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Estimation of Total Factor Productivity Growth (TFPG) and Factors Affecting Production of Cotton Crop in Rajasthan, India

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ABSTRACT

Cotton, popularly called as "white gold" is a leading commercial crop grown world over for its valuable fibre. India has become the global leading grower and largest producer of cotton. The present study was carried out to determine the factors affecting cotton production in Rajasthan. This paper based on secondary data collected over the years i.e; from 2000-01 to 2015-16. The Cobb-Douglas production function was used to the observation for the estimation of elasticities of selected variables contributing to the production of cotton in Rajasthan state, Cobb Douglas type production function was employed to assess the effects of seed, fertilizer, manure, human labour, irrigation, bullock labour and plant protection measures on cotton production. The Tornqvist Theil Index was used to compute the total output index, total input index and total factor productivity index. The results from the study have shown that fertilizer, human labour and irrigation water were positively significant while the variable corresponding to plant protection measures was negatively significantly affecting the cotton production. TFP in cotton (3.80%) despite a 90.22 per cent share in the total cotton output of the state. The real cost of production of cotton decreased by 2.10 per cent per annum.

Keywords: Cotton, Cobb Douglas, Index and Cost

Cotton is the most essential natural fiber crop in the world for textile produce, accounting for about 50 per cent of all fibers used in the textile industry. It is more important than the various synthetic fibers, and it is grown all over the world in about 80 countries. It is unique among agricultural crops, because it is the main natural fiber crop, which provides edible oil and seed by-products for livestock feed. Further, it also provides income for hundreds of millions of people. It is one of the agro-industrial crops which are produced in both developing and developed countries. Cotton fibers are used in clothing and household furnishings. It has played an important role since the industrial revolution of the 17th century. Currently, it is an important cash crop especially for a number of developing countries at local and national levels.

With the decline in the share of agriculture in the GDP, Indian economy has faced structural changes. Even though a fall in its share from 55.11 per cent in

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1950-51 to 13.90 per cent in 2017-18 (Hazari 2015). Despite two big reasons the importance of agriculture has not diminished. First, the country achieved self-sufficiency in food grain production at the macro level, but still is a food deficit country acing massive challenges of high prevalence of malnourished children and high incidence of rural poverty. There is a high demand on agriculture to produce more and double the farmer's income. Second, the rural workforce 's reliance on agriculture for jobs did not decline in relation to its sectorial contribution to GDP. As a result, the income gap between the agricultural and non-agricultural sectors has increased (Chand and Chauhan, 1999). The experiences of developed countries have shown that there has been a transition of labour-power from agriculture to non-agricultural generally and in particular to the manufacturing sector. This had brought improved agricultural production growth and higher incomes Gollin*et al.* (2002). Under these situations, higher growth in agriculture assumes huge importance and is a matter of worry for policy makers and research scholars in current times.

The basic challenge every farmer facing in agriculture is to increase output and minimize the cost. For this, one must know how efficiently the farmers are currently using the inputs, identify the inputs that are inefficiently used, and then measures can be suggested to efficiently use such inputs to increase production and also to minimize cost Chand *et al*. (2007). In order to identify the efficient use of inputs production function analysis is the relevant technique. The production function analysis gives an explicit idea regarding the use of inputs and their influence on output. The production function analysis determines the productivity levels of different inputs and assesses the contribution at margin to the output. To know input - output relationship among the farmers contacted in the present study, Cobb – Douglas production function technique is employed. The use of Cobb-Douglas production function in agriculture production economics is due to (1) computational manageability with this algebraic form and (2) the information regarding returns to scale which it provides and theoretical fitness to agriculture. The Cobb-Douglas production function has been estimated using least square method of regression Douglas *et al.* (2002).

MATERIALS AND METHODS

The present investigation was based on cost of cultivation scheme running in the department of Agricultural Economics & Management, Rajasthan College of agriculture, Udaipur. The crops included namely cotton which are under the cost of cultivation scheme, were selected for the present study. The study was rely on secondary data. During the study we have examined factors responsible for temporal changes in production for the period 2000-01 to 2015-16. The data on crop inputs included human labour (man days/ha), bullock labour (pair days/ha), machine labour (man days/ha), seed (kg/ha), manure (tonne/ha), fertilizer (kg/ha), insecticides (kg/ha) and irrigation (₹/ha).

Research Method

A Cobb-Douglas production function models the relationship between production output and production inputs (factors). It is used to calculate ratios of inputs to one another for efficient production and to estimate technological change in production methods. The Cobb-Douglas Production Function is employed to assess the effects of various inputs seed, fertilizer, manure, irrigation, plant protection, human and bullock labour of temporal change in production of pulse crops.

The Model

The following model of Cobb-Douglas production function was used in the study (Chaudhry and Khan, 2009).

$$Y = A\, X_i^{b1} X_i^{b2} X_i^{b3} X_i^{b4} \ldots\ldots\ldots\ldots X_n^{bn}$$

Where,

Y = production (kg/ha); X_i = seeds, plant nutrients, plant protection chemicals, human and bullock labour etc. (in physical/value units per hectare); A = Scale parameter; b = Production elasticity; X_1 = Seed; X_2 = Fertilizer; X_3 = Manure; X_4 = Human labour; X_5 = Bullock labour; X_6 = Irrigation; X_7 = Plant protection measures

The aims of this study determine the factor affecting to production and the relative importance of each factor in increasing production. Hence, relying on scientific research, we can expect an improvement in the productivity and performance of the agricultural units. The overall goal of the study is to estimate the crop production yield, determining the elasticity of production, measuring the effect of factor in production Sekhar *et al.* (2018).

In the present study, the Tornqvist Theil index was used for computing the total output index, total input index and total factor productivity index. TFP captures the amount of increase in total output that is not accounted for by increases in total input, but that occurs due to shift in production function, which could be to improved technology, management, knowledge, infrastructure and other knowledge-based factors. Input quantity data were available for some inputs namely seed, fertilizer, manure, human labour and bullock labour. Therefore, input quantity indices were worked out directly for each it. However, for the inputs like irrigation charges, insecticides, machine labour, rental value of land and other paid out cost, data were available only in value terms. Therefore, an indirect method has been used to compare their quantity indices. First, their value indices were prepared which were than divided with respective price indices. Due to non-availability of such regional price indices, all India price indices for pesticides, pump driven irrigation and all commodities have been used under the assumption that the price of proxy inputs represents the price of these inputs and relative price structure remaining the same (Kumar & Parminder, 2012). These indices were calculated as follows:

Total Output Index (TOI)

Total output indices were constructed using the Tornqvist Theil index approach as follows (Olayiwola, *et al.* 2015):

$$:\frac{TOI_t}{TIOI_{t-1}} \equiv \pi_j \left(\frac{Q_{jt}}{Q_{jt-1}}\right)^{(R_{jt}+R_{jt-1})^{1/2}}$$

TOI_t = Total output index in t^{th} year.

TOI_{t-1} = Total output index in (t–1)t^{th} year.

Q_{jt} = Output of j^{th} crop in t^{th} year.

Q_{jt-1} = Output of j^{th} crop in (t–1) t^{th} year.

R_{jt} = Output share of j^{th} crop in total revenue in t^{th} year.

R_{jt-1} = Output share of j^{th} crop in total revenue in (t–1)t^{th} year

R_{jt} was calculated follows:

$$R_{jt} = \frac{\text{value of j}^{\text{th}}\text{ crop output in t}^{\text{th}}\text{ year}}{\text{Aggregate crop output value in t}^{\text{th}}\text{ year}}$$

$$R_{jt} \equiv Q_{jt} \times P_{jt} / \sum_{j=1}^{n} Q_{jt} \times P_{jt}$$

Where,

Q_{jt} = output of j^{th} crop in t^{th} year

P_{jt} = Post/farm harvest price of j^{th} crop in t^{th} year.

Thus, total output indices for individual crops were worked out taking 1999-2000 as the base period and was multiplied to arrive TOI for crop sector. The output index includes the main product as well as by products.

Total Input Index (TII)

Total input indices were constructed using the Tornqvist Theil index approach as follows:

$$\frac{TII_t}{TII_{t-1}} \equiv \pi_j \left(\frac{X_{it}}{X_{it-1}}\right)^{(S_{It}+S_{It-1})^{1/2}}$$

Where,

TII_t = Total input index in t^{th} year.

TII_{t-1} = Total input index in (t–l) t^{th} year.

X_{it} = Quantity of i^{th} input used in j^{th} crop in t^{th} year.

X_{it-1} = Quantity of i^{th} input used in j^{th} crop in (t–1) t^{th} year.

S_{It} = Share of input '*i*' in total input cost in t^{th} year.

S_{It-1} = Share of input '*i*' in total input cost in (t–l)t^{th} year.

Thus, input indices for individual inputs were prepared taking 1999- 2000 as the base year and was multiplied to arrive at the total input index of individual crops. The input indices for individual crops were then multiplied to get the total input index of crop sector (Rao, *N. C. 2005).*

Total Factor Productivity Index (TFPI)

Total factor productivity indices were computed as the ratio of total output index (TOI) to total input index (TII).

$$TFPI_t = (TOI / TII_t) \times 100$$

RESULTS AND DISCUSSION

Production Function Estimates for Cotton Crop

For estimation of elasticities of important variables of cotton production in Rajasthan state Cobb – Douglas production function was used (Table 1). The Cobb-Douglas production function was employed to assess the effects of various inputs such as seed, fertilizer, manure, irrigation, plant protection measures, human and bullock labour in production of cotton crop. The value for the coefficient of multiple determinations (R^2) 0.78 directly explained that the selected resources jointly contributed 78 per cent to the total variation in cotton production in Rajasthan state.

Table 1: Cobb-Douglas Production Function Estimates for Cotton Crop

Sl. No.	Particulars	Regression coefficient	Value of coefficient
1	Constant	A	-2.30
2	Seed (kg) X_1	b_1	-0.05 (0.24)
3	Fertilizer (kg) X_2	b_2	1.03** (0.47)
4	Manure (kg) X_3	b_3	0.26 (0.17)
5	Human Labour (hrs.) X_4	b_4	0.84* (1.21)
6	Bullock Labour (Pair hrs.) X_5	b_5	0.07 (0.07)
7	Irrigation (X_6)	b_6	0.37* (0.30)
8	Plant protection measure (X_7)	b_7	-0.58* (0.60)
9	R^2		0.78

*** and * significant at 1 and 5 per cent level of significance, respectively; Figures in the parenthesis indicates standard error of respective coefficients.*

The variables such as fertilizer, human labour and irrigation water were found positive and significant. It indicated that the more fertilizer, human labour and irrigation water use, the higher the cotton production. These results are in confirmative with Hong and Yabe (2015) in tea in Vietnam. On the contrary plant protection measures had negative and significant effect on cotton production. The negative sign of plant protection measures signals that chemical input had been over utilized in cotton disease control. The coefficient of fertilizer, human labour and irrigation water were 1.03, 0.84 and 0.37, respectively. Thus, one percent increase in fertilizer, human labour and irrigation water would lead 1.03, 0.84 and 0.37 percent increase in cotton production, respectively. While 1 per cent increase in plant protection measures would lead to 0.58 per cent decrease in the cotton production. Manure and bullock labour were found positive but non significant factors to contribute for production for cotton. While seed was found to be negatively contributing factor but insignificant.

Growth in Input, Output and TFP Index of Cotton

Cotton is the most important cash crop of India which plays crucial role in the world economy. Cotton, the king of textile fibres, made significant contribution to Indian economy. It provides sustainable livelihood for millions of rural populations. The textile industry is nourished by cotton for over a century. Maharashtra occupies the first position in area and second position for cotton production in India.

It can be observed from Table 2 and Fig. 1 that the total output index of cotton exceeds more than 100 per cent in 15 years out of 16 years of study in Rajasthan state. It shows that the yield and value of cotton increased continuously in the time of study period. The compound growth rates of total output, total input and TFP were 4.21, 0.40 and 3.80 per cent per year, respectively. Similar finding in the line reported by Sanap *et al.* (2015) in cotton crop in Maharashtra state.

The total output index of cotton varied from 97.38 per cent in 2009-10 to 281.03 per cent in 2003-04 and total input index varied from 89.71 per cent in 2004-05 to 133.10 per cent in 2002-03 during the period of 16 years. The TFP growth or technological change had been responsible for contributing about 90 percent of total output growth. The cost of production of cotton almost remained constant during the study period as the cost of input remained stagnant and the output growth substantially increased, this resulted into decline in the real cost of cotton by 2.10 per cent per annum during the study period.

Table 2: Growth in Input, Output and TFP Index of Cotton in Rajasthan during the Period 2000-01 to 2015-16

Year	Output Index	Input Index	TFP Index
1999-00	100.00	100.00	100.00
2000-01	110.58	110.56	100.01
2001-02	186.80	102.38	182.45
2002-03	168.34	133.10	126.47
2003-04	281.03	111.06	253.04
2004-05	162.14	89.71	180.73
2005-06	107.27	91.06	117.80
2006-07	173.26	95.44	181.53
2007-08	205.15	101.86	201.40
2008-09	203.91	105.87	192.60
2009-10	97.38	107.95	90.20
2010-11	273.86	94.88	288.63
2011-12	249.56	106.42	234.50
2012-13	239.64	117.00	204.82
2013-14	229.52	108.52	211.50
2014-15	248.10	106.71	232.49
2015-16	242.73	123.92	195.87
CGR (%)	**4.21**	**0.40**	**3.80**
Real cost of production (%)		**-2.10**	
Share of TFP in Output growth (%)		**90.22**	

The achievement of high TFP growth of cotton in Rajasthan state was mainly due to release of high yield varieties *viz*., RS 2013 variety was resistant to cotton leaf curl virus disease and moderately tolerant to jassids and american ball worm, RS 810 variety resistant to cotton leaf curl virus disease, RST 9 had high ginning per cent in this variety 1st irrigation can be delayed up to 50 days. RS 875, RG 8 variety early in maturity and hybrid varieties viz., Maru vikas, LHH 144 and RAJDH 9 developed byRajasthan state agricultural universities and introduction of high yielding Btcotton varieties in the state, which remarkably increased the productivity.

The TFP analysis of cotton also clearly revealed that the research expenditure incurred during the study period for evolving better varieties of cotton in the state played a greater role for increasing productivity and reduction in the cost of production in the state.

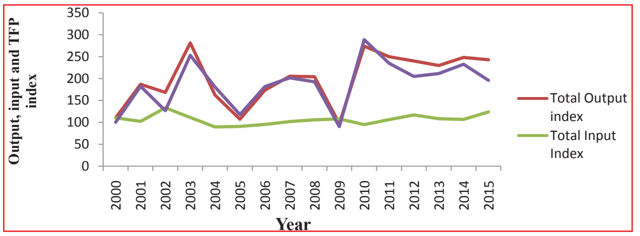

Fig. 1: Output, Input and TFP Index of Cotton in Rajasthan State for the Year 2000-01 to 2015-16

CONCLUSION

The Cobb- Douglas production function used in cotton resulted that fertilizer, human labour and irrigation variables were positively significant while the variable plant protection measures were significant negatively affected on wheat production. The value for the coefficient of multiple determinations (R^2) for cotton crop was 0.78.The annual compound growth rate of total output, total input use and TFP of cotton were 4.21, 0.40, and 3.80 per cent per annum, respectively. To address the issue of technological progress and crop sustainability in Rajasthan, the selected crops were classified into five groups according to the magnitude of growth in TFP, as under, as given by (Chand *et al.* 2011).

Negative growth	TFP growth less than zero
Stagnant growth	TFP growth positive but less than 0.5 %
Low growth	TFP growth of 0.5 to 1 %
Moderate growth	TFP growth of >1-2%
High growth	TFP growth of more than 2%

REFERENCES

Chand, R. and Sonia, C. 1999. Are Disparities in Indian Agriculture Growing?. Policy Brief No. 8. New Delhi: National Centre for Agricultural Economics and Policy Research.

Chand, R., Raju, S.S. and Pandey, L.M. 2007. Growth Crisis in Agriculture: Severity and Options at National and State Levels. *Economic and Political Weekly*, **42**(26): 2528-33

Hazari, S. 2015. Performance of Major Crops in Maharashtra State, India. *Elixir International Journal*, **88**: 36415-36417.

Douglas, G., Parente, S. and Rogerson, R. 2002. Role of agriculture in development. *The American Economic Review*, **92**(2): 160-164.

Gollin, D. Parente, S. and Rogerson, R. 2002. The role of agriculture in development. *The American Economic Review*, **92**(2): 160-164.

Chaudhary, I.S. and Khan, M.B. 2009. Factors affecting cotton production in Pakistan empirical evidence from Multan District. *Journal of Quality and Technology Management*, **5**(2): 91-100.

Kumar, S. and Parminder, S. 2012. Determinants of total factor productivity growth for major agricultural crops in Punjab. *Indian Journal of Economics and Development*, **8**(2): 49-62.

Sekhar, C., Venkatesan N., Vidhyavathi, A. and Murugananthi, M. 2018. Factors influencing moringa cultivation in Tamil Nadu – an economic analysis. *Horticulture International Journal*, **2**(5): 223-230.

Olayiwola, O.O., Awasthi, P.K. and Raghuwanshi, N.K. 2015. Total factor productivity of major crops in central India. *International Journal of Novel Research in Civil Structural and Earth Sciences*, **2**: 1-6.

Rao, N.C. 2005. Total Factor Productivity in Andhra Pradesh Agriculture. *Economics Research Review*, **18**: 1-19.

Sanap, D.J., More, S.S. and Bonkalwar, N.R. 2016. Total factor productivity growth of pigeon pea crop in Maharashtra. *Indian Journal of Agricultural Research*, **50**(2): 126-130.