Economics of Sugarcane Production using Ecofriendly Technology in Cuddalore District, Tamil Nadu

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I

INTRODUCTION

The chemical pathway has been pursued year after year for the sole purpose of increasing food grain production. The over use of chemicals to intensify crop production led to poisoning people and animals as well as polluting the environment. In areas where a high fertilizer dose was used, the problem of salinity, water logging due to the depletion of organic matter and nutritional imbalances in soils has started surfacing and it is now threatening the sustainability of agricultural production. The other problem linked to the over use of pesticides is the contamination of soil and water sources including the aquatic system. Persistent pesticides like BHC and DDT remain in the ecosystem for a longer period and pose a great danger to the soil fauna and flora.

On the one hand, the inorganic fertiliser consumption is continuously increasing and agricultural systems have encountered various kinds of environmental problems and decreased soil fertility etc. On the other hand, our population is also increasing. While considering the population explosion, the food grain demand is estimated to be around 260-264 M.T by 2020 A.D. The use of bio-inputs is the best way to reduce fertiliser consumption, to feed the growing population and to retain soil fertility and productivity. The average bio-fertiliser consumption in India is 0.04 kg/ha. Among bio-fertilisers, major growth has occurred with phosphate solubilising microorganisms, which account for about 45 per cent of total bio-fertiliser production and use. The present consumption level of bio-pesticides has increased from around one per cent share in the Indian pesticide market in 2001 to around 2.5 per cent currently and it is expected to reach 12-15 per cent by the end of 2010, mainly through the chorus of Organic Farming (Fertiliser Statistics, 2005; Tamil Nadu Economic Appraisal, 2005).

In Tamil Nadu, the usage of bio-inputs has picked up since the inception of integrated pest management in 1985. At present, the production of bio-pesticides is

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confined to manage pest and diseases in important agricultural and horticultural crops. Among the different agents, production of egg parasites, *Trichogramma* sp. in the form of *Tricogramma* cards for the control of shoot and internode borers in sugarcane, *Pseudomonas fluorescens, Tricoderma viridae* for the control of major diseases and soil borne pathogens, pheromone traps for the control of worms, *chrysopa* predators to control pest like aphids and Nuclear Polyhedrosis Virus (NPV) to control *prodenia* were common.

Due to raising awareness among the consumers about the pesticide residues in agricultural products, consumers prefer the pesticide free food commodities. The post-WTO regime paves the way for expanding naturally grown agricultural products wherein bio-inputs usage plays a major role. In this context it becomes important to analyse the economics of bio-input usage for the sugarcane crop and to identify the factors determining the adoption of bio-inputs. Therefore the present study is undertaken in Annagramam block with the following objectives: (i) to work out the costs and returns associated with sugarcane cultivation and (ii) to identify the factors determining the adoption of bio-inputs.

II

**METHODOLOGY**

Cuddalore District consists of 13 blocks. Among these blocks, the Annagramam block was selected purposively for this study as it has the highest area under sugarcane cultivation and it makes the universe of the study. The villagewise consumption of bio-inputs for sugarcane cultivation in the selected block was collected with the help of records maintained by the block statistics office, the office of the Agricultural Development Officer and E.I.D. Parry (India) Pvt. Ltd. After arranging the villages in the descending order of magnitude based on the bio-input consumption level, the first three and last three villages were selected to ensure an adequate sample size.

The selection of farmers was done using the stratified random sampling technique and the respondents were stratified on the basis of the adoption of bio-inputs. A list of farmers who are using bio-inputs for sugarcane cultivation was prepared for each of the selected villages with the help of the records of the Village Administrative Officers and EID Parry. To compare the economics of sugarcane in adopter and non-adopter farms, 10 adopter farmers and 10 non-adopters were selected randomly from each selected village. Hence the total sample size was 120 sugarcane growers consisting of 60 adopters and 60 non-adopters selected randomly from the list of bio-input adopters and non-adopters prepared for the selected villages. The required information was collected from the selected respondents using a pre-tested schedule for the year 2007-08. The collected information was analysed using the following tools:
(i) Conventional Analysis

Descriptive statistics, viz., mean and percentage analyses were performed for making comparisons of costs and returns in sugarcane cultivation and in other analyses wherever necessary.

(ii) Costs and Returns

The sugarcane crop was grown both in the case of bio-input usage and bio-input non-usage with a recommended package of practices. The information about other important crops have also been collected, analysed and presented. To analyse the data and interpret the results, tabular and budgeting techniques as well as statistical methods have been used. To work out the economics of bio-input usage, the cost of production of sugarcane crop and gross and net returns have been worked out by using the standard concepts as follows (Johl and Kapur, 1996; Raju and Rao, 1990; Sharma and Sharma, 1978; Tandon and Dhondyal, 1978):

Cost A₁ – Cost of setts and planting material, value of farmyard manure, bio-inputs, fertilisers, pesticides, bullock and casual labour, value of machinery power, interest on working capital, depreciation on farm tools and machinery.
Cost A₂ – Cost A₁ + rent paid on leased in land.
Cost B – Cost A₂ + imputed rental value of owned land + interest on fixed capital.
Cost C – Cost B + imputed value of family labour.
Gross return = yield x unit price.
Net return = Gross return – Total cost of cultivation.
Family labour = The wages for family labourers were computed on the basis of the wage payment made to the casual labourers.
Rental value of owned land = The rental value for owned land was computed on the basis of the value of rental value of leased in land.

The computation of the cost of production was done on the basis of the input and output price prevailing in the study area during the period of the study.

(iii) Decomposition Analysis

The effect of bio-inputs on the output of sugarcane in the study area was studied using decomposition analysis. For measuring these effects, the decomposition model as adopted by Bisalaih, 1977; and Poucheppparadjou et al., 2005 was adopted. The model involves Cobb-Douglas type of production function by decomposing the natural logarithm of the ratio of gross returns in sugarcane production. Here, the two groups considered were adopters and non-adopters of bio-inputs.
Adopters

\[
\ln \text{YLD}_{AD} = \ln A_{AD} + a_{AD} \ln \text{SETT}_{AD} + b_{AD} \ln \text{MANURES}_{AD} + c_{AD} \ln \text{FERTILISER}_{AD} + d_{AD} \ln \text{PPC}_{AD} + e_{AD} \ln \text{HLAB}_{AD} + f_{AD} \ln \text{MPOW}_{AD} + u_{AD}
\]

Non-adopters

\[
\ln \text{YLD}_{NA} = \ln A_{NA} + a_{NA} \ln \text{SETT}_{NA} + b_{NA} \ln \text{MANURES}_{NA} + c_{NA} \ln \text{FERTILISER}_{NA} + d_{NA} \ln \text{PPC}_{NA} + e_{NA} \ln \text{HLAB}_{NA} + f_{NA} \ln \text{MPOW}_{NA} + u_{NA}
\]

where,

- YLD - Yield of sugarcane per hectare in tonnes,
- SETT - Value of setts in Rs./ha,
- MANURES - Value of manures in Rs./ha,
- FERTILISER - Value of NPK in Rs./ha,
- PPC - Value of plant protection chemicals in Rs./ha,
- HLAB - Value of human labours in Rs./ha,
- MPOW - Value of machinery power in Rs./ha.

The subscript ‘AD’ and ‘NA’ denotes adopters and non-adopters of bio-inputs respectively. ‘A’ – is the scale parameter and \(a, b, c, d, e\) are all output elasticities with respect to different inputs.

Taking the difference between the equations for the adopter and non-adopter and simplification gives the following equation.

\[
\ln \left(\frac{\text{YLD}_{NA}}{\text{YLD}_{AD}}\right) = \ln \left(\frac{A_{NA}}{A_{AD}}\right) + \left\{[(a_{NA} - a_{AD}) \ln \text{SETT}_{AD}] + [(b_{NA} - b_{AD}) \ln \text{MANURES}_{AD}] + [(c_{NA} - c_{AD}) \ln \text{FERTILISER}_{AD}] + [(d_{NA} - d_{AD}) \ln \text{PPC}_{AD}] + [(e_{NA} - e_{AD}) \ln \text{HLAB}_{AD}] + [(f_{NA} - f_{AD}) \ln \text{MPOW}_{AD}]\right\} + \left\{a_{AD} \ln \left(\frac{\text{SETT}_{AD}}{\text{SETT}_{NA}}\right) + b_{AD} \ln \left(\frac{\text{MANURES}_{AD}}{\text{MANURES}_{NA}}\right) + c_{AD} \ln \left(\frac{\text{FERTILISER}_{AD}}{\text{FERTILISER}_{NA}}\right) + d_{AD} \ln \left(\frac{\text{PPC}_{AD}}{\text{PPC}_{NA}}\right) + e_{AD} \ln \left(\frac{\text{HLAB}_{AD}}{\text{HLAB}_{NA}}\right) + f_{AD} \ln \left(\frac{\text{MPOW}_{AD}}{\text{MPOW}_{NA}}\right)\right\} + (u_{NA} - u_{AD})
\]

This equation approximately apportions the difference in yield per hectare between the adopters and non-adopters. The first term on the right hand side indicates the percentage change in yield due to a shift in scale parameter A. The next term measures the effect of changes in slope parameters (output elasticities), these two terms sum up to the total of bio-inputs effect. The third term measures the contribution of change in input levels to changes in output. The last term is a random term.
(iv) Adoption Model

The logit model was employed to identify the factors determining the adoption of bio-inputs in the study area.

The logit model in this study postulated that $P_i$, the probability that farmer ‘i’ adopted bio-inputs was a function of an index variable $Z_i$ summarising a set of individual attributes:

$$P_i = f(Z_i) = f(\beta x_i) = \frac{1}{1 + e^{-n_i}} = \frac{1}{1 + e^{-[\beta x_i]}}$$

Where, $\beta$ is a (K x 1) vector of coefficient, $X_i$ is a (Kx1) vector of the farmer i’s attributes, and $e$ is the base of natural logarithm. The index variable $Z_i$ is a dichotomous variable, i.e., it takes the value of one ($Z_i=1$) if a farmer adopts bio-inputs and the value is zero otherwise ($Z_i = 0$). $Z_i$ has been shown to be the logarithm of the odds ratio (Kennedy, 1985; Singh et.al., 2003; Gujarati, 2005 and Sundaravaradarajan et al., 2006). $P_i$ is the probability of adopting bio-input and $1-P_i$ is the probability of non-adoption. Taking the natural logarithm of the ratio of probability that a farmer will adopt bio-input to the probability that he will not adopt it then $Z_i$ will be:

$$Z_i = \ln \left[ \frac{P_i}{1-P_i} \right] = \beta x_i$$

Since $P_i$ in the above said equation would be equal to 1 if a choice was made and zero otherwise, the correct estimation of this equation requires the use of Maximum Likehood Estimation (MLE) procedure. The empirical model specification was:

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + e$$

where,

$X_1$ - Age of the respondent in years
$X_2$ - Farm income in Rs./year
$X_3$ - Numbers of years of formal education
$X_4$ - Size of farm holding in hectares
$X_5$ - Experience in handling bio-input in years
$e$ - Error term
$\beta_0$ - Intercept term and
$\beta_1$ to $\beta_2$ - Elasticity coefficient

The error term, which represented unobservable socio-economic factors and characters of surveyed households were assumed to be independently distributed.

III

RESULTS AND DISCUSSION

The collected data was analysed using econometric tools and the results are discussed in the following three sections.
(i) Costs and Returns

The cost of production per tonne was obtained by dividing the cost of cultivation attributable to the main product by the yield on a unit area basis. The cost of cultivation was computed for sugarcane separately for the adopter and non-adopter and it is presented in Table 1.

<table>
<thead>
<tr>
<th>Sr.No.</th>
<th>Particulars</th>
<th>Bio-input adopter</th>
<th>Bio-input non adopter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Expenditure (3)</td>
<td>Percentage of expenditure (4)</td>
<td>Expenditure (5)</td>
</tr>
<tr>
<td>1.</td>
<td>Setts</td>
<td>9145.95</td>
<td>21.37</td>
</tr>
<tr>
<td>2.</td>
<td>Manures</td>
<td>2582.03</td>
<td>6.03</td>
</tr>
<tr>
<td>3.</td>
<td>Fertilisers</td>
<td>2179.41</td>
<td>5.09</td>
</tr>
<tr>
<td>4.</td>
<td>Bio-input</td>
<td>7714.00</td>
<td>18.03</td>
</tr>
<tr>
<td>5.</td>
<td>Plant protection chemicals</td>
<td>174.19</td>
<td>0.41</td>
</tr>
<tr>
<td>6.</td>
<td>Human labour</td>
<td>19452.78</td>
<td>45.46</td>
</tr>
<tr>
<td>7.</td>
<td>Machinery use</td>
<td>1546.49</td>
<td>3.61</td>
</tr>
<tr>
<td>I.</td>
<td>Sub-total</td>
<td>42794.85</td>
<td>100.00</td>
</tr>
<tr>
<td>II.</td>
<td>Cost A₁</td>
<td>47930.22</td>
<td>-</td>
</tr>
<tr>
<td>III.</td>
<td>Cost A₂</td>
<td>47930.22</td>
<td>-</td>
</tr>
<tr>
<td>IV.</td>
<td>Cost B</td>
<td>55762.87</td>
<td>-</td>
</tr>
<tr>
<td>V.</td>
<td>Cost C</td>
<td>57827.35</td>
<td>-</td>
</tr>
<tr>
<td>VI.</td>
<td>Yield (tonne/ha)</td>
<td>123.00</td>
<td>-</td>
</tr>
<tr>
<td>VII.</td>
<td>Price (per tonne)</td>
<td>1020</td>
<td>-</td>
</tr>
<tr>
<td>VII.</td>
<td>Gross return</td>
<td>125460.00</td>
<td>-</td>
</tr>
<tr>
<td>IX.</td>
<td>Net return</td>
<td>82665.15</td>
<td>-</td>
</tr>
<tr>
<td>X.</td>
<td>Cost of production (Rs./tonne)</td>
<td>347.92</td>
<td>-</td>
</tr>
</tbody>
</table>

It could be seen from the table that the total cost of cultivation per hectare was Rs. 42794.85 in bio-input adopter farms, which was 2.35 per cent higher than the total cost in bio-input non-adopter farms. Among the components of total cost, human labour (45.46 per cent) occupied the highest percentage followed by setts (21.37 per cent) and value of bio-inputs (18.03 per cent); where as in bio-input non-adopter farms, the highest percentage of total cost was incurred for human labourers (49.50 per cent) followed by setts (49.50 per cent) and fertiliser (14.71 per cent).

In the bio-input adopter farms, the share of fertiliser cost in the total cost of cultivation was only five per cent and share of plant protection chemicals was very meagre. Since, more than 60 per cent of the adopters are educated and have good contact with agricultural officers and cane officers, non-adopters also apply less quantum of plant protection chemicals and its share in the total cost of cultivation was less than one per cent only. Further it could be seen from the table that the net income in bio-input adopter farms was 10.74 per cent higher than that of bio-input non-adopter farms. This was due to the reason of a higher productivity in bio-input
adopter farms. The unit cost of production was worked out as Rs. 347.92 and Rs. 366.22 in the adopter and non-adopter farms respectively.

(ii) Decomposition Analysis

The decomposition of the total difference in the gross income between the bio-input adopter and the bio-input non adopter were estimated and is given in Table 2.

<table>
<thead>
<tr>
<th>Sources of differences</th>
<th>Absolute contribution</th>
<th>Per cent contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difference in gross returns</td>
<td>9002.61</td>
<td>100.00</td>
</tr>
<tr>
<td>Difference in gross return due to bio-input</td>
<td>5666.6394</td>
<td>62.9444</td>
</tr>
<tr>
<td>Difference in gross return due to inputs</td>
<td>-661.4846</td>
<td>-7.3477</td>
</tr>
<tr>
<td>(i) Sets</td>
<td>-2.2727</td>
<td>-0.0252</td>
</tr>
<tr>
<td>(ii) Manures</td>
<td>-3.3558</td>
<td>-0.0373</td>
</tr>
<tr>
<td>(iii) Fertiliser</td>
<td>-46.8402</td>
<td>-0.5203</td>
</tr>
<tr>
<td>(iv) Plant protection chemicals</td>
<td>0.0855</td>
<td>0.0009</td>
</tr>
<tr>
<td>(v) Human labour</td>
<td>-695.335</td>
<td>-7.7237</td>
</tr>
<tr>
<td>(vi) Machinery</td>
<td>86.2336</td>
<td>0.9579</td>
</tr>
<tr>
<td>Difference in gross return due to others</td>
<td>3997.4526</td>
<td>44.4033</td>
</tr>
</tbody>
</table>

It could be observed from the table that the total difference in gross return per hectare of sugarcane between the adopters and non-adopters of bio-input was Rs.9002.61. In the total difference bio-input alone accounted for 62.94 per cent. The variations due to the other inputs put together negatively contributed to the differences in gross return and therefore the other factors not included in the model accounted for 44.40 per cent.

(iii) Adoption Analysis

The result of the logit analysis for bio-input adoption is presented in Table 3.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Variables</th>
<th>Coefficient (3)</th>
<th>Standard Error (4)</th>
<th>Odds Ratio (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Intercept</td>
<td>-7.3327</td>
<td>3.7589</td>
<td>-</td>
</tr>
<tr>
<td>2.</td>
<td>Age</td>
<td>0.2737*</td>
<td>0.1444</td>
<td>1.3149</td>
</tr>
<tr>
<td>3.</td>
<td>Income</td>
<td>0.1466*</td>
<td>0.0843</td>
<td>1.1579</td>
</tr>
<tr>
<td>4.</td>
<td>Education</td>
<td>0.1034**</td>
<td>0.0416</td>
<td>1.1089</td>
</tr>
<tr>
<td>5.</td>
<td>Farm size</td>
<td>0.1643**</td>
<td>0.0735</td>
<td>1.1786</td>
</tr>
<tr>
<td>6.</td>
<td>Experience in handling bio-inputs</td>
<td>0.2963***</td>
<td>0.1048</td>
<td>1.3449</td>
</tr>
<tr>
<td></td>
<td>Log-likelihood</td>
<td>-69.7881</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chi-square</td>
<td>42.934</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Count R²</td>
<td>0.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of observations</td>
<td>120</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: ***, ** and * indicate significance at 1, 5 and 10 per cent level, respectively.
The comparison of the log likelihood function and Chi-square test from the table provide evidence that the estimated model is significant. The count $R^2$ takes the value of 0.78, i.e., it inferred that the number of correct predictions was 78 per cent which confirms the goodness of fit of the model. It could be seen from the table that all the coefficients of the independent variables had expected signs, i.e., all the coefficients were positively significant.

The observation on odds ratio indicated that among the variables determining the bio-input adoption, the experience in handling bio-inputs played a significant role followed by the age of the respondent, farm size and income of the respondent. The odds of experience in handling bio-inputs indicated that the increase in the years of experience above the mean would increase bio-input adoption by 1.35 times.

IV

CONCLUSION

The Government of India should aim at boosting bio-inputs on a large scale for sugarcane production. It should set up an Organic Agriculture Research Institute (OARI) with its all India network and centres in different states. The proposed OARI should conduct research and provide extension services, training, extension skills, biodiversity, methods of making improved farm yard manure (FYM), compost, vermiculture, biological control of harmful insects and other pests.

Economic incentives act as a driving force in making bio-input adoption. The subsidies, tax exemption on bio-inputs, institutional credit and insurance, awards/recognition to bio-input adopting farmers are some of the driving forces which will influence non-adopters to adopt bio-inputs.

Though, the plant protection research has produced a number of biological pest management technologies, many of these are not applicable under the field conditions because of the high application cost. This necessitates the need to develop low cost technologies for their greater commercialisation and use. To promulgate widespread bio-inputs adoption, the extension system should document the success stories and widely publicise their improved benefit-cost ratios and also develop local leadership to motivate the farmers for effective participation in the bio-input programmes.

Since a major portion of sugarcane production cater to domestic consumption, the government must create awareness and health consciousness among domestic consumers and this will necessitate creating a market for pesticide free products.

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REFERENCES


