Costs, returns, resource use efficiency of American cotton production in Irrigated North Western Plain Zone of Rajasthan, India

ABSTRACT

The study was carried out at Irrigated North Western Plain Zone 1b of Rajasthan in agricultural year 2012-13. This zone covers about 80 percent of the total area of cotton in the state. The study focused on the cost and return, efficiency of resource use and problems faced by the farmers in American cotton production under different farm sizes. Two villages namely 4C and Mirjawala were selected from Sriganganagar tehsil of the zone. Thirty farmers were selected at random in proportion to the total number of farmers in each size group from the list of from American cotton farmers group. The total variable cost of per hectare American cotton was Rs 28985. The yield per ha was 18.70 quintals. The return over variable cost per hectare American cotton was Rs 61436. The Cobb Douglas production function, revealed that the in American cotton farmers were underutilized fertilizer. Non-availability of labour during peak season was reported as highly acute constraint for cotton farmers. The damage caused by insect pests was reported as main problem for American cotton sample farmers.

KEYWORDS: cost and return, Resource-use efficiency, constraint.

INTRODUCTION

“India ranks first in cotton area in the world and third in production. About 15 million farmers in the country spread across 10 states are engaged in cotton production. Cotton is grown in about 10 million hectares in India and is cultivated in three distinct agro-ecological regions viz., North, Central and South. Out of total, 21 per cent area is under cultivation in North zone which is 100 per cent irrigated and contributes 25 per cent of the production” [Kumar and Shekhawat.2018]. “Cotton occupies a pre-eminent place among cash crops touching the country’s economy at several points. Cotton occupies a place of pride, being the prime supplier of raw material (85%) for textile industry, which is one of the leading industries in the country. Cotton industry provides

means of livelihood for about 250 million people in the world and about 60 million people through its cultivation, trade and industries in India. Commercially, cotton is one of the best vital raw materials and contributes nearly 20 per cent of the entire industrial output of the country" (James, 2002).

About 80% of the total cotton area of the entire state of Rajasthan is being grown in Irrigated North Western Plain zone Ib. This zone covers Sriganganagar and Hanumangarh districts of Rajasthan. This is a contiguous area of around 15 lakh ha and the wheat is cultivated in the almost entire area after cotton during the rabi season. Development of early-maturing cotton varieties made it possible to follow cotton-wheat cropping system in a year.

"Cotton is a soft, fluffy staple fiber that grows in a boll, or protective capsule, around the seeds of cotton plants of the genus Gossypium in the family of Malvaceae. Research on Bt. Cotton in India is monitored and regulated by the Department of Biotechnology, Government of India. Mahyco in collaboration with Monsanto Company of USA started efforts to commercialize Bt. Cotton in India. After thorough field evaluation of the different Bt. hybrids and their environmental safety considerations, Government of India in 2002 accorded approval for the release of three Bt. Cotton hybrids namely, MRC 12 Bt, MECH 162 Bt and MECH 184 Bt for commercial cultivation in south and central growing states. In 2009 about 522 hybrids have been recommended for commercial cultivation. All these hybrids were developed by private seed companies utilizing different genes. In India the first two-gene commonly known as Bollgard II (BGII) was developed by Mahyco and sourced from Monsanto, featured the two genes cry1Ac and cry2Ab, and was approved for sale for the first time in 2006" [Bheemappa et al.2004; Ashfaq et al.2012].

"Amongst all the pests which attack cotton in India, bollworms namely, American bollworm (Helicoverpa armigera), spotted bollworm (Earias insulana and Earias vitella) and pink bollworm (Pectinophora gossipiella) cause major damage. Nearly 54 per cent of the total pesticides are used for the control of pests in cotton alone, out of which about 60 per cent are used for the control of bollworms. Indiscriminate use of pesticides has adversely affected pest control and Farmers and farm workers face acute and

chronic health hazards due to their prolonged exposure to pesticides. Eye, skin, pulmonary, neurological and gastro-intestinal problems are associated with long term pesticides exposure" (Pingali,1994). Under these circumstances, Bt. Cotton has emerged as an attractive option for the cotton farmers.

- Cost and returns in American cotton cultivation across different farm size holders.
- Resource use efficiency in American cotton cultivation.
- Constraints faced in production of American cotton and remedial measures.

METHODOLOGY

Present study has been conducted in Irrigated North Western Plain Zone 1b of Rajasthan. This zone covers about 80 percent of the total area of cotton in the state. This zone covers a geographical area of 2.1 m ha spread over Sriganganagar and Hanumangarh districts. One district out of the two districts was selected purposively for the study. Looking to the time constraint and facilities available with the single handed worker, only one Tehsil out of the total 9 tehsils of Sriganganagar district was selected purposively. The selected Tehsil was Sriganganagar. From the selected tehsil Sriganganagar, two villages 4C and Mirjewala having substantial area under cotton were selected randomly. A list of all the farmers of the selected villages was prepared along with their size of operational land holding under American cotton for the previous year 2012-13. The farmers of each group were divided into following three size groups.

(i) Small Less than 2 ha

(ii) Medium 2-4 ha

(iii) Large More than 4 ha.

Sixty farmers were selected at random in proportion to the total number of farmers in each size group from the list of cotton farmers group and similarly another 60 farmers were selected from American cotton farmers group. Crop production data from selected farmers were collected on various inputs used & output obtained by survey method through personal interview with the help of a schedule specially designed for the purpose.

Functional analysis

The Cobb-Douglas type of production function was used to study the effect of various inputs on American cotton outputs. On account of its well-known property of its computational simplicity, justifies its wide application in analyzing production relations (Handerson and Quandt, 1971). The estimated regression coefficients represented the production elasticities.

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

$$Y = aX_1^{b1}X_2^{b2}X_3^{b3}X_4^{b4}X_5^{b5}$$

Where,

Y= Gross returns in Rs. per hectare

a = Intercept

$X_{1=}$ Expenditure on seeds (Rs/ha)

$X_{2=}$ Expenditure on Plant Protection chemicals (Rs/ha)

$X_{3=}$ Expenditure on Fertilizer (Rs/ha)

$X_{4=}$ Human labour expenditure (Rs/ha)

$X_{5=}$ Machine labour expenditure (Rs/ha)

bi's= Output elasticities of respective factor inputs, i = 1, 2..5 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.

$$\log Y = \log a + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5$$

The regression coefficients (bi's) were tested using't' test at chosen level of significance.

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 efficiently.

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

$$MVP\, i^{th}\, resource = bi \times \frac{\bar{y}}{\bar{x}}$$

Where,

MVP = marginal value product

b_i = Regression coefficient i^{th} independent variable

$\overline{y}$ = Geometric mean of the output

$\overline{x}$ = Geometric mean of 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_1) 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.

The criterion for determining optimality of resource use was,

MVP/MFC > 1 underutilization of resource

MVP/MFC = 1 optimal use of resource

MVP/MFC < 1 excess use of resources.

RESULT AND DISCUSSION

The findings obtained from the present study are presented below:

Physical inputs:

Input use pattern on American cotton farms is given in Table 1. It reveals that average seed used was 15.43 kg per hectare. The use of urea varied between 134.00 to 147.00 kg/ha with an overall average of 140.33 kg/ha. The use of DAP varied between 62.00 to 72.00 kg/ha with an overall average of 67.67 kg/ha. The use of SSP varied between 69.00 to 88.00 kg/ha with an overall average of 80.33 kg /ha. The use of chemical fertilizers increased with increase in size of land holding. The use overall average of Plant protection chemical was Rs.4182.67. The use of plant protection varied between Rs. 3039 to 5095.The use of labour increased with increase in size of land holding with an overall average of 45.46 man days/ha. The use of machine labour varied between 10.50 to 13.50 hours/ha for all operations with an overall average of 12.00 hours/ha.

Table 1 Average Input use pattern on American cotton kg per hectare

S. No.	Particulars	Small	Medium	Large	Overall
1	FYM (Qtls)	107.00	39.00	21.00	55.67
2	Seed Kg	15.25	15.44	15.61	15.43
3	Chemical fertilizers				
	a. Urea(kg)	134.00	140.00	147.00	140.33
	b. D.A.P.(kg)	62.00	69.00	72.00	67.67
	c. S.S.P(kg)	69.00	84.00	88.00	80.33
4	Plant protection chemicals(Rs)	3039.00	4414.00	5095.00	4182.67
5	Irrigation(No.)	5.11	5.28	6.49	5.63
6	Human labor(Man days)	39.90	45.23	51.25	45.46
7	Machine labor(Hours)	10.50	12.00	13.50	12.00

Human labour and machine labour use on American cotton sample farms/ha

Human labour and machine labour use on American cotton sample farms per hectare is presented in Table 2. It reveals that total labor use (man days/ha) on an overall basis was 45.46 man days/ha. It increased with increase in size of land holding. Harvesting and picking operation alone utilized 12.17 labour per hectare and followed by irrigation (11.33 labour/ha). The use of machine labor was 12.00 hours/ha. It increased with increase in size of land holding. The major operations accounting for higher share of machine labor use were land preparation tillage followed by Marking lines & Sowing.

Table 2 Operation-wise break-up of human labour and machine labour use in cultivation of American cotton sample farms/ha

S. No.	Inputs	Small	Medium	Large	Overall
1	**Preparation tillage**				
I	Man days/ha	2	2	3	2.33
Ii	Machine labour (hours/ha)	3.5	4	4.5	4.00
2	**Planker**				
I	Man days/ha	1	1	1	1.00
Ii	Machine labour (hours/ha)	2	2	2	2.00
3	**FYM application**				
I	Man days/ha	2	3	3	2.67
4	**Marking lines & Sowing**				

I	Man days/ha	3	3	3	3.00
Ii	Machine labour (hours/ha)	2	2	2	2.00
5	Gap filling				
I	Man days/ha	1	1	2	1.33
6	**Fertilizer application**				
	Man days/ha	0.90	0.98	1	0.96
7	**Spray of plant protection chemicals**				
	Man days/ha	7	8.5	9	8.17
Ii	Machine labour (hours/ha)				
8	**Irrigation**				
	Man days/ha	10	11	13	11.33
9	**Inter culture operation**				
	Man days/ha	2	2.5	3	2.50
Ii	Machine labour (hours/ha)	3	4	5	4.00
10	**Harvesting picking**				
	Man days/ha	11	12.25	13.25	12.17
	Total labour (man days/ha)	39.90	45.23	51.25	45.46
	Total machine labour (hours/ha)	10.50	12.00	13.50	12.00

Cost of production, value of output and profit in American cotton sample farms

Cost and returns in cultivation of American cotton is given in Table 3. It reveals that the total variable cost on an overall basis worked out to be Rs. 28985.54.The working expenditure increased with increase in size of holding due to better resource base of the medium and large farms. However, the yield obtained on small farms was lower compared to medium and large farms. The gross returns varied between Rs. 85760.10to 91525.20 with an overall average of Rs. 90421.60/ha. The human labour component accounted for 47.05 percent of the total cost followed by plant protection chemical (14.43) and Machine labour (12.42%). The returns over variable cost, on an overall basis, were worked out to be Rs. 61436.06 and B:C ratio obtained was 2.98, on an overall basis. The returns over variable cost were higher on medium farms as compared to small and large farms.

Table 3 Cost of production in rupees per hectare of American cotton

Inputs	Small	Medium	Large	Overall
FYM (Rs./ha)	1284 (4.94)	468 (1.61)	252 (0.79)	668 (2.30)
Seed (Rs./ha)	3050 (11.74)	3088 (10.65)	3122 (9.77)	3086.67 (10.65)
Fertilizer	2656 (10.22)	2952 (10.18)	3084 (9.65)	2897.33 (10.00)
Plant protection chemicals	3039 (11.70)	4414 (15.22)	5095 (15.94)	4182.67 (14.43)
Irrigation (Rs./ha)	160 (0.62)	160 (0.55)	160 (0.50)	160 (0.55)
Labour (Rs./ha)	11970.00 (46.07)	13569.00 (46.78)	15375.00 (48.09)	13638.00 (47.05)
Machine labour (Rs./ha)	3150.00 (12.12)	3600.00 (12.41)	4050.00 (12.67)	3600.00 (12.42)
Interest on working capital	674.91 (2.60)	753.36 (2.60)	830.35 (2.60)	752.87 (2.60)
Total variable cost	25983.10 (100.00)	29004.36 (100.00)	31968.35 (100.00)	28985.54 (100.00)
Product yield (qtl/ha)	17.73	19.44	18.93	18.70
By product (qtl/ha)	21.87	22.25	22.04	22.05
Gross returns	85760.10	93979.50	91525.20	90421.60
Returns over variable cost	59776.19	64975.14	59556.85	61436.06
B:C ratio	3.30	3.24	2.86	3.13

*Figures in parentheses indicate percentage

Resource use efficiency and allocative efficiency on American cotton sample farms

The Cobb-Douglass production function was estimated to analyze relationship between resource use and productivity of American cotton using the data from sample farmers. The gross income in rupees per hectare realized from American cotton output was taken as dependent variable while expenditure made on seed (Rs), Plant protection chemical (Rs), fertilizers (Rs), human labour (Rs) and machine labour (Rs) were taken as independent variables. The estimates of the production functions are presented in Table-4. The inputs included in model explained 65.1 per cent variation for American cotton as revealed by the coefficient of multiple determination (R^2). The estimated

parameter of American cotton for pesticides (0.048) was significant at five per cent, while fertilizer at (0.155) co-efficient was significant at one per cent. Marginal value productivity at geometric levels was calculated for American cotton for various inputs such as seed, fertilizer, plant protection chemicals, human labour and machine labour. The results are presented in table 4. “Marginal value productivities (MVP) at factor cost for all these inputs are the same as MVP because all inputs and output values have been taken in monetary terms. MVP/MFC American cotton the MVP/MFC ratio for plant protection chemicals (1.02) this indicates that use of plant protection chemicals was at the optimum level. MVP/MFC ratio for fertilizer was 4.34 which indicate that one rupee additional investment on fertilizer will bring rupees 4.34 returns. Therefore, farmers should use more fertilizers to increase returns from American cotton cultivation. MVP/MFC ratio for seed, human labour and machine labour were found non significant in American cotton” [Kumar and Shekhawat.2018].

Table 4 Estimated Cobb-Douglas Production Function Coefficients in American cotton sample farmer

(Hectare)

Sl. No	**Explanatory variables**	**Parameters**	**American cotton**	**GM**	**MVP**	**MVP/MFC ratio**
1	Constant	A	3.830 (0.619)	91785(GR)		
2	Seed	b_1	0.072 (0.161)	3098	2.13	2.13
3	Plant protection chemicals	b_2	0.048** (0.020)	4315	1.02	1.02
4	Fertilizer	b_3	0.155* (0.045)	3275	4.34	4.34
5	Human labour	b_4	0.012 (0.027)	11178	0.10	0.10
6	Machine labour	b_5	0.035 (0.039)	3766	0.86	0.86
	R^2		.651			

Note: Figures in the parentheses indicate their respective standard errors
* Significant at one per cent probability level, ****** Significant at five per cent probability level, GM - Geometric mean MVP - Marginal Value Product. MFC – Marginal Factor Cost

Constraints faced by farmers

The constraint analysis was carried out by classifying the problems faced by the farmers as highly acute, acute and not acute and results are presented in Table 5. The results indicated that non-availability of labour during peak season was reported as highly acute constraint of American cotton farmers as opined by 46.67 per cent American cotton sample farmers. The damage caused by insect pests was reported as highly acute problem of American cotton sample farmers (50.00 per cent).

Table 5 Constraints faced American cotton sample Farmers

Sl. No.	Constraints faced by farmer	American cotton		
		Highly acute	Acute	Not acute
1	Low fertility status of soil	17 (28.33)	13 (21.67)	30 (50.00)
2	Non ability quality seed	9 (15.00)	10 (16.67)	41 (68.33)
3	Non ability of fertilizer on time	15 (25.000	27 (45.00)	18 (30.00)
4	Damage caused by insect pest	30 (50.00)	19 (31.67)	11 (18.33)
5	Irrigation	7 (11.67)	14 (23.33)	39 (65.00)
6	Non-availability of labour during peak season	28 (46.67)	16 (26.67)	16 (26.67)
7	Lack of guidance from Dept. officials	0 (0.00)	9 (15.00)	46 (76.67)
8	Yield uncertainty	29 (48.33)	20 (33.33)	11 (18.33)
9	Price fluctuations	27 (45.00)	24 (40.00)	9 (15.00)
10	Credit inadequacy	10 (16.67)	18 (30.00)	32 (53.33)

Note: Figures in the parentheses indicate percentage to total

CONCLUSIONS AND POLICY IMPLICATIONS

The total cost of production per hectare was relatively higher for the large size farms of American cotton. Seed cost accounted 10.65 per cent for American cotton and cost on plant protection chemicals accounted around 14.43 per cent for American cotton .Cost on human labour accounted 47.05 per cent for American cotton production. Variable cost was on American cotton (Rs.28985.54/ha) sample farms. Average yield of American Cotton was (18.70quintal/ha). Gross returns per hectare American cotton sample farms (Rs. 90421.60/ha). Benefit cost ratio for American cotton (3.13) sample farms. The Cobb-Douglass production function was estimated to analyze relationship between resource use and productivity of American cotton using the data from sample farmers. The inputs included in model explained 65.1 per cent variation for American cotton as revealed by the coefficient of multiple determinations (R^2).The estimated parameter of American cotton for pesticides (0.048) was significant at five per cent, while fertilizer at (0.155) co-efficient was significant at one per cent. MVP/MFC ratio for of American cotton for plant protection chemicals (1.02) indicates that use of plant protection chemicals was at the optimum label. MVP/MFC ratio for fertilizer was 4.34 which indicate that one rupee additional investment on fertilizer will bring rupees 4.34 returns. Therefore, farmers should use more fertilizers to increase returns from American cotton cultivation. MVP/MFC ratio for seed, human labour and machine labour were found non significant in American cotton.

REFERENCES

Ashfaq, M. Bakhsh, A.k. and Fatima, N., (2012) Analysis of resource use efficiencies and return to scale of medium sized Bt cotton farmers in Punjab, Pakistan. *Sarhad Journal of Agriculture.*, **28** (3): 493-498.

Bheemappa, A. Hirevenkanagoudar, L. V. and Chandargi, D. M., (2004) Analysis of constraints in adoption and reinvention of cotton production technology by the farmers of Tungabhadra command area, Karnataka. Paper presented in the symposium strategies for sustainable cotton production- a global vision; held at the University of Agricultural Sciences, Dharwad.

Handerson, J.M and Quandt, R. E., (1971) Microeconomic Theory- A Mathematical Approach (2 nd edition), McGraw Hill Company Limited, New York.

Gowdru V N., Kallega K H., and Kumar A. (2013) A resources use efficiency analysis of BT and Non BT cotton farmers in Karnataka, India. *Journal of Global Economy.*, Volume 9 – 3.

Gwandi, O., Bala M., and Danbaki J W. (2010) Resource-use efficiency in cotton production in gassol local government area of Taraba State, Nigeria. *J. Agric. Soc. Sci.,* **6**: 87–90.

James, C., (2002) Global status of commercialized transgenic Crops. *ISAAA* Briefs n. 27 Ithaca, New York.

Nandal, R.S. and Punia, D., (2011) An economics analysis of production and marketing of Bt cotton, American cotton and desi cotton in Sirsa district of Haryana. *Annals of Bio Research.,* **16**(1): 47-51.

Pingali, P.L., (1994) Pesticides and philippines rice farmer health: A medical and economic analysis". *American J. Agril. Econ.*, **76**: 587-592.

Puran, M., Krishna Kakumanu Reddy, Manjunatha A. V. and Siegfried Bauer., (2010) Economic profitability and adoption of Bt. Cotton and non-Bt. cotton in North India. conference on international research on food security, Natural Resource Management and Rural Development. *Tropentag ETH Zurich*, pp. 1 –16.

Ramagopal, N., (2006) Economics of Bt. cotton vis-à-vis traditional cotton varieties a study in Andhra Pradesh, Agro-Economic Research Centre, Andhra University, Andhra Pradesh.

Singh, S., Kingra, H.S. and Singh, R., (2013) Input utilization and constraints of cotton production in Punjab. *Journal of cotton Research and Development.,* **27**(1): 144-148.

Kumar P, Shekhawat RS. Analysis of Resource Use efficiency in Bt. Cotton and American Cotton in Sri Ganganagar District of Rajasthan. Int. J. Pure App. Biosci. 2018;6(5):462-6.