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ECONOMIC ANALYSIS OF ORGANIC AND BT FARMING OF COTTON IN ERODE DISTRICT OF TAMIL NADU

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ABSTRACT
Increasing awareness towards health and environmental issues associated with the intensive use of chemical inputs has led to alternate forms of agriculture. Organic farming is one among the production methods that are supportive of the environment. The other being the Bt farming which modifies the genetical make up of a plant by introducing genes of the bacteria *Bacillus thuringiensis.* This makes the plant produce an insecticide that prevents bollworms from feeding on it thereby reducing the application of pesticides. However pests often develop resistance, making it necessary to use pesticides again and again thus increasing the financial risk of farmers. In order to compare these two extreme forms of agriculture, a survey was made on organic and Bt cotton farms in Erode district of Tamil Nadu to ascertain the benefits in terms of technical efficiency and cost and returns. The study revealed that organic farms were more technically efficient and in terms of cost and returns, organic farms provided higher net profit to farmers compared to Bt farms.

KEYWORDS: Technical efficiency, Stochastic Frontier Production, Partial Budgeting.

INTRODUCTION

Of all the cash crops, Cotton plays a dominant role in India's economy. Cotton and its value-added products are major export earners for India's national income. The Indian cotton industry provides employment to more than 15 million people, contributing 20% to the Gross National Product and 30% to the total agricultural exports. (Subbiah and Jeyakumar, 2009). But cotton is also considered as the high pesticide consumption crop due to application of the most hazardous pesticides for controlling the pest "boll worm". In order to relieve the farmers from the application of pesticide particularly for boll worms, Bt cotton was introduced. The introduction of Bt cotton in 2002 pushed India to the rank of second-largest global producer of cotton. Now in India almost 90% of the cotton cultivation area is under Bt Cotton. The data, for the year 2010-11, shows that out of total area of 111.42 lakh hectares under cotton cultivation, 98.54 lakh hectares are under Bt Cotton. Since most of the Bt cotton hybrids produce only the medium and long staple lint, increase in area under Bt cotton has led to decline in output of premium quality cotton. i.e extra long staple cotton which fetches good price in the market. Moreover incidence of other pests in Bt field has also increased. Thus the farmers were in need of applying more pesticides, fertilizers and irrigation to improve the yield. This has demanded eco-friendly cotton i.e organic cotton. India is the world leader in production of organic cotton. It occupies a share of about 61 % of global organic cotton production. (Organic Cotton Farm and Fibre Report, 2009). Though organic farming is gaining importance in recent years, increasing the production to meet out the need is a vital concern. Therefore, it is essential to critically examine the performance of organic and Bt farming. Thus the study aims at estimating the technical efficiency and cost and returns under organic and Bt farming of cotton.

METHODOLOGY

The study was taken up in Erode district of Tamil Nadu, since it occupies the second largest area under organic farming in Tamil Nadu. Out of the total 22 development blocks in the district, Anthiyur block was purposively selected due to the fact that in this block efforts are being made by the KVK - Myrada to help the cotton farmers in adopting organic farming. A cluster of 3 villages, *viz*. Pudupalayam, Adhireddiyur and Bommanpatti were selected randomly from this block. From the selected villages, a list of farmers including both adopters and non-adopters of organic farming were prepared. In case of organic farmers, except two all others were not certified, but they practice organic farming for 4-5 years. In all the 3 villages, all the non adopters were found to be Bt farmers. Thus 20 farmers (10 adopters and 10 non-adopters) were selected randomly from each village, making the sample size of 60 farmers. During the survey it was found that the majority of the organic farmers have grown extra long staple varieties MCU5 and Surabhi. Whereas SP 1037 and BT jackpot were the varieties grown by Bt farmers.

The data obtained were analysed using both descriptive and inferential statistics. Means, standard deviations, percentages and frequencies were used in analyzing the input and output variables and the distributions of efficiency levels**.** The measurement of the efficiency of the production is an important area of research and it is defined as the ratio of the maximum possible output obtained on the production frontier to a given level of input. In general efficiency is measured using deterministic and stochastic approaches. The deterministic approach is called Data Envelopment Analysis (DEA). It is non-parametric in nature and it does not impose restrictions on the dataset (Coelli, 1996a,1996b). The stochastic Frontier Approach (SFA) is parametric in nature and applies random production, cost, or profit functions to

measure efficiency (Andreu and Grunewald, 2006). The DEA method has been criticized due to its inability to account for errors and to test for significance. SFA has also drawbacks like apriori assumption of the functional form, but it accounts for measurement errors such as technical inefficiency and random disturbances due to climate factors *etc*. (Coelli, 1996b). For this study, SFA was used for calculating the efficiency of cotton farms because of its advantages over DEA. The estimation of stochastic frontier production function made it possible to find out whether the deviation in technical efficiency from the frontier output was due to firm specific factors or due to external random factors. The stochastic frontier model was estimated using the computer program FRONTIER 4.1 written by Coelli (1996).

The model can be represented as
$Y = f(X, \beta) + (U-V)$
Where
Y = Yield (production)
X = Vector of input quantities
β = Vector of unknown parameters
U = Non negative random variable assumed to account for technical efficiency in production.
V = Random error (not under the control of farmer)

A Cobb-Douglas function was fitted to the stochastic frontier production function, since it is the most commonly used functional form for analyzing agricultural production data. It is preferred for its mathematical properties, simplicity of computation, and interpretation. The cobb Douglas function used is stated below

$Y = \beta o\ X1^{\beta 1} X2^{\beta 2} X3^{\beta 3} X4^{\beta 4} X5^{\beta 5} e^{Ui-Vi}$
Which when linearised becomes

$\ln Y = \ln \beta o + \beta 1 \ln X1 + \beta 2 \ln X2 + \beta 3 \ln X3 + \beta 4 \ln X4 + \beta 5 \ln X5 + Ui - Vi$
βo = Intercept
X1= cost incurred for machine labour (Rs per acre)
X2= cost incurred for manures (Rs per acre)
X3= cost incurred for seeds (Rs per acre)
X4= cost incurred for plant protection (Rs per acre)
X5= cost incurred for human labour (Rs per acre)
β_i's = the parameters estimated
Ui = Non negative random variable
Vi = Random error (not under the control of famer)

RESULTS &DISCUSSION

Technical Efficiency of Organic Farms

The Maximum Likelihood estimates for parameters of stochastic frontier for organic farms are shown in Table 1.

TABLE 1: Stochastic Frontier Production Function for Organic Farmers

Variable	Parameter	Coefficient	T ratio
Intercept	β_0	0.4009	0.3830
Machine hours	β_1	0.2215*	1.8163
Manures	β_2	0.1559**	2.6679
Seeds	β_3	-0.07686	-1.3386
Natural plant protectors	β_4	0.4967**	2.3390
Human labour	β_5	0.0684	0.6285
Sigma-squared	σ^2	0.524**	2.542
Gamma	γ	0.770**	2.143

**, * Significant at 5% and 10% probability level, respectively

It is inferred from the Table 1 that the coefficients of organic manure (0.15) and natural plant protectors (0.49) were significant at the five percent level. Machine hour (0.22) was significant at ten per cent level. The coefficients represent percentage changes in the yield as a result of one percentage change in the respective variables. It was observed that machine hours were found to be significant because majority of the organic farmers were of the belief that a well puddle soil requires little application of manures. Likewise application of natural plant protectors such as neem seed kernel, neem seed powder, neem oil and usage of various traps like sticky yellow trap, oil trap, castor trap etc., reduces the pest attack and improves the yield. The coefficient of seed and human labour was not significant because increasing labour use or seed does not have any influence over the yield. The gamma value was found to be 0.77 and significant. It indicates that 77 per cent of the variation in output of cotton was attributed to technical inefficiency. The sigma-square was 0.52 and significant, indicating the correct fitness of the model.

Technical Efficiency of Bt farms

The Maximum Likelihood estimates for the parameters of stochastic frontier for Bt farms are shown in Table 2. The results indicated that the elasticity's of machine hours and inorganic fertilizers have a positive and significant relation with the output. The variable plant protection chemicals have a negative relation with the output which indicates that one percent increase in plant protection chemical application will decrease the yield by 0.1 per cent. Significant negative value for chemicals indicates over use and its negative effect on production. The Gamma value was 0.63 and significant. It is an indication that 63 per cent variation in output was due to the factors which are within the control of farmer's *i.e.* technical inefficiency. It demands the correct dosal application of all the inputs. The sigma squared value on the other hand was 0.54 and significant indicates the goodness of fit of the model.

TABLE 2: Stochastic Frontier Production Function for Bt farmers

Variable	Parameter	Coefficient	T ratio
Intercept	β_0	0.2047	0.1544
Machine hours	β_1	0.5606***	6.6415
Inorganic fertilisers	β_2	0.3428***	3.0865
Seeds	β_3	0.1202	1.1611
Plant protection chemicals	β_4	-0.1431*	-1.7227
Human labour	β_5	0.0299	0.2530
Sigma-squared	σ^2	0.543***	5.235
Gamma	γ	0.638***	3.393

***, * Significant at 1% and 10% probability level, respectively

It could be observed from Table 3 that the majority of the organic farms (56%) where in the technical efficiency range of 71-80 per cent. The mean technical efficiency of organic farmers was 80 percent, implying that the farmers were not fully efficient as the observed output was 20 per cent less than the maximum output. Shortfall in yield was due to the factors which are outside the control of the farmer. The mean technical efficiency index for Bt farmers was observed to be 69 per cent, suggesting that farmer's output can be improved by 31 per cent through improved resource allocation. It is inferred from this result that the farms operating at low technical efficiency should be improved to the average technical efficiency. However, due to microclimate and soil differences all the farms cannot attain higher or average technical efficiency. The farmers should be trained to achieve higher efficiency levels

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TABLE 3. Frequency Distribution of Farm-Specific Technical Efficiency

S.No	Technical efficiency range	No of organic farmers	Percentage	No of Bt farmers	Percentage
1	<50	0	0	2	6.67
2	51-60	0	0	3	10.00
3	61-70	0	0	9	30.00
4	71-80	17	56.67	4	13.33
5	81-90	10	33.33	5	16.67
6	90-100	3	10.00	7	23.33
	Total	30	100	30	100

Cost and Returns for Organic and Bt Farmers

It could be seen from Table 4 that the cost of cultivation of organic farmers was lower than Bt farmers. The lower cost could be attributed to less cost on irrigation, reduced cost on seed and non-use of chemical fertilizers and pesticides. Most of the organic farmers reported that they did not purchase costly inputs from the market, rather they used self-produced inputs such as seeds, manures like panchakavyam, Navathaniya karaisal, jeevamirtham, leaves extract, ginger garlic chillie extract, green manure, vermi-compost, farm compost, natural plant protectors , etc. While Bt farmers opined that though the incidence of boll worm in Bt cotton field was less compared to other hybrids, the regular plant protection measures were necessary for controlling other sucking pests. Moreover cost of the Bt Cotton seeds was found to be very high; it was almost doubled compared to normal varieties. Thus after adding all those additional costs, the cost of cultivation for Bt farming was found to be 4.2 per cent higher than the organic farming.

TABLE 4. Cost Comparison for Organic and Bt Farmers (Rs/acre)

Operations	Organic famers	Bt farmers	Change in gross margin
Land preparation	3100	3000	100
Seed and planting	500	1450	-950
Manures and manuring	6025	4821	1204
Chemical fertilizers	NIL	1031	-1031
Weeding and intercultural operations	3084	3266	-182
Irrigation	890	1400	-510
Plant protection	791	1069	-279
Harvesting	5884	5090	794
Total cost	20274	21127	-853

From Table 5 it has been seen that price per kg of lint was more for organic cotton (Rs. 41) than that of Bt cotton (Rs.38). The difference in price was mainly because of the quality of the lint. The varieties grown under organic farming such as MCU-5 and Surabhi are extra long staple varieties which fetches good price compared to long

staple Bt varieties like SP 1037 and Jackpot . Though yield was lower in organic farming (1032 Kg/ ac) when compared to Bt (1041 Kg/ac), but because of decrease in cost of cultivation and increase in revenue, farmers were able to reap profit of Rs 4150 per acre more when compared to Bt farmers

TABLE 5. Revenue Comparison for Organic and Bt Farmers

S.No	Particulars	Organic	Bt farming
1	Price per kg	41.26	38.33
2	Yield per acre(kg)	1032.55	1041.42
3	Total revenue (per acre)	42569	39272
4	Profit/acre (Rs)	22295	18145
5	BCR	2.09	1.88

Partial budgeting analysis (Table 6) shows that organic farming results in a net gain of Rs 3151 / acre when compared to Bt farming.

TABLE 6 . Partial Budgeting of Organic Vs Bt Farming of Cotton

S.N	Debit		S.N	Credit	
a	Increase in costs /ac	Rs	a	Decrease in costs /ac	Rs
1	Land preparation	100	1	Seed and planting	950
2	Manures & manuring	1204	2	Chemical fertilizers	1031
3	Harvesting	794	3	Weeding & intercultural operations	182
			4	Irrigation	510
			5	Plant protection	279
b	Decrease in returns/ac	nil	b	Increase in returns / ac	2297
A	Total (a+b)	2098	B	Total (a+b)	5249
	Net Gain(B-A) (Rs /ac)	3151			

CONCLUSION

The following are the broad conclusions of the study

1) The technical efficiency measurement using stochastic frontier production has shown that there was variation in efficiency between the organic and Bt farmers. The mean technical efficiency of organic farmers was found to be higher than that of Bt farmers.
2) Bt farmers continue to use large amount of pesticides for sucking pests and occasionally for bollworm. This heavy application of inorganic fertilizers and pesticides in the study area will pose a serious threat to the soil and water quality.
3) No significant difference in yield between two farming situations. It was also found that the cost of cultivation of organic farmers are lower than the Bt farmers by 4 per cent due to less expenses on seeds, manures, natural plant protectors and irrigation.
4) Higher profitability is the important feature of organic cotton farming. The net income in organic farming was more than Rs 4150 per acre than in the Bt farming.
5) In the study area there is no separate market for organic cotton. The farmers sell their produce in the market where both the organic and Bt cotton were taken together for auction. Currently the price is fixed based on the staple length of cotton. The profitability of organic farms can still be increased if the organic cotton fetches separate price premium in the market.
6) Ultimately, Bt cotton pose a financial risk to the farmers and organic farming becomes a ray of new hope for financial stability and sustainability of cotton farmers. CATOGREE

REFERENCES

Andreu, M.L. and Grunewald, O. (2006) Sources of inefficiency in Kansas farms. Paper presented at the Southern Agricultural Economics Association Annual Meetings, Orlando, Florida.

Coelli, T. (1996) A guide to DEAP version 2.1: A data envelopment analysis (Computer) program. CEPA Working Paper 96/08, Centre for Efficiency and Productivity Analysis, University of New England.

Coelli, T.J. (1996a) A guide to *DEAP* version 2.1: A data envelopment analysis (Computer) program. CEPA Working Paper No. 8/96, Armidale, Australia: Department of Econometrics, University of New England.

Coelli, T.J. (1996b) A guide to Frontier version 4.1: A computer program for stochastic frontier production and cost function estimation. CEPA Working Paper 96/07, Armidale, Australia: Department of Econometrics, University of New England.

Web sites

Organic Exchange (2009) Organic Cotton Fiber Report, available in: www.organicexchange.org

Subbiah, A. and Jeyakumar, S. (2009) Cotton: White gold of India, Market Survey, available in: http://ffymag.com/admin/issuepdf/Cotton-Oct09.pdf.