail diminishing pesticide savings and yield advantages over time. In addition, given that most GM crops so far have been commercialized by private sector multinationals, there are fears that monopolistic market structures might increasingly prevail. This could lead to excessive prices being charged for Bt seeds, resulting in lower farm profits and restricted technology access, especially for resource-poor farmers [13]. Accordingly, some developing country governments have started to intervene in GM seed pricing[14]. In India, for instance, since 2006 state authorities have set official maximum retail prices for Bt cotton seeds, which are significantly lower than the prices charged by seed companies before. The broader implications are not yet fully understood.

4. Objective of the study

The main objective of the is to understand the factors contribution to productivity of Bt cotton in Coimbatore district.

5. Methodology of the study

a) Source of Data

To study the objective set, the present project relied on both secondary and primary data. More specifically, to analyse the trends in the growth in area, output and yield of cotton crops among the major cotton growing states and the inequality among them, the secondary data on the area, output and yield of cotton by states were collected from the various issues of Handbook of Statistics published by the Directorate of Economics & Statistics, Ministry of Food and Agriculture, Government of India.

The Primary data were collected from the selected farmers from canvassing an interview schedule that is, by personal interview method.

b) Selection of district

As the area under cotton has been relatively high in Coimbatore district in Tamilnadu. This district has been selected purposively.

c) Selection of Blocks

Among the blocks in Coimbatore district the cotton cultivation is intensive in the blocks of Avinashi, Pollachi, Udumalpet, Kinathukadavu, Mettupalayam, Madukarai, Thondamuthur and Sulur. To make it intensive, it was it was decided to select sample farmer respondents from four blocks. Hence, the four blocks namely, Pollachi, Kinathukadavu, Madukarai and Sulur were selected randomly at first instance. The Rural Agricultural Cooperative Societies operating in these areas were identified from the District Agricultural Cooperative Society (DACS). The officials of these rural agricultural cooperative societies were met and a list of cotton growers was prepared. From this list, it was found that there are 2554 farmers grown Bt cotton during 2011-12 agricultural year. From this list, one fifth of the population was selected as the samples. This gave a sample size of 511. The identified sample Bt cotton growers were met and the information pertaining to their socio economic status, information relating to their farm practices, the cost involved in raising the crop, the revenue accrued, the marketing strategies adopted were obtained with the help of a pre tested questionnaire.

d) Selection of Farmers

The distribution of the farmers selected in each of the sample blocks identified is given in the table below:

Table 1: Distribution of Sample Farmers

S. No.	Name of the Block	No. of Farmers	Samples Selected
1.	Pollachi	1020	204
2.	Kinathukadavu	800	160
3.	Madukarai	204	41
4.	Sulur	530	106
	Total	2554	511

Source: Unpublished Records of Rural Agricultural Cooperative Societies, Coimbatore.

6. Period of study

The study involves both the primary and the secondary data. The secondary data on the state wise area, output yield of cotton were collected for a period of 48 years from 1964-65 to 2011-12. The required primary data were collected for a period of one year from May, 2013 to April, 2014.

Factors contribution to productivity of cotton: A production function analysis

The present study it is attempted to examine the impact of the social and farm related factors on the productivity of cotton. To capture the yield response of cotton and the yield effect due to Bt seed more precisely, a production function analysis was carried out. Following the convention and the straightforward way in which the elasticities of production could be obtained, the Cobb-Douglas production has been used in the present study and the results are presented in Table 2. The adjust R^2 value of 0.0.9312 Indicates that as high as 93 per cent of the variation in the dependent variable, that is productivity, is being explained by the five independent labour and capital related variables considered for the analysis. Among the coefficients estimated, the coefficient arrived at in the case of the variable on human labour is 0.38752. This indicates that every one unit (human days per hectare) of increase in human labour increases the productivity of cotton by 0.38 quintal per hectare. The coefficient arrived at in the case of machine labour with 0.0997 implies that every one unit (hour per hectare) of increase in the machine labour increases the productivity by 0.0097. It can be inferred that the productivity contribution by (human) labour is found to be higher than the machine labour and the probable explanation for this higher contribution of human labour than the machine labour is that with the application of capital namely, the tractors and other machineries, the users of these machineries namely the human labour productivity increases.

Table 2: Factors Contribution To Productivity Of Cotton: Regression Results
Dependent variable: Cotton yield (q/ha)

Variables	Estimated co-efficient	Standard Error	t-values
Constant	0.6875	0.46525	1.407
Human labour	0.3872*	0.0918	3.846
Machine labour	0.0997*	0.0364	4.954
Fertilizer—Potash	0.0385*	0.0809	2.007
Plant protection chemicals	-0.0471*	0.00659	6.116
Irrigation	0.0512	0.0276	1.569
R2	0.9312		
Adjusted R2	0.9282		
F-value	1277.25		
DF	6		
D	505		

Notes: * indicates significant at 5 per cent level.
Source: Computed from Primary Data.

The coefficient of fertilizer, namely potash is 0.0385. This implies that every one unit (kgm.) of increase in the application of fertilizer increases the cotton productivity by 0.0385 quintals per hectare. The estimated coefficient for the variable on plant protection chemicals is -0.0471. This indicates that that every one unit (litres per hectare) of increase in the application of pesticides reduces the cotton productivity by 0.0471 quintals. The probable explanation for a negative coefficient is that farmers use excessive quantities of pesticides than the recommended level which contributes negatively to productivity. In the case of the coefficient of irrigation, the coefficient arrived at as 0.0512 indicates that every unit (number of irrigations) of increase in irrigation increases the productivity of cotton by 0.0512 quintals. However, the variable is not significant. The probable explanation for this variable to turn out to be insignificant is that all the farmers irrigated to the recommended level and there was not much variation in number of irrigation across farms.

Thus from the above analysis, it can be concluded that except irrigation, all the variables included in the analysis were found to be statistically significant in explaining the yield variability of cotton.

Impact of social and farm related variables on productivity of cotton: A multiple regression analysis

Previous studies attempted to explain the cause of variation in cotton output could come out with the conclusion that the human resource variables such as education and experience are significant factors in adopting agricultural technology which influences the cotton productivity positively. Hence, it is attempted to examine the relative impact of human resources together with a few crucial farm related factors that determines the productivity of cotton. As it could be seen in Table 3, the adjust R^2 value of 0.673 indicates that 67 per cent of the variation in the dependent variable, that is productivity, is being explained by the eight independent variable considered for the analysis.

Table 3: Impact of Social and Farm Related Variables on Productivity of Cotton: A Multiple Regression Analysis

S. No.	Variables	Coefficients	SE	't' value
1.	Constant	7.2345	2.3158	3.12*
2.	Education (years)	7.2345	2.3158	3.95*
3.	Experience (years)	0.0916	0.0232	2.41*
4.	Fertilizers (Rs)	0.0159	0.0066	4.14*
5.	Farm improvement expenditures (Rs)	0.0029	0.0007	3.00*
6.	Farm yard manure (Rs)	0.0003	0.0001	2.10*
7.	Landholding size (ha)	0.00042	0.0002	3.13*
8.	Irrigation (Rs)	0.0467	0.0149	2.35*
9.	Pesticides (Rs)	0.00094	0.0004	2.35*
	R^2	0.00095	0.0005	2.05*
	Adjusted R^2	0.673		-
	F value	126.32*		-
	D-W value	1.99		-
	N	511		-
	D.F.	502		

Notes: * indicates significant at 5 per cent level.
Source: Computed from Primary Data.

The results of regression coefficients presented in the table suggest that the variables considered appear to have significantly contributed to the productivity of the cotton crop. It can be inferred from the table, apart from the farm related variables, the human resource variables included in the model like, the level of education of the farmers and the years of experience in farm have turned out to be significant factors of influence on the productivity. The explanation for this significant influence is that at higher levels of education and experience, the farmers are able to understand the better the

input combination that required for achieving a higher productivity. The positive and significance of the variable on size of land holdings indicate that at higher size of land holdings, the farmers find it convenient to apply modern machineries and implements in their farms which ultimately increase the productivity.

7. Conclusion

The multiple regression run to estimate the factors contributing to productivity of cotton indicated that except irrigation, all the variables included in the analysis were found to be statistically significant in explaining the yield variability of cotton. The impact of social and farm related variables on productivity of cotton indicated that the variables considered appear to have significantly contributed to the productivity of the cotton crop. It can be inferred, apart from the farm related variables, the human resource variables included in the model like, the level of education of the farmers and the years of experience in farm have turned out to be significant factors of influence on the productivity. The explanation for this significant influence is that at higher levels of education and experience, the farmers are able to understand the better the input combination that required for achieving a higher productivity. The positive and significance of the variable on size of land holdings indicate that at higher size of land holdings, the farmers find it convenient to apply modern machineries and implements in their farms which ultimately increase the productivity.

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