1745 ECONOMICS OF NATURALLY COLOURED COTTON PRODUCTION UNDER CONTRACT FARMING IN INDIA

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Cotton (*Gossypium* spp.), 'the white Gold' or the "king of fibres" is closely linked to human civilization itself. Cotton is one of the most important commercial crop playing a key role· in economic, political and social affairs of the world. Cotton is one of the most important fibre crop constituting more than 37 per cent share in total fibre usage. About 78 countries are growing cotton in the world on an area of 32.80 million hectares with annual production of 94.63 million bales of 170 kgs each. At present, China, USA, India, Pakistan and Uzbekistan are the top five cotton producing countries of the world. However, of them only US is having considerable share in the world exports. At present, the average per capita annual consumption of textile fibres in the world is about 8 kgs of which 3 kgs is cotton.

India is the third largest producer of cotton in the world with production of around 3.95 million MT (Approximately 15.71% of world Production). Area under cotton is around 9.50 million hectares contributing about 29 per cent to the world cotton area and keeps fluctuating owing to monsoon and other factors. Despite having the largest area under cotton in the world, India ranks third in world output of cotton due to its abysmally low average yield of 415 kgs against a world average of 723 kgs per hectare. Cotton is cultivated in almost all the states in the country, the 9 states of Punjab, Haryana, Rajasthan, Gujarat, Maharashtra, Madhya Pradesh, Andhra Pradesh, Tamil Nadu and Karnataka account for more than 95 per cent of the area under cotton.

Karnataka is one of the nine major cotton-growing states in the country. Area under cotton in the state is around 5.12 lakh hectares, with the production and productivity of 8.00 lakh bales and 266 kg/ha, respectively (AICCIP, Annual Report 2005-06). The main cotton growing districts in Karnataka are Dharwad, Haveri, Mysore, Gadag, Bellary, Belgaum, Raichur, and Gulbarga. There is a fluctuation in cotton production over the years. The same trend is also seen with area and productivity. Dharwad district had the largest area accounting for 23.26 per cent of state's total area and it ranked second in production with 39,526 bales during 2003-04.

Cotton provides nearly 50 per cent of global fibre requirements, using 10 per cent of pesticides and 22.5 per cent of all insecticides applied in agriculture (on only 2.5% of agricultural land). These pesticides cause a range of health and environmental problems. Organic cotton is grown in India, Turkey, China, the USA, Peru and Paraguay. The organic cotton market offers major opportunities to help improve livelihoods for farmers through business and trade. Some of the more experienced farmers in the study area are obtaining higher yields than conventional farmers and organic farmers are clear that they will not go back to using chemicals unless forced to. Their incomes are usually higher as their purchases of inputs are reduced, and their health improves, reducing spending on health care, which is usually relatively expensive in developing countries.

Farmers who cultivated chemically had a greater incidence of pest attack in their fields. In the chemically cultivated cotton crop, flower drop was higher. Though these plants appeared tall and green, it was attacked by aphids and fruit borers. The cotton crop cultivated organically was not green and was short in stature. But the weight and colour of the cotton lint was superior in the organically cultivated plants. Using chemical fertilizers and pesticides for cotton crop, only increases the cost of cultivation. On the other hand, it does not increase the yield.

Cotton with naturally coloured lint, other than white is referred as coloured cotton. In nature, coloured cotton and white linted cotton are found from time immemorial. Colour cotton was used to create nets, clothing, tapestries, shrouds, saddlebags and blankets. Fossils obtained indicated the cultivation of colour cottons like blue, purple, green, tan and red colours in Peru. But Peru was the main producer of colour cotton in the World. Around 10 to 15 thousand of tribals were used to grow this cotton. Use of artificial dyes is avoided when the fabrics are manufactured from naturally coloured cotton. Even those having sensitive skin can safely use such fabric. Thus, fabric manufactured from naturally coloured cotton has been found to be best for human health (Waghmare *et al*, 2005).

Objectives of the Study

The present study was undertaken with the following specific objectives.

1. To estimate the costs and returns in naturally coloured cotton production.
2. To analyze the resource use efficiency in naturally coloured cotton production.

II. METHODOLOGY Sampling Procedure

Multistage purposive sampling technique was adopted in the selection of the district, taluk, village and cultivators. Dharwad district was purposively selected for the study, as this district is the major cotton-growing district in the state. Dharwad district ranked first and third in cotton area (16.39 %) and production (11.64%) of cotton respectively in the state and coloured cotton is also grown in this district. Dharwad taluk was purposively selected for the study, as coloured cotton is grown in Uppinbetageri village of this taluk under contract farming. Talukwise area under cotton in Dharwad. From Uppinbetageri village of Dharwad taluk, all the 80 farmers cultivating naturally coloured cotton under the system of contract farming were chosen purposively for the study. Contract was made between the University of Agricultural Sciences, Dharwad and Khadi Nekar Sahakari Utpadak Sangha Niyamit, Uppinbetageri. The study was based on the data collected from 80 farmers using purposive sampling technique.

Analytical Tools and Techniques Employed

The analytical techniques used to evaluate the objectives of the present study are summarized below.

a. Tabular Presentation Technique

The data collected were presented in tabular form to facilitate easy comparisons. This technique of tabular analysis was employed for estimating the cost and return structure, processors as well as garments manufacturer. The problems in production and processing units faced by the contract farmers and processors elicited were also analyzed by this technique. Terms of contract and modus operandi between UAS, Dharwad and Khadi Nekar Sahakari Utpadak Sangh Niyamit, Uppin Betageri were documented using averages, means and percentages.

The data were summarized with the aid of statistical tools like averages, percentages *etc.* to obtain the meaningful results.

b. Functional analysis

The Cobb-Douglas type of production function was used to study the effect of various inputs on coloured cotton output. On account of its well known properties like its computational simplicity that justify its wide application in analyzing production relations (Handerson and Quandt, 1971). It being a homogenous function provided a scale factor enabling one to measure the returns to scale. The estimated regression coefficients represented the production elasticities.

The form of Cobb-Douglas production function used in the present study is as follows.

$Y = aX_1^{b1}X_2^{b2}X_3^{b3} X_4^{b4} X_5^{b5}X_6^{b6} X_7^{b7}e^u$ _____________ (1)

Where,

Y = Gross output in rupees

a = Intercept (efficiency) term

X_1 = Farm size (ha)

X_2 = quantity of seeds in kgs

X_3 = quantity of FYM in tonnes

X_4 = Human labour in mandays

X_5 = Bullock labour in pair days

X_6 = quantity of Biopesticides in liters

X_7= quantity Trichocard in numbers

e^u = Random error term

bi's = Output elasticities of respective factor inputs, i = 1, 2….7 and

The Cobb-Douglas production function was converted into log linear form and parameters (coefficients) were estimated by employing Ordinary Least Square Technique (OLS) as given below.

$\log Y = \log a + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + b_6 \log X_6 + b_7 \log X_7 + u \log e$ _____________ (2)

The regression coefficients (b_i's) were tested using 't' test at choosen level significance.

$$t = \frac{b_i}{\text{Standard error of } b_i} \quad (3)$$

In order to know the goodness of fit, the adjusted co-efficient of multiple determination $\bar{R}^2$ was calculated by using the formula.

$$\bar{R}^2 = 1 - (1 - R^2)\frac{(n-1)}{(n-p)} \quad (4)$$

Where,

$\bar{R}^2$ = The adjusted coefficient of multiple determination (adjusted for the size of the sample)

R^2 = The coefficient of multiple determination which is given by

$$R^2 = \frac{\text{Regression sum of squares}}{\text{Total sum of squares}}$$

n = Number of observations in the sample

P = Number of parameters in the function

c. Measurement of efficiency

The analysis of efficiency should help to identify the possibilities for increasing income while conserving resources. The role of efficiency may be viewed as an important component in policy making to stimulate income and/or promote resource conservation.

The concept of efficiency was first defined by Farrel (1957) in terms of its two dimensions, technical efficiency and allocative efficiency. Technical efficiency arises when the maximum output is obtained from a given bundle of inputs and allocative efficiency arises when inputs are used in proportion, which yield maximum output. Allocative efficiency exists when resources are allocated within the farm according to market prices. It is therefore, suggested that within a static framework measures of technical efficiency retain validity as a measure of goal achievement in a materialistic world (Russel and Young, 1983). The idea of frontier production function is built around the concept of efficiency adduced by Farrel (1957).

d. Technical efficiency

(i) Timmer's output based measure of technical efficiency

Timmer (1971) imposed the Cobb-Douglas production function on the frontier and computed an output-based measure of efficiency. The approach adopted here is to specify a fixed parameter frontier amenable to statistical analysis. This takes the following general form.

$Y = f(x)\ eu,\ u \leq 0$ ____________________ (5)

and the Cobb-Douglas production function in natural logarithmic form would be:

$1n\ Y = a + \sum_{J=1}^{n} b_j \log x_j + u,\ u \leq 0$ ______________ (6)

In estimating the above equation, the Corrected Ordinary Least Squares (COLS) regression is chosen as the most convenient means. This method is briefly outlined as under.

As a first step, the foregoing equation is estimated by the method of OLS yielding the best linear unbiased estimates of b_i's coefficients. The intercept 'a' is then corrected by shifting the function until no residual is positive and one case is zero. This is done by adding the largest error term of the fitted model to the intercept. Greene (1980) has shown that a consistent, though biased, estimate of 'a' which imposes the sign uniformity on the residuals will be generated by this procedure.

Thus, Timmer measure of technical efficiency (TEi) of a farm 'i' is the ratio of actual output to potential (Frontier) output, given the level of input use on farm 'i'. It thus indicates how much extra output could be obtained if farm 'i' were on the frontier with the given technology and level of input.

T

_____________ (7) immer measure of technical efficiency is given by:

$$TEi = \frac{Y}{Y^*} \leq 1$$

Where,

Y = Actual output

Y* = The potential output obtainable for given level of inputs

(ii) The Kopp measure of technical efficiency (KTE)

Kopp (1981) suggested a different approach within the Farrell framework, which involves the econometric estimation of a parametric frontier function followed by the algebraic identification of the efficiency standard for each data point. The Kopp measure of technical efficiency compares the actual level of input use to the frontier level of input use given the input use ratios. For this, the following procedure was used.

$R_i = X_2 \div X_1,\ R_2 = X_3 \div X_1, \ldots\ldots\ldots\ R_n = X_n \div X_1$ ___________ (8)

$$\ln X_1^* = (\ln Y - A^* \sum_{i=1}^{n} b_i \ln R_i) \div \sum_{i=1}^{n} b_i$$

Where, R_1 indicates input use ratios obtained by dividing the quantity of other inputs by one common X_1 input. Then the optimum use level of X_1 input i.e. frontier usage (X_1*) will be given as shown before.

_____ (9)
Where, A* is sum of the intercept and the maximum positive error term ($Y-\hat{Y}$);

'b_is' are the respective production function estimates; 'n' indicate the number of inputs and other terms are the same as defined earlier.

The degree of efficiency of X_1 resource among the sample farms is assessed by dividing the frontier usage (X_1*) with the actual quantity used. Subsequently technical efficiency will be:

$KTE = (X_1^* \div X_1)$ ____________________ (10)

Similar procedure was used for calculating the frontier usage of other inputs.

e. Allocative efficiency

Given the technology, allocative efficiency exists when resources are allocated within the farm according to market prices and it implies the proper level of input use in production. To decide whether a particular input is used rationally or irrationally, its marginal value products will be computed. If the marginal value product of an input just covers its acquisition cost it is said to be used most efficiently.

The Marginal Value Products (MVP) were calculated at the geometric mean levels of variables by using the formula.

$$\text{MVP } i^{th} \text{ resource} = b_i \frac{\bar{Y}}{\bar{X}_i} \qquad (11)$$

Where,

$\bar{Y}$ = Geometric mean of the output

$\bar{X}_i$ = Geometric mean of i^{th} independent variable

b_i = The regression coefficient of the i^{th} independent variable

In order to determine the efficiency of allocation of the resources or price efficiency, the value of the marginal product obtained by multiplying the marginal product (b_i) by the price of the product was compared with its marginal cost. A ratio of the value of marginal product to the factor price more than unity implied that the resources were advantageously employed. If the ratio was less than one, it suggested that resource was over utilized.

Finally, the Economic Efficiency (EE) was estimated as the product of technical efficiency and allocative efficiency.

$$EE = TE \times AE \qquad (12)$$

III. RESULTS

Labour utilization pattern in naturally coloured cotton cultivation

The results presented in Table 1 indicated average human labour utilization in coloured cotton cultivation. Among the various operations, harvesting/picking utilized higher proportion of human labour as this operation was carried out for 2-3 times. The entire crop cannot be harvested at one stretch and the picking of the opened bolls has to be carried out at suitable intervals. Spreading of picking operation over several weeks requires huge amount of human labour. Weeding was the next major operation, which consumed substantial amount of human labour. This was mainly because weeding was carried out two-three times. This was followed by loading, transportation and spreading of FYM (14.30%), baling / packing (5.28%) and spraying (3.83%).

The results on bullock labour and tractor labour utilization presented in the Table 1 which indicated that, among the various operations harrowing operation utilized more bullock labour (4.63 bullock pair days), as many of the farmers carried out harrowing operation through bullock labour for 2-3 times. The bullock labour utilization for ploughing (2.28 pair days) and transportation of FYM (1.37 pair days) was less, as some of the sample farmers employed tractor for these operations.

Input use pattern in naturally coloured cotton cultivation

Inputs used per hectare in naturally coloured cotton cultivation in the study area (Table 2) revealed that the farmers used 67.92 man days of human lobour because most of the operations such as harvesting/picking, weeding were human labour intensive. Most of the farmers used bullock labour (14.70 pair days) as against use of tractor labour (1.43 hours) because use of bullock labour worked out to be cheaper than tractor labour use, but some large farmers used tractor for ploughing and other operations. Farmers in the study area used large quantity of farmyard manures (7.02 tonnes), as there was no application of chemical fertilizers in anticipation of good yield. Bio-pesticides were also used to minimize / control the pests/ diseases as there was no spraying of chemicals. But it involved minimum cost as the variety (DDCC-1) used was diseases/pest resistant variety. This variety was exclusively cultivated organically under contract farming in the study area.

Cost of production of naturally coloured cotton

Results on per hectare and per quintal cost of production of coloured cotton in the study area (Table 3) revealed that the total cost incurred by the farmers in the cultivation of coloured cotton was Rs.15,934.30 per hectare and Rs.1,868.02 per quintal. About 82.08 per cent of this cost was formed by the variable cost and remaining 17.92 per cent by fixed cost. The cost of human labour, farmyard manures, nimbucidine and bullock labour were the items of cost with major share in the variable costs, because most of the operations like harvesting/picking, spraying and weeding are human labour intensive operations and the other operations like harrowing and inter-cultivation were bullock labour intensive.

As farmyard manure is an important input in the cultivation of coloured cotton, all the coloured cotton growers applied farmyard manure to the crop. The supply of farmyard manure being limited and the demand for it from the coloured cotton growers in the region being high the naturally coloured cotton farmers had to purchase farmyard manure at higher prices. Because, farmers had not applied any chemical fertilizers in the study area. The farmyard manures accounted for 14.32 per cent of the total cost of cultivation because the farmers in the study area wanted to maintain the quality of coloured cotton to get the higher returns. The cost on bio-pesticides accounted for 19.25 per cent of the total cost of cultivation because the farmers in the study area had to control pest and diseases. The interest on fixed and working capital together account for about 7.99 per cent because of prevailing nominal rates of interest.

All the farmers cultivated naturally coloured cotton on their own land and hence imputed rental value of owned land was the major item of the fixed cost.

The cost of marketing of coloured cotton was Rs.440.64 per hectare and Rs.51.66 per quintal of coloured cotton of which the cost on packing material and packing charges accounted for 73.36 per cent were the major items of cost of marketing because the packing material (bales) for coloured cotton costs more. The transportation cost was low (17.98 %) because it was locally transacted. The study conducted by Ramasundaram *et al*. (2005) on the economics of rainfed hybrid cotton production in Central India revealed similar results with respect to total cost of cultivation per hectare (Rs.15,640) and per quintal (Rs.2148).

Cost and Returns Profile of coloured cotton production

Table 4 reveals that the total cost of cultivation (Cost C) was Rs.16,374.94 per hectare while the gross returns realized was Rs.19,772.50 per hectare indicating a net income (profit at Cost-C) of Rs.3,838.20 per hectare and per hectare net income (profit at Cost-D) of Rs.3,397.56. The marketing cost of coloured cotton was Rs.440.64. The Per hectare yield of naturally coloured cotton was 8.53 quintals. The cost of production per quintal was Rs.1919.68 and the benefit-cost ratio obtained was 1.21.

The study carried out by Mahantesh (2002) in the economics of cotton production in the Belgaum District revealed similar results with respect to net income (Rs.3088.98/ha) and the benefit-cost ratio (1.10).

Resource use Efficiency in Naturally Coloured Cotton Production

The Cobb-Douglas production function was employed to analyze the relationship between the resources used and productivity of coloured cotton using the field level data of sample *farmers* The total gross returns realized as the dependent variable and the amount of seeds, FYM, human labour, bullock and tractor charges, bio-pesticides and trichocards as independent variables for naturally coloured cotton production. The results presented in the Table 5 revealed that the variables included in the function satisfactorily explained the variation in the dependent variable (92.00 %). The regression equation was estimated in order to capture the nature and magnitude of the effects of the independent variables on the productivity of naturally coloured cotton production.

The output elasticity of human labour was positive and significant, which implies the increased usage of labour and thus the gross income. Since the coloured cotton crop was labour intensive and the operations such as manures application, hand weeding, spraying of bio-pesticides, which significantly contributes towards increased yield and thus the income.

The other inputs such as land and farmyard manure were significant and had positive impact on gross income. This reveals that as more land brought under coloured cotton cultivation in the study area only, which seeks application of more manures, seeds and bio-pesticides as a result increasing the income.

The sum of production elasticities ($\Sigma b_{i\,=}$ 1.30) revealed increasing returns to scale in naturally coloured cotton production. A one per cent increase in all the inputs used in the production simultaneously would result in an average increase of gross returns by 1.30 per cent.

Allocative efficiency in naturally coloured cotton production.

The ratio of Marginal Value Product (MVP) to Marginal Factor Cost (MFC), presented in the Table 6 reveals that allocative efficiency was positive and greater than unity in the case of land, seeds, manures, human labour, bio-pesticides and trichocard indicating that still there is scope to use these inputs and increase the gross returns of coloured cotton production.

The Marginal Value Product (MVP) to Marginal Factor Cost (MFC) ratio for land was 1.52, which reflected the scope for increasing area under coloured cotton to increase the gross income in the study area.

The MVP to MFC ratio for seeds (3.09), manures (1.16), human labour (3.16), bio-pesticides (1.97) and trichocard (10.25) were more than one indicating that still there is scope for higher utilization of these inputs and which in turn would increase the gross income. This would help to maximize their profit in naturally coloured cotton production.

The MVP to MFC ratio for bullock labour was less than unity (0.09) indicated excessive use of this input for the sole reason of increasing the yield. The results obtained in respect of land and labours are in conformity with the results of Mahantesh (2002).

Technical Efficiency in Naturally Coloured Cotton Production

a. Timmers measure of technical efficiency in naturally coloured cotton production

The technical efficiency in naturally coloured cotton production was measured as a ratio of actual output to maximum attainable physical output by each farmer based on timmer measure of technical efficiency (Table 7). The average technical efficiency was 0.75654. The proportion of farmers in different technical efficiency ratings, about six per cent of farmers were found to operate in technical efficiency rating of below 0.75. Less than three per cent of farmers were found to be operating under high level of technical efficiency rating of above 0.90.

About 15 per cent of farmers were found to operate in technical efficiency ratings of 81-90 per cent. Thus, the study revealed that a large majority (more than 50%) of the farmers in the study area were found to have achieved only 75.65 per cent of average technical efficiency and hence there is vast scope for improving naturally coloured cotton productivity by reducing technical inefficiency without using additional resources.

b. Kopp measure of technical efficiency

The results presented in Table 8 indicated the extent of excess use of resources in view of the existence of technical inefficiency in naturally coloured cotton production. The quantities of different inputs required for the farmers to produce the existing level of output at the highest level of technical efficiency were called as frontier level of inputs. The coloured cotton-growing farmers by enhancing technical efficiency could save 23.75 per cent of land, 14.40 per cent of seeds, 5.31 per cent of manures, 12.74 per cent of human labour, 16.67 per cent of bullock labour, 12.67 per cent of bio-pesticides and 4.60 per cent of trichocard.

The farmers could produce 11.27 quintals of coloured cotton against 8.53 quintals by using existing quantities of different inputs if they operate at the highest technical efficiency level. Thus the analysis of technical efficiency in naturally coloured cotton production in the study area revealed that by improving the technical efficiency of the farmers, about 15-21 per cent of cost on different inputs could be saved. Thereby, there will be a substantial reduction in the cost of cultivation and increase in the returns from naturally coloured cotton to the *farmers*

Technical, allocative and economic efficiency for naturally coloured cotton farmers are presented in Table 9. The average technical efficiency was 0.756. This implied that there existed 24 per cent potential for increasing income of farmers by using existing quantities of resources. Allocative efficiency was 0.585. The allocative inefficiency was also more pronounced. Thus, the study indicated that allocative inefficiency in naturally coloured cotton production was more than the technical inefficiency. This implied that returns from naturally coloured cotton production in the study area could be maximized by reorganization of resources and by enhancing the technical efficiency. In view of the high allocative inefficiency, the economic inefficiency was also more in naturally coloured cotton production in the study area. By improving the efficiency (both technical and allocative) in naturally coloured cotton production, the profits could be maximized on farmers in the study area. Hence, more concerted efforts are needed to improve efficiency (both allocative and technical) in naturally coloured cotton production.

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Table-1: Labour utilization pattern in naturally coloured cotton cultivation

(Hectare)

SN	Operations	Unit	Numbers	Percentage
I.	Bullock and Tractor Labour			
1.	Ploughing			
a.	Bullock labour	Pair days	2.28	15.51
b.	Tractor labour	Hours	1.29	90.21
2.	Harrowing			
a.	Bullock labour	Pair days	4.63	31.50
3.	Transportation of FYM			
a.	Bullock labour	Pair days	1.37	9.32
b.	Tractor labour	Hours	0.14	9.80
4.	Sowing			
a.	Bullock labour	Pair days	2.68	18.23
5.	Inter cultivation			
a.	Bullock labour	Pair days	3.74	25.44
	Total Bullock labour	Pair days	**14.70**	**100.00**
	Total Tractor labour	Hour	**1.43**	**100.00**
II.	Human labour			
1.	Loading, transportation and spreading of FYM	Mandays	9.71	14.30
2.	Sowing	Mandays	7.42	10.92
3.	Weeding	Mandays	12.10	17.81
4.	Spraying	Mandays	2.60	3.83
5.	Harvesting/picking	Mandays	32.50	47.85
6.	Baling/packing	Mandays	3.59	5.28
	Total Human labour	Mandays	**67.92**	**100.00**

Table-2: Input use pattern and output obtained in naturally coloured cotton cultivation

(Hectare)

SN	Particulars	**Units**	**Quantity**
1.	Seeds	Kgs	6.25
2.	Human labour	Mandays	67.92
3.	Bullock labour	Pair days	14.70
4.	Tractor labour	Hours	1.43
5.	Farm yard manure	Tonnes	7.02
6.	Biopesticides		
i.	Numbucidine	Ltrs.	13.91
ii.	NPV	LE	400.00
7.	Trichocard	Nos.	10.00
8.	Average Yield		
i.	Main Product (*Kapas*)	Qtls.	8.53
ii.	By-product (stalk))	Qtls.	29.00

Table-3: Costs in Production and Marketing of Naturally Coloured Cotton

SN	Particulars	Rs./Hectare	Rs./Quintal	Percentage
I.	**Variable cost**			
1	Human labour	3396.00	398.12	21.31
2	Bullock labour	2205.00	258.50	13.84
3	Tractor power	429.00	50.29	2.69
4	Seeds	625.00	73.27	3.92
5	Farm yard manure	2281.50	267.47	14.32
6	Biopesticides			
a	a. Nimbucidine	2267.33	265.81	14.23
b	b. NPV	800.00	93.79	5.02
7	Trichocard	50.00	5.86	0.31
8	Interest on working capital	1024.58	120.11	6.43
	Sub total (I)	**13078.41**	**1533.22**	**82.08**
II.	**Fixed cost**			
1	Rental value of land	2500.00	293.08	15.69
2	Land revenue	25.00	2.93	0.16
3	Depreciation	83.12	9.74	0.52
4	Interest on fixed capital	247.77	29.05	1.56
	Sub total (II)	**2855.89**	**334.80**	**17.92**
	Total cost of cultivation (I + II)	**15934.30**	**1868.02**	**100.00**
III.	**Marketing cost**			
1	Packing material and packing charges	323.22	37.90	73.36
2	Loading and unloading charges	38.17	4.47	8.66
3	Transport cost	79.25	9.29	17.98
	Sub total (III)	**440.64**	**51.66**	**100.00**

Table-4: Cost and Returns Profile of Naturally Coloured Cotton Production

SN	**Particulars**	**Rs./ Hectare**
1	Cost-A	10006.53
2	Cost-B	12754.30
3	Cost-C	15934.30
4	Cost-D	16374.94
5	Cost of production (Rs./qtl)	1868.02
6	Gross returns including by-products (Rs./ha)	19772.50
7	Yield (Qtls/ha)	8.53
8	Farm business income (Profit at cost-A)	9765.97
9	Farm labour income (Profit at cost-B)	7018.20
10	Net income (Profit at cost-C)	3838.20
11	Net income (Profit at cost-D)	3397.56
12	B:C ratio	1.21

Table-5: Estimated Cobb-Douglas Production Function Coefficients

SN	Explanatory variables	Unit	Parameters	Coefficients
1.	Intercept		a	-0.1519
2.	Land	Hectare	b_1	0.4942** (0.1265)
3.	Seeds	Kgs	b_2	0.1182 (0.1027)
4.	Farmyard manure	Tonnes	b_3	0.1118* (0.0490)
5.	Human labour	Mandays	b_4	0.4612** (0.0811)
6.	Bullock labour	Pair days	b5	0.0078 (0.0476)
7.	Biopesticides	Rs	b6	0.0722 (0.0690)
8.	Trichocards	Nos.	b_7	0.0318 (0.0651)
9.	Coefficient of multiple determination (R^2)			0.9210
10.	Returns to scale (Sb_i)			1.2971

Note: Figures in the parentheses indicate their respective standard errors

*** - Significant at one per cent probability level*

** - Significant at five per cent probability level*

Table-6: MVP to MFC ratios of resources in Naturally Coloured Cotton Production

SN	**Explanatory variable**	**Parameters**	**MVP: MFC Ratios**
1	Land in hectare	b_1	1.517
2	Seeds in kgs	b_2	3.091
3	Farmyard manure in tones	b_3	1.164
4	Human labour in mandays	b_4	3.159
5	Bullock labour in pair days	b5	0.089
6	Biopesticides in Rupees	b6	1.970
7	Trichocards in numbers	b7	10.248

Note: MVP – Marginal value product, MFC – Marginal factor cost

Table-7: Distribution of Coloured Cotton Producers according to Technical Efficiency ratings

SN	**Relative efficiency (%)**	**Number**	**Percentage**
1.	< 70	5	6.25
2.	70-80	61	76.25
3.	81-90	12	15.00
4.	> 90	2	2.50
	Total	**80**	**100.00**
	Average Technical Efficiency	**0.75654**	

Table-8: Actual and frontier input use level in naturally coloured cotton production

SN	Items	Units	Actual	Frontier	Savings	Savings (%)
1.	Land	Ha.	0.80	0.61	0.19	23.75
2.	Seeds	Kg.	6.25	5.35	0.90	14.40
3.	Farmyard manure	Tonnes	7.02	6.647	0.373	5.31
4.	Human labour	Mandays	67.92	59.27	8.65	12.74
5.	Bullock labour	Pairdays	14.70	12.25	2.50	16.67
6.	Biopesticides	Rs.	3067.33	2678.67	388.66	12.67
7.	Trichocards	Numbers	10.00	9.54	0.46	4.65
8.	Yield	Quintals	8.53	11.27		

Table-9: Efficiency of sample farmers

SN	Particulars	Rating
1.	Technical efficiency	0.756
2.	Allocative efficiency	0.585
3.	Economic efficiency	0.443