

Comparing Cobb-Douglas Production Function of Cotton in Gujarat and Maharashtra, India

PREMA BORKAR^{1*}

Gokhale Institute of Politics and Economics (Deemed University), Pune, Maharashtra, India

**Corresponding Author E-mail: prema.borkar@gipe.ac.in, premaborkar@gmail.com*

Abstract: Cotton, commonly referred to as “white gold,” is a prominent economic crop cultivated globally for its valued fiber. India has emerged as the world’s foremost cultivator and largest producer of cotton. This study aimed to identify the factors influencing cotton output in Gujarat and Maharashtra. This article utilizes secondary data from 2010-11 to 2021-22. The Cobb-Douglas production function was employed to observe and estimate the elasticities of specific variables influencing cotton output in the states of Gujarat and Maharashtra. A Cobb-Douglas production function was utilized to evaluate the impact of seed, fertilizer, manure, human labour, irrigation, bullock labour, and plant protection measures on cotton yield. The study’s results indicated that the Cobb-Douglas production function applied to cotton demonstrated that fertilizer, human labour, irrigation water, and plant protection measures were positively significant, whereas manures exerted a considerable negative effect on cotton production in Gujarat. The analysis revealed that fertilizer, plant protection measures, and manure positively influenced cotton production in Maharashtra, whereas human and bullock labour had a detrimental effect. The multiple determinations correlation (R^2) for cotton crops was 0.94 and 0.83, signifying that the chosen resources together explained 94 percent and 83 percent of the overall variation in cotton production in Gujarat and Maharashtra, respectively.

Keywords: Cotton, Cobb Douglas, Gujarat, Maharashtra

INTRODUCTION

Cotton is an important cash crop for millions of small farmers, which benefits the rural economy. Cotton is historically and culturally significant, playing an important role in traditional apparel and crafts. It is the principal raw material for the enormous textile industry, which manufactures needed apparel and other products. The cotton industry is important to economic prosperity since it produces raw materials for textiles, creates major employment in farming and manufacturing, contributes to GDP, and generates foreign exchange through export. It also supports a vast range of associated businesses, from equipment to chemical processing, serving as the foundation of both rural and national economies in India.

Beyond textiles, its by-products are animal feed, oil, and paper.

Millions of individuals, including farmers, factory workers in textile mills, and those employed in processing, commerce, and transportation, are employed by the industry. It significantly contributes to the Gross Domestic Product (GDP) of a nation. Significant foreign exchange revenues are generated by the export of cotton and cotton products. The industry provides support to a diverse array of other sectors, such as the production of chemicals for dyeing and sterilizing, packaging materials, and transport services. The complete cotton plant is utilized. The lint is used to produce paper and other cellulose products, while the

seeds are processed to produce oil (which is used in cooking, and salad dressing) and meal (which is produced for livestock fodder).

Gujarat is India's main cotton-producing state, recognized for its high productivity, with major growing regions in Saurashtra and Kutch, as well as crucial districts like Amreli, Bhavnagar, and Junagarh. Although Maharashtra is currently the leading cotton-producing state, Gujarat is still a top producer with a high production and has been in the forefront of developing new cotton varieties. Maharashtra is India's second-largest cotton producer, accounting for a considerable share of the national total. The state's black soil and suitable temperature encourage cultivation, with Jalgaon, Yavatmal, Aurangabad, Wardha, and Amravati being the most productive districts.

In order to comprehend and quantify the correlation between the inputs employed in the production process and the output produced, the production function has been devised (Gordon, 2011). In order to optimize resource utilization, it is imperative that producers and businesses possess a basic comprehension of production principles (Onalan and Basegmez, 2018). The relationship between the output produced and physical capital and labor inputs is illustrated by the Cobb-Douglas production function (Besanko and Braeutigam, 2010). It is founded on an empirical investigation of the American manufacturing sector that was conducted (Felipe, 2005). It was a significant milestone in the field of macroeconomic modeling (Felipe, 2005; Mishra, 2007). The Cobb-Douglas production function is an extensively used and well-known type of production function in the agricultural industry (Besanko and Braeutigam, 2010).

The fundamental obstacle that every farmer encounters in the agricultural sector is the simultaneous reduction of costs and the enhancement of output. To achieve this, it is necessary to ascertain the current efficiency of

the producers' input utilization, identify the inputs that are being used inefficiently, and then recommend measures to optimize the use of these inputs to increase production and reduce costs (Chand et al., 2007). Production function analysis is the appropriate methodology for determining the most effective utilization of inputs. An explicit understanding of the utilization of inputs and their impact on output is provided by the production function analysis. The productivity levels of various inputs are determined by the production function analysis, which also evaluates the marginal contribution to the output. The Cobb-Douglas production function technique is implemented to ascertain the relationship between input and output among the producers surveyed in this investigation.

Due to its computational manageability and theoretical appropriateness for agriculture, the Cobb-Douglas production function is employed in agricultural production economics. Additionally, it provides information on returns to scale. The least squares method of regression was employed to estimate the Cobb-Douglas production function (Douglas et al., 2002). The present study aimed to identify the factors influencing cotton output in Gujarat and Maharashtra.

MATERIAL AND METHODS

This study focused on comparing the cultivation costs of cotton in Gujarat and Maharashtra. The research employs secondary time series data sourced from the Directorate of Economics and Statistics, Department of Agriculture & Cooperation, Ministry of Agriculture, Government of India. The data was gathered from the 2010-2011 to the 2021-2022 period. The statistics on agricultural inputs comprised human labour (man days/ha), bullock labour (pair days/ha), machine labour (man days/ha), seed (kg/ha), manure (tonnes/ha), fertilizer (kg/ha), plant protection measures (kg/ha), and irrigation (rupees/ha).

To obtain an understanding of the itemized distribution of cotton input utilization in Gujarat and Maharashtra, compound annual growth rates (CAGR) were calculated.

A Cobb-Douglas production function characterizes the connection between production output and input factors. It is utilized to compute the ratios of inputs relative to each other for optimal output and to assess technological advancements in production techniques. The Cobb-Douglas production function is utilized to evaluate the impact of several inputs—seed, fertilizer, manure, irrigation, plant protection, human labour, and bullock labour on the temporal variation in cotton crop yield.

Cobb-Douglas Production Function

The study utilized the Cobb-Douglas production function model (Chaudhry and Khan, 2009).

$$Y = A X_1^{b_1} X_2^{b_2} X_3^{b_3} \dots X_n^{b_n}$$

Where, Y = production (kg/ha);

X_i = seeds, plant nutrients, plant protection chemicals, human and bullock labor, etc. (in physical/value units per hectare);

A represents the scale parameter;

b denotes production elasticity

X_1 = Seed;

X_2 = Fertilizer;

X_3 = Manure;

X_4 = Human labor;

X_5 = Bullock labor;

X_6 = Irrigation;

X_7 = Plant protection measures

The objectives of this study are to identify the factors influencing production and to assess the relative significance of each element in enhancing productivity. Consequently, based on scientific research, we anticipate an enhancement in the productivity and performance of agricultural units. The primary

objective of the Cobb-Douglas is to assess agricultural production yield, ascertain the elasticity of production, and evaluate the impact of production factors. (Sekhar et al., 2018).

RESULT AND DISCUSSION

The item-wise breakup of input utilization of cotton in Gujarat was depicted in Fig. 1. The Seed rate used by farmers ranges from 1.58 to 2.13 kg/ha of cotton in Gujarat. The seed rate showed a positive growth rate of 0.79 percent, which indicated that the seed rate had not changed much over the period of time. Fertilizer application to cotton crop in Gujarat was 203.50 kg/ha in 2010-11, which declined to 171.89 kg/ha in 2021-22. The growth rate of the cotton crop registered a negative growth rate of 0.58 percent and was found to be non-significant. Manure application declined from 40.90 quintals in 2010-11 to 18.14 quintals in 2021-22. Manures registered a negative growth rate of 6.77 percent and was found to be significant. Human labour and animal labour registered a negative growth rates of 1.96 percent and 13.40 percent, respectively and found to be significant. Plant protection measures registered a significant positive growth rate of 5.14 percent, whereas irrigation charges were found to negative and non-significant.

Table 1: Item-wise Breakup of Input Utilization of Cotton in Gujarat

Input Utilization	TE 2010-11	TE 2014-15	TE 2018-19	TE 2021-22	CAGR
Seed (kg)	1.58	2.13	1.78	1.97	0.79
Fertilizer (kg)	203.50	215.67	186.10	171.89	-0.58
Manure (Qtl.)	40.90	31.84	32.47	18.14	-6.77**
Human Labour (Pair Hrs)	1335.62	1014.73	844.85	885.21	-1.96**
Animal Labour (Pair hrs)	42.54	18.43	13.36	6.45	-13.40**
Plant protection measures	3069.38	3541.82	2464.84	3703.17	5.14**
Irrigation Charges	3075.33	3357.62	3414.47	2460.84	-0.17

Figure 2 shows the breakup of the input utilization of cotton in Maharashtra state. The

Seed rate used by farmers registered a positive growth rate of 1.08 percent and was found to be insignificant. The seed rate used by farmers ranges from 1.83 to 2.36 kg/ha of cotton in Gujarat. Fertilizer application to cotton crop in Maharashtra was 218.17 kg/ha in 2010-11, which increased to 256.01 kg/ha in 2021-22. The fertilizer growth rate of the cotton crop registered a positive growth rate of 0.56 percent and was found to be non-significant. Manure application declined from 19.94 quintals in 2010-11 to 3.16 quintals in 2021-22. Manures registered a negative growth rate of 17.05 percent and was found to be significant. Human labour and animal labour registered a negative growth rate of 1.84 percent and 6.12 percent, respectively and found to be significant. Plant protection measures registered a significant positive growth rate of 7.56 percent, whereas irrigation charges were found to positive and non-significant.

Table 2: Item-wise Breakup of Input Utilization of Cotton in Maharashtra

Input Utilization	TE 2010-11	TE 2014-15	TE 2018-19	TE 2021-22	CAGR
Seed (kg)	1.87	2.36	1.83	2.21	1.08
Fertilizer (kg)	218.17	215.99	216.69	256.01	0.56
Manure (Qtl.)	18.94	13.52	7.24	3.16	-17.05**
Human Labour (Pair Hrs)	1067.47	930.28	895.76	974.16	-1.84**
Animal Labour (Pair hrs)	109.52	84.46	72.24	53.09	-6.12**
Plant protection measures	1449.27	2152.27	3063.82	4478.32	7.56**
Irrigation Charges	703.79	2318.86	2879.39	1453.70	0.70

Production Function Estimates for Cotton in Gujarat

The Cobb-Douglas production function was employed to estimate the elasticities of significant factors in cotton production in Gujarat state (Table 3). The Cobb-Douglas production function was utilized to evaluate the impact of several inputs, including seed, fertilizer, manure, irrigation, plant protection measures, and both human and bullock labour, on cotton crop yield. The coefficient of multiple

determinations (R^2) value of 0.94 indicates that the chosen resources collectively accounted for 94 percent of the overall variation in cotton production in Gujarat state. The variables, including fertilizer, human labour, irrigation water, and plant protection measures were identified as positive and significant. The data suggested that increased utilization of fertilizer, human labour, irrigation water, and plant protection measures correlates with higher cotton production in Gujarat state. On the contrary, manures had a detrimental and considerable impact on cotton yield. The coefficients for fertilizer, human labour, irrigation water, and plant protection measures were 0.80, 0.20, 0.24, and 0.19, respectively. Thus, a 1% increase in fertilizer, human labour, irrigation water, and plant protection measures would result in 0.80, 0.20, 0.24, and 0.19 percent increases in cotton yield, respectively. While a 1% increase in manure would result in a 0.22% drop in cotton yield. Bullock labor and seed were determined to be favorable but not substantial contributors to cotton output.

Table 3: Cobb-Douglas Production Function Estimates for Cotton in Gujarat

Sr. No.	Particulars	Regression Coefficient	Value of Coefficient
1	Constant	A	-6.23 (4.55)**
2	Seed (kg) X_1	b_1	0.19 (0.32)
3	Fertilizer (kg) X_2	b_2	0.80 (0.31)**
4	Manure (kg) X_3	b_3	-0.22 (0.21)**
5	Human Labour (hrs) X_4	b_4	0.20 (0.65)**
6	Bullock Labour (Pair hrs) X_5	b_5	0.22 (0.23)
7	Irrigation X_6	b_6	0.24 (0.21)**
8	Plant protection measure X_7	b_7	0.19 (0.31)**
9	R^2		0.94

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

Production Function Estimates for Cotton in Maharashtra

The Cobb-Douglas production function was employed to estimate the elasticities of significant factors in cotton production in Maharashtra state (Table 4). The coefficient of multiple determinations (R^2) value of 0.83 indicates that the chosen resources collectively accounted for 83 percent of the overall variation in cotton production in Maharashtra state. The variables, including fertilizer, plant protection measures, and manure, were determined to be positive and significant. The data suggested that increased application of fertilizer, plant protection measures, and manure correlates with higher cotton production. Conversely, human labour and bullock labour exerted a detrimental and considerable impact on cotton production in Maharashtra. The negative correlation of human and bullock labour indicates that labour was excessively exploited in cotton production. The coefficients for fertilizer, plant protection methods, and manures were 0.02, 0.07, and 0.26, respectively. A one percent increase in fertilizer, plant protection measures, and manures would result in proportionate increases of 0.02, 0.07, and 0.26 percent in cotton yield. A 1% increase in human and bullock labour would result in a

0.13 and 0.63 percent loss in cotton production, respectively. Irrigation water was identified as a negative yet substantial factor influencing cotton productivity. Although seed was identified as a negatively contributing element, its impact was deemed minor.

CONCLUSION

The Cobb-Douglas production function was used to assess the effect of various inputs on cotton crop yield, including seed, fertilizer, manure, irrigation, plant protection measures, and both human and bullock labour. The Cobb-Douglas production function utilized in cotton revealed that fertilizer, human labour, irrigation water, and plant protection measures variables were favourably significant, however manures had a substantial negative impact on cotton production in Gujarat. The correlation of multiple determinations (R^2) for cotton crop was 0.94, indicating that the selected resources accounted for 94% of the entire variation in cotton production in Gujarat state. It further indicated that fertilizer, plant protection measures, and manure had a positive significance, however human labour and bullock labour negatively impacted cotton production in Maharashtra. The correlation of multiple determinations (R^2) for cotton crops was 0.83, indicating that the selected resources together accounted for 83 percent of the total variation in cotton production in Maharashtra.

Table 4: Cobb-Douglas Production Function Estimates for Cotton in Maharashtra

Sr. No.	Particulars	Regression Coefficient	Value of Coefficient
1	Constant	A	5.77 (2.99)**
2	Seed (kg) X_1	b_1	-0.53 (0.39)
3	Fertilizer (kg) X_2	b_2	0.02 (0.29)**
4	Manure (kg) X_3	b_3	0.26 (0.09)**
5	Human Labour (hrs) X_4	b_4	-0.13 (0.31)**
6	Bullock Labour (Pair hrs) X_5	b_5	-0.63 (0.46)**
7	Irrigation X_6	b_6	-0.03 (0.22)**
8	Plant protection measure X_7	b_7	0.07 (0.06)**
9	R^2		0.83

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

REFERENCES

- Besanko, D.A., and Braeutigam, R.R., 2010. Microeconomics (4th ed.). John Wiley and Sons.
- 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
- 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.
- Douglas, G., Parente, S. and Rogerson, R. 2002. Role of agriculture in development. The American Economic Review, 92(2): 160-164

- Felipe, J., and Adams, F.G., 2005. A theory of production, the estimation of the Cobb-Douglas function: A retrospective view. *Eastern Economic Journal*, 31 (3), Pp. 427-445. <https://www.jstor.org/stable/40326423>
- Gordon, R.V.D., 2011. The historical role of the production function in economics and business. *American Journal of Business Education*, 4 (4).
- Mishra, S.K., 2007. A brief history of production functions. North-Eastern Hill University Shillong (India), Department of Economics. [https:// doi.org/10.2139/ssrn.1020577](https://doi.org/10.2139/ssrn.1020577)
- Onalan, O., and Basegmez, H., 2018. Estimation of economic growth using grey Cobb-Douglas production function: An application for US economy. *Journal of Business, Economics and Finance*, 7 (2), Pp. 178-290. <https://doi.org/10.17261/Pressacademia.2018.840>
- Sekhar, C., Venkatesan N., Vidhyavathi, A. and Muruganathi, M. 2018. Factors influencing moringa cultivation in Tamil Nadu – an economic analysis. *Horticulture International Journal*, 2(5): 223-230.