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AN ANALYSIS OF COST AND PRODUCTION FUNCTION OF ENERGY UTILISATION OF COTTON CULTIVATION IN THOOTHUKUDI DISTRICT.

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Abstract

In this study cost and returns structure of irrigated and un-irrigated farmers, producing cotton are framed. For this purpose the collected data have been analysed for cost and returns structure including various cost components cost function, production function, input output structure. The Regression model was estimated by the method of least squares for irrigated, un-irrigated and overall farmers cultivating cotton cost separately. There is a positive relationship between the total cost of cotton cultivation and various factor costs. The multiple regression model was estimated by the method of least square. It is found that the independent variables in the regression model are jointly responsible for 93.70 per cent (R^2) variations in the total cost of cotton cultivation irrigated farmers in the study area. The independent variable human labour is positively related to the total cost of irrigated cotton cultivation in the study area. It means that an additional unit made in this variable may lead to the increase of 1.213 per cent with the total cost in cotton cultivation. It is inferred from the analysis that the variable total cost of irrigated cotton cultivation has a greater influence on the human labour in irrigated area cultivation. The F value (705.510) shows that the model fitted is statistically significant at 5 per cent level. In the case of un-irrigated farmers R^2 value indicated that about 94.10 per cent of variations in the total cost. It was also found that

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the human labour and fertilizer had a greater influence on the determination of cost of cotton cultivation. The impact of the variable, yield per acre was found to be higher in the case of un-irrigated farmer. Thus it may be concluded from the analysis of cultivation of cotton, cultivation of land and yield of cotton was found to be significant variables in the case of irrigated and un-irrigated farmers and total cost found to be significant in overall farmers. Total cost is considered as an important variable for overall farmers.

Keywords: Cost, production, Cotton Cultivation, irrigated, un irrigated, energy, farmer.

Introduction

Cotton is the most important commercial crop of our country contributing upto 75 per cent of total raw material needs of textile industry and provides employment to about 60 million people. India has the largest area under cotton cultivation with relatively low productivity and it is primarily due to the large area under rainfed cultivation with inadequate supply of inputs. India ranks first in world in area-wise, whereas, it ranks second in production next to China. Only in India, all the four spinnable fibre yielding species of Gossypium viz., *Gossypium hirsutum, G. barbadense, G. arboreum* and *G. herbaceum* are cultivated commercially.

Cotton production is an important industry worldwide, supplying the textile industry with raw fibre for the manufacturing of garments. Pressure from synthetic fibres has seen that the industry has become aware of the need for producing high yields of quality fibre in a most efficient manner. Precise management practices including fertiliser application and ground preparation play a significant role in accomplishing the superior product. Knowledge and experience of interactions between climate, plants, soils and microorganisms is needed to improve the efficiency and sustainability of cotton production.

Energy input and output are two main factors for determining the energy efficiency and environmental impact of crop production. Energy utilization and output differs among crops, production systems and intensity of management. Energy productivity, as the quality of a given agricultural product per unit of energy required for its production, is a critical indicator for more efficient use of energy. The analysis of energy is therefore necessary to decide on methods for minimizing the energy inputs and enhancing the energy productivity (Fluck and Baird, 1982).

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Energy requirements in a farm unit can be separated into direct energy and indirect energy, either of these sections could also be classified as renewable energy or non-renewable energy. Direct energy is mainly used for land preparation, planting, irrigation, applying chemicals, harvesting and transporting products to and from market (Singh, 2004). Indirect energy is used for producing pesticides and fertilizers. Renewable energy includes human labour, irrigation water, seeds and non-chemical fertilizers while non-renewable energy consists of fossil fuels, pesticides, chemical fertilizers and machinery (Mohammadi et al., 2008).

Problems of the study

Due to the spread of new agricultural technology which requires increased use of mechanical power and high pay off inputs, the demand for the use of non- conventional sources of energy such as diesel, petrol and electricity is steadily increasing in rural areas. Cultivation of cotton poses more problems when compared to other agricultural commodities. The cultivation of cotton generally depends on fertility of soil, climatic conditions, high yielding varieties of seeds and rainfall. The farmers are facing many problems in the cultivation of cotton. The cotton growers are affected by various problems in the cultivation of cotton due to the non- availability of labour, high wage rate, high transportation cost, storage cost, poor quality of fertilizers, non-availability of fertile seeds, loss due to pest and inadequate technical know-how. Thus the aim of the present study is to examine the energy consumption pattern of cotton cultivation in the rural villages, to foster the importance of energy and to analyse the possibility and feasibility of introducing new forms of energy inrural areas in the agricultural sectors.

Objectives of the study

1. to study the cost and return structure of cotton cultivation under irrigated and un-irrigated conditions for two groups of farmers namely small and marginal farmers;
2. to study the cost of production in cotton cultivation in the study area.
3. To analyse the energy utilization of cotton cultivation in Thoothukudi District.

Methodology

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The study depends upon both secondary and primary data. For the purpose of collecting the primary data. the major techniques such as observation, informal talks and interview schedule may be the best ones. The survey method is to be used as a tool for data collection and to study the energy consumption pattern of the agricultural sectorof the selected villages. To analysis the data on energy use pattern in the study area statistical tools such as log-linear multiple regression, Chow's test, input Output analysis, Marginal Value Productivity (MVP) and factor analysis are to be employed. The 590 sample cotton cultivators from irrigated and un-irrigated areas were selected and the conditions were post stratified into two groups namely marginal and small farmers.

Review of the study

Narayana et al., (2000) in their study reveals that cotton in India is grown under irrigated as well as unirrigated conditions. Over 60 per cent of cotton is unirrigated in India. Productivity of cotton has been pulled down mainly due to the predominance of unirrigated cotton the productivity of which is around 2.4 times less than that of irrigated cotton. The contribution of unirrigated cotton to the production of cotton in India and Tamilnadu is of great importance. It is needed to break many natural and artificial barriers affecting cotton productivity and production potential. Therefore, a comparative study on the problems related to the production aspects of irrigated and unirrigated cotton cultivation is needed inan area where cotton cultivation is predominant under both situations.

Sawant (1993) in his article reveals that cost minimization is an important goal in production economics, reduction costs imply higher returns. In crop production also cost minimisation by the cotton growers ensures them higher monetary returns, these monetary returns, in turn act as an incentive to cotton farmers to grow more cotton. This calls for an analysis of various cost components and input output structure in irrigated and unirrigated cotton cultivation in respect of small and large farmers under the both situations with continuous deterioration in domestic terms of trade and a distinct trend of increasing cost of cultivation being set in Indian agriculture has entered a critical phase in the nineties.

Erdal Dagistan et al., (2009) the aim of this research is to determine the energy input

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and output involved in cotton production in the Hatay province of Turkey. The average energy consumption of the farms investigated in this study is 19 558 MJha-1. Of the total energy, 2.87 per cent is direct and 71.13 per cent is indirect. Renewable energy accounts for 12.30 per cent and energy usage efficiency is found to be 2.36. The total energy input into the production of one kilogram of average Turkish cotton is estimated to be 4.99 MJ. The dominant contribution to input is energy in the form of nitrogen fertiliser is 40.28 per cent followed by water for irrigation with 22.37 per cent and diesel oil with 17.04per cent. The cost of cotton production per hectare is found to be 2 246 $ha-1 inthe region, with 79.87 per cent of this being variable costs. It can be concluded that intensive cotton farms are being operated in the area since the variable cost ratio is quite high. As a result of benefit-cost ratio analysis with 1:24, cotton production is found to be economically efficient.

Mohammad Azam Khan et al., (2009) in their study reveals that energy is a key factor in boosting crop yield for rapidly growing world population. Plan to conserve energy for future generations without threatening the food supply, requires a comprehensive analysis of energy inputs and outputs as a result. A study was conducted in 2002-03 to ascertain the effects of different parameters of energy inputs on biomass production of rice and cotton in Liuyuankou Irrigation System, Henan province of China. The contribution of direct energy, including human, pumping and tractor was 30 per cent and 14 per cent of the total energy required to grow rice and cotton crops respectively. Pumping energy alone was 13 per cent and one per cent of the total energy required for growing rice and cotton crops respectively. Fertilizer was another major component of indirect energy inputs for both of these crops accounting for 76 per cent and 63 per cent for cotton and rice, respectively. The fertilizer application on Indian farms was too low to impact on yield. However, it improved energy efficiency. The overall energy efficiency, energy productivity, water productivity and combined energy and water productivity were lower for cotton crop. The net return was higher for cottonbecause of its higher price in the market.

Result and Discussion

In this study cost and returns structure of irrigated and un-irrigated farmers, producing cotton are framed. For this purpose the collected data have been analysed for cost and returns structure including various cost components cost function,

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production function, input output structure.

1.1 Cost Function

In order to identify the cost function of cotton cultivation, the followingform of multiple regression model was fitted by the method of least squares.

$C = a_0 + B_1 \log x_1 + B_2 \log x_2 + B_3 \log x_3 + B_4 \log x_4 + B_5 \log x_5 + B_6 \log x_6 + U$Where,

C = Total cost (inRs)

X_1 = Labour cost (inRs)

X_2 = Tractor application cost (inR s)

X_3 = Manure cost (inRs))

X_4 = Fertilizer cost (inRs))

X_5 = Pesticide cost (in Rs)

X_6 = Seed cost (in Rs)

U = disturbance term

a_0, B_1, B_2, B_3 ….. are parameters.

The Regression model was estimated by the method of least squares for irrigated, un-irrigated and overall farmers cultivating cotton cost separately. The estimated results are presented in the following tables.

1.1 Estimated Result of Regression Model of Cotton in IrrigatedFarmers

There is a positive relationship between the total cost of cotton cultivation and various factor costs. The multiple regression model was estimated by the method of least square and the result is furnished in Table 1.

Table: 1 - Estimated Result of Regression Model of Irrigated Cotton Cultivators

Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.968	0.937	0.936	1351.757

a Predictors: (Constant), human labour, seed cost, pesticide cost, manure cost, tractor application cost, fertilizer cost

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ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	7.735E9	6	1.289E9	705.510	.000
Residual	5.189E8	284	1827246.456		
Total	8.254E9	290			

a Predictors: (Constant), human labour, seed cost, pesticide cost, manure cost, tractor application cost, fertilizer cost

b Dependent Variable: Total cost

Coefficients

	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
(Constant)	9804.535	1703.214		5.756	.000
Seed Cost	1.011	0.229	0.092	4.410	.000
Pesticide Cost	1.420	0.169	0.158	8.379	.000
Fertilizer Cost	1.580	0.072	0.486	21.906	.000
Manure Cost	0.673	0.177	0.068	3.811	.000
Transport Application Cost	2.269	0.163	0.253	13.887	.000
Human Labour	1.213	0.087	0.273	13.902	.000

a. Dependent Variable: Total cost

It is found from Table 1 that the independent variables in the regression model are jointly responsible for 93.70 per cent (R^2) variations in the total cost of cotton cultivation irrigated farmers in the study area. The independent variable human labour is positively related to the total cost of irrigated cotton cultivation in the study area. It means that an additional unit made in this variable may lead to the increase of 1.213 per

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cent with the total cost in cotton cultivation. It is inferred from the analysis that the variable total cost of irrigated cotton cultivation has a greater influence on the human labour in irrigated area cultivation. The F value (705.510) shows that the model fitted is statistically significant at 5 per cent level.

1.2 Estimated Result of Regression Model of Cotton in Un-Irrigated Farmers

There is a positive relationship between the total cost of cotton cultivation and various factor costs in un-irrigated farmers. The multiple regression model was estimated by the method of least square and the result is furnished in Table 2.

Table: 2 - Estimated Result of Regression Model of Un-Irrigated Cotton Cultivators

Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.970	0.941	0.939	1289.174

a Predictors: (Constant), human labour, seed cost, pesticide cost, manure cost, tractor application cost, fertilizer cost

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	7.683E9	6	1.281E9	770.477	.000
Residual	4.853E8	292	1661970.722		
Total	8.168E9	298			

a Predictors: (Constant), human labour, seed cost, pesticide cost, manure cost, tractor application cost, fertilizer cost

b Dependent Variable: Total cost

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Coefficients

	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
(Constant)	9568.026	1649.449		5.801	.000
Seed Cost	0.820	0.216	0.075	3.805	.000
Pesticide Cost	1.513	0.164	0.171	9.212	.000
Fertilizer Cost	1.568	0.071	0.484	22.233	.000
Manure Cost	0.744	0.174	0.073	4.267	.000
Transport Application Cost	2.512	0.156	0.277	16.113	.000
Human Labour	1.178	0.084	0.263	13.953	.000

a. Dependent Variable: Total cost

It is observed from table 2 that in the case of un-irrigated farmers R^2 value indicated that about 94.10 per cent of variations in the total cost were jointly caused by the six explanatory variables included in the model. Human labour, fertilizer, transport cost and pesticides are positively more influenced with increase in total cost. It indicated that one unit increase in these variables could increase the cost by 1.178 unit, 1.568 unit, 2.512 unit and 1.513 units respectively. It was also found that the human labour and fertilizer had a greater influence on the determination of cost of cotton cultivation. As per 'F" value (770.477) the fitted regression model was statistically significant at 5 per cent level.

1.3 Production function

In order to identify the determinants of production function of cotton yield for irrigated, un-irrigated and overall farmers, the following from of multiple linear Model of Cobb-Douglas type is used.

$Y = a_0 + B_1 \log x_1 + B_2 \log x_2 + B_3 \log x_3 + B_4 \log x_4 + U$Where,

Y = Total output

x_1 = Cultivation of land (in acres)

x_2 = Yield per acre

x_3 = Price per kg (inRs

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x4 = Total cost (inRs)

U = Disturbance term

a_0, B_1, B_2, B_3 etc ….. are parameter.

Estimated Results of Regression Model for yield of Cotton in Irrigated Cotton Farmers

The Regression Model was fitted by the method of least squares for irrigated farmers producing yield of cotton. The results are presented in table.

Table: 3 - Estimated Result of Regression Model for yield of Cotton in Irrigated Cotton Cultivators

Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.959	0.919	0.919	0.033

a Predictors: (Constant), Total Cost, Cultivation of Land, Yield per Acre, Price per kg.

ANOVA

	Sum of Squares	Df	Mean Square	F	Sig.
Regression	7.301	4	1.825	1665.790	.000
Residual	0.641	585	0.001		
Total	7.942	589			

a Predictors: (Constant), Total Cost, Cultivation of Land, Yield per Acre, Price per kg.

b Dependent Variable: Total Yield

Coefficients

	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
(Constant)	0.393	0.208		1.890	.000
Total Cost	0.104	0.036	0.001	2.889	.000

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Cultivation of Land	0.254	0.015	0.744	16.821	.000
Yield per Acre	0.029	0.002	0.786	17.143	.000
Price per kg.	0.824	0.120	0.722	6.867	.000

a. Dependent Variable: Total Yield

It is inferred from table that in the case of irrigated farmers, R^2 value indicated that about 91.90 per cent of variation in yield of cotton were jointly caused by the four explanatory variables included in the model. The cultivation ofland and yield per acre were found to be statistically significant at 5 per cent level. It indicated that one unit increase in the variables could yield by 0.029 unit and

0.254 unit respectively. It was also found that the price as well as total cost had aninfluence on the determination of yield. As per 'F' value 1665.790 the fitted regression model was statistically significant at 5 per cent level.

1.4 Estimated Results of Regression Model for yield of Cotton inUn-irrigated Cotton Farmers

The regression model was fitted by the method of least squares for un- irrigated farmers producing yield of cotton. The results are presented in table.

Table: 4 - Estimated Result of Regression Model for Yield of Cotton in Un-irrigated Cotton Cultivators

Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.941	0.885	0.884	0.039

a Predictors: (Constant), Total Cost, Cultivation of Land, Yield per Acre, Price per kg.

ANOVA

	Sum of Squares	Df	Mean Square	F	Sig.

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Regression	3.495	4	0.874	551.689	.000
Residual	0.453	286	0.002		
Total	3.948	290			

a Predictors: (Constant), Total Cost, Cultivation of Land, Yield per Acre, Price per kg.

b Dependent Variable: Total Yield

Coefficients

	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
(Constant)	0.608	0.376		1.616	.000
Total Cost	0.014	0.004	0.068	3.500	.000
Cultivation of Land	0.115	0.007	0.013	16.429	.005
Yield per Acre	1.085	0.024	0.954	45.410	.000
Price per kg.	0.049	0.062	0.016	0.782	.543

a. Dependent Variable: Total Yield

As far as un-irrigated farmers were concerned, all the four explanatory variables together accounted for nearly 88.50 unit variation in the yield of cotton. Out of four variables, three are included in the regression model, namely yield cultivation of land and total cost were found to be statistically significant at 5 per cent level. It indicated that one unit increase in these variables could increase yield per acre by 1.085 unit, 0.115 unit and 0.014 unit respectively. The impact of the variable, yield per acre was found to be higher in the case of un-irrigated farmer. The 'F' value showed that the estimated regression model was statisticallysignificant at 5 per cent level.

In the case of overall farmers four independent variables jointly accounted for about 88 per cent of the variation in the yield of cotton. Among four, three variables had a positive effect on the determination of yield. Input variables such as total cost, cultivation of land and price of cotton were found to be significantly related to cultivation of cotton. The 'F' value 540.079 showed that the overall regression model

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emerge statistically significant at 5 per cent level.

Thus it may be concluded from the analysis of cultivation of cotton, cultivation of land and yield of cotton was found to be significant variables in the case of irrigated and un-irrigated farmers and total cost found to be significant in overall farmers. Total cost is considered as an important variable for overall farmers.

1.5 Input- Output structure for Irrigated and Un-irrigated Farmersper acre

The input-output structure of cultivation cotton for irrigated and un-irrigated farmers is shown in table.

In order to test the difference between mean input-output structures of farmers cultivating cotton yield, the following form of 'Z' test was carried out.

Table: 5 - Input- Output structure for Irrigated and Un-irrigated Farmers of Cultivation of Cotton per acre

S.No	Variable	Irrigated Farmer	Un-irrigated Farmer	'Z' Test
1	Human Labour (in man days)	54.25	60.45	27.321*
2	Tractor (in hours)	3.48	4.32	1.945
3	Fertilizers (in Rs`)	2,280.84	1,050.24	13.452*
4	Pesticides (in Rs`)	3,150.50	2,400.00	8.120*
5	Seeds (in `Rs)	1,820.25	2,340.45	34.89*
6	Yield (in Kg)	1924.54	1421.58	13.124*
	Sample Size	**291**	**299**	

* Indicates significance at 5 per cent level.

It is revealed from table that the yield per acre of cotton was 1,924.54 kgs for irrigated farmer and 1,421.58 kgs for un-irrigated. This shows that there is a significant difference in the yield between irrigated and un-irrigated farmers. The difference in yield works out to 502.96 kgs. In the case of human labour, the amount of

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labour required was 54.25 mandays for the irrigated farmers and 60.45 mandays for un-irrigated farmers. The irrigated farmers used the tractor for 3.48 hours while the un-irrigated farmers took 4.32 hours for the required output. The irrigated farmers spent the amount of Rs 2,280.84 for the purchase of fertilizer and the un-irrigated farmers spent the amount of Rs 1,050.24 for the above same. Irrigated farmers spent the amount of Rs 3,150.50 for the purchase of pesticides but in the case of un-irrigated farmers it is registered as Rs 2,400 per acre. Irrigated farmers spent the amount of Rs 1,820.25 for the purchase of seeds and Rs 2,340.45 for un-irrigated farmers.

Apart from yield the differences in the utilization of other input variables like fertilizers, pesticides and seeds were also found to be significant between irrigated and un-irrigated farmers. With regard to the use of other variable namely tractor technology, the difference between irrigated and un-irrigated farmers were not found to be significant.

Figure 1

Cost and Returns Structure of Cotton for Small andMarginal Farmers in Irrigated Area

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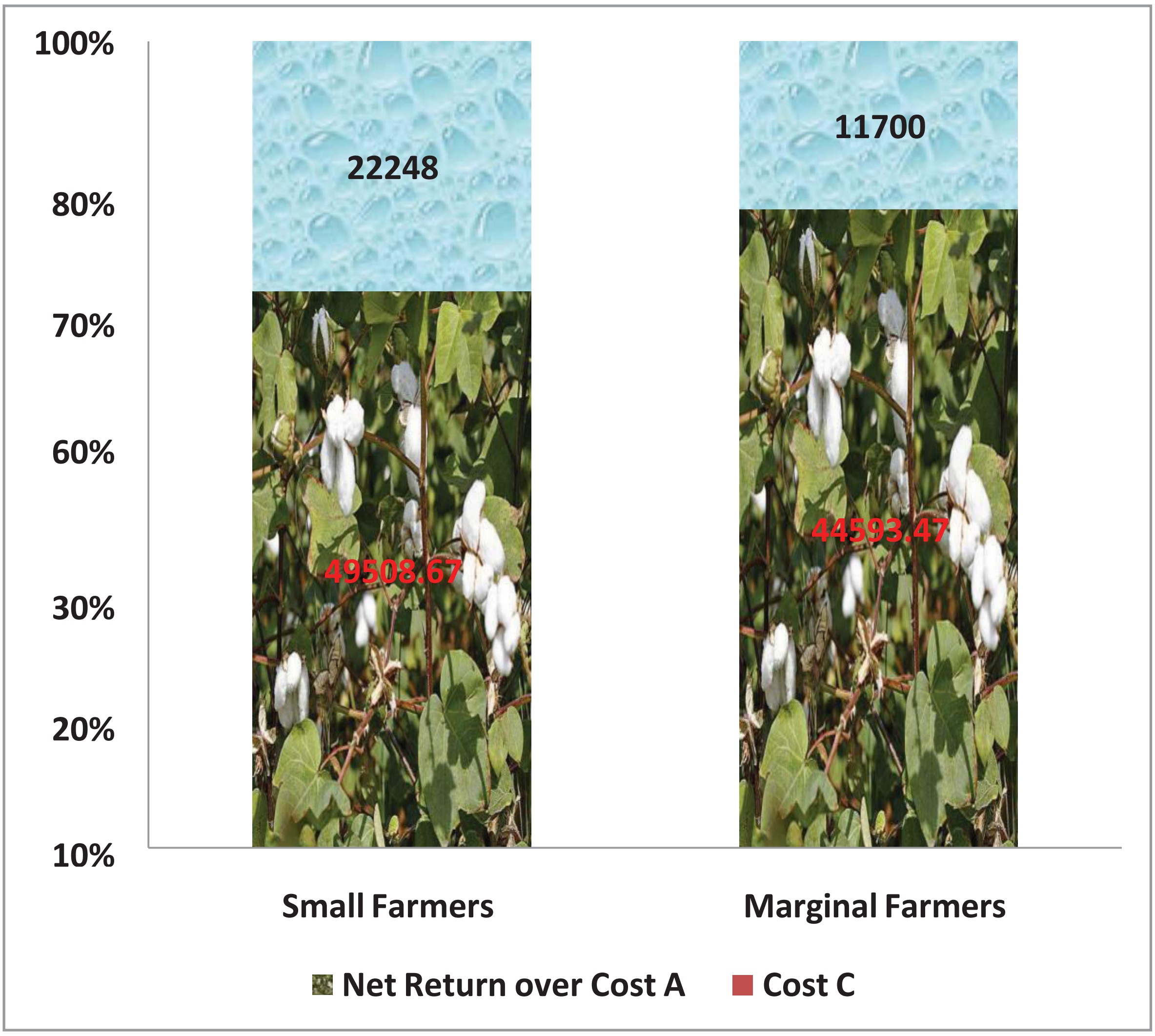

Findings

In this study cost and returns structure of irrigated and un-irrigated farmers producing cotton are framed and analysed. In the case of irrigated farmers, they are incurring expenses for the purpose of obtaining 1,924 kg of yield. Their gross returns and net returns are `1,08,908 and `37,368 respectively. In un-irrigated farmers, they are incurring expenses for the purpose of obtaining 1,421 kg of yield and their gross and net returns are `88,301 and `30,971 respectively.

In the case of irrigated farmers producing cotton, all the five regression co-efficients of Independent variables were positive and they accounted for 94 per cent of the variations in the production of cotton. In un-irrigated farmers, 94 per cent of the variations in the output of cotton were caused by five explanatory variables. They had a positive effect on per acre output of cotton except the fertilizer cost. The regression analysis was found to be statistically significant at one per cent level.

The difference in average requirement of human labour per acre was significant and it was 145.78 mandays in the case of small farmers and 164.12 man days in the case of marginal farmers. The utilisation of fertilizer and irrigation cost was also statistically significant between the small and marginal farmers. The marginal farmers utilised more mechanical power per acre than the small farmers. The marginal farmers used 6.78 hours of mechanical power and small farmers used only 5.46 hour per acre of mechanical power in the study area.

Conclusion

Thus it may be concluded from the analysis of cultivation of cotton, cultivation of land and yield of cotton was found to be significant variables in the case of irrigated and un-irrigated farmers and total cost found to be significant in overall farmers. Total cost is considered as an important variable for overall farmers.

Thus it may be concluded from the analysis the explanatory variables included in the model together explained that about more than 94 per cent of the observed variability in the cultivation cost of cotton in the case of irrigated, un- irrigated and overall farmers. Fertilizer and transport cost was found to be the considerable significant input influencing the cultivation cost of cotton in the case of un-irrigated and overall farmers cultivating the yield of cotton whereas in the case of irrigated farmers fertilizer and human labour had an influence on yield of cotton. The utilisation of fertilizer and irrigation cost was also statistically significant between the small and marginal farmers. In the case of irrigated farmers producing cotton, all the five regression co-efficients of Independent variables were positive and they accounted for 94 per cent of the variations in the production of cotton. In un-irrigated farmers, 94 per

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cent of the variations in the output of cotton were caused by five explanatory variables. They had a positive effect on per acre output of cotton except the fertilizer cost.

Human labour, fertilizer, transport cost and pesticides are positively more influenced with increase in total cost. It was also found that the human labour and fertilizer had a greater influence on the determination of cost of cotton cultivation.

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