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ESTIMATION OF TOTAL FACTOR PRODUCTIVITY GROWTH OF MAIZE PRODUCTION IN CENTRAL INDIA

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ABSTRACT

Maize popularly known as "corn" is one of the most versatile emerging cash crop having wider adaptability under varied climatic condition. It is called of cereals globally .In India, maize is the third important food cash crops after wheat and rice. Present investigation shows that output index was highest during 2002-2011 (3.047). TFP growth was positive during all the period of time and highest growth rate during 2002-2011(3.195). But still fertilizer is the principal source of growth for maize crop. This indicates that in future more fertilizer responsive varieties will determine the positive growth of maize. It accounts for 9 per cent of total food grain production in the country. By cultivating maize, farmers can protect the worsening quality of soil as well as other factor, which affect the productivity.

Key words : *TFP Growth, Tornqvist indices, Maize productivity, Central India.*

Maize is the second most important cereal crop in the world in terms of acreage and is called the 'Queen of Cereals'. Global maize production touched approx. 1040 million MT in 2016-17, wherein, US has been the leading producer, followed by China, accounting for about 38% and 23% respectively. Maize production in India has grown at a CAGR of 5.5 per cent over the last ten years from 14 lakh tonns in 2004-05 to almost about 26 lakh tonns in 2016-17. Maize is the third most important food grain crop in India and accounts for about 10% of total cereal production besides rice (42%) and wheat (38%). India stands that 5 rank in Maize hybridization with the contribution around 2% to the total world production in maize with a quantum of 26 million MT in 2016-17. 15 million farmers in India engaged in Maize cultivation which qualifies as potential crop for doubling farmer's income. Maize is an important cereal of India and is grown over 4 per cent of the net area sown of the country it's an inferior grain which is used both as corn/food and furnishes huge quantities of green fodder for the cattle. More than half the maize of India is produced in four states of Madhya Pradesh, Andhra Pradesh, Karnataka and Rajasthan. Madhya Pradesh is the largest producer of maize in India. This state contributed over 14 per cent of maize from about 13.5 per cent of maize area of the country. Madhya Pradesh has large percentage of cropped area under maize cultivation in the districts of Mandla, Ujjain, Indore, Ratlam and Jhabua. The Maize is less water demanding and gives higher yield per hectare as well as save 90% of water, 70% of power compared to paddy by the farmers. The feed accounts for about 60% of the consumption in India Maize Production. The most important use and demand driver of maize is poultry feed which accounts 47% of total maize consumption, livestock feed accounts for 13%. The food consumption accounts for 20% of Maize consumption, with direct consumption being 13% and that in form of processed food being 7% (1). The high yielding production technologies recommended during the period of green revolution created some serious problems like nutrient imbalances caused by the huge application of nitrogenous fertilisers, depletion of soil micronutrients, over-exploitation of groundwater, degradation of land, more frequent emergence of pests and diseases, and the diminishing returns to inputs (2). Significant TFP growth in the Indian crops sector was produced by investments, primarily in research but also in extension, markets, and irrigation (3). The cropping system is sustainable if it can maintain total factor productivity growth over time. The studies by (4, 5) highlighted that the total factor productivity growth of important crops is decelerating in India.

RESEARCH METHODOLOGY

The study based on purely secondary data and was collected from Directorate of Economics and Statistics, "Cost of Cultivation of Maize Crop" scheme of Government of India. Divisia-Tornqvist index has been proposed study for computing the TFP for the crop sector. The Divisia-Tornqvist index of Total Factor Productivity is commonly used for computing total output, total input and total factor productivity by the farm sector (Reddy, 2009). The data were collected for the period of 1981-82 to 2011-12 from the published litrature of the Comprehensive Scheme from Cost of Cultivation of Maize Crop in Madhya Pradesh under the study. These data have been classified into three periods viz. 1982-91, 1992-2001 and 2002-2011 along with overall period (1982-2011). For construction of output index principal crops of the State were taken into account. The physical quantities of production of maize for all the years were collected and multiplied with the respective Minimum

Table-1 : Growth rates of Input and Output Index and TFP of Maize in M.P.

Period	Output	Input	TFP
1982 to 1991	-0.633	-1.902	0.627
1992 to 2001	-0.428	-2.206	1.411
2002 to 2011	3.047	0.129	3.195
1982 to 2011	1.048	-0.707	1.600**

**Significant at 1% level

Table-2 : Source of Growth in TFP of Maize in Madhya Pradesh.

Period	Seed (kg)	Fertilizer (kg)	Manure (Quintal)	Human Labour (Hrs.)	Animal Labour (Pair Hrs.)
1982 to 1991	-11.681	4.846	-7.760	-2.161	-0.689
1992 to 2001	1.686	2.004	-10.267	-0.950	-5.036
2002 to 2011	-1.748	5.820	0.337	-1.100	-0.080
1982 to 2011	-1.811	2.173	-2.598	-0.347	-1.636

Table-3 : Factors affecting Total Factor Productivity of Maize in M P

Variables	Constant - (a)	Seed (kg) - X_1	Fertilizer (kg) - X_2	Manure (Qtl) - X_3	Human labour (Hrs) - X_4	Animal Labour (Pair Hrs.) X_5	R^2
Maize	-8.956	-0.013**	0.029***	0.115***	0.012***	0.028***	99.12

*Significant at 10% level, **Significant at 5% level and ***Significant at 10% level

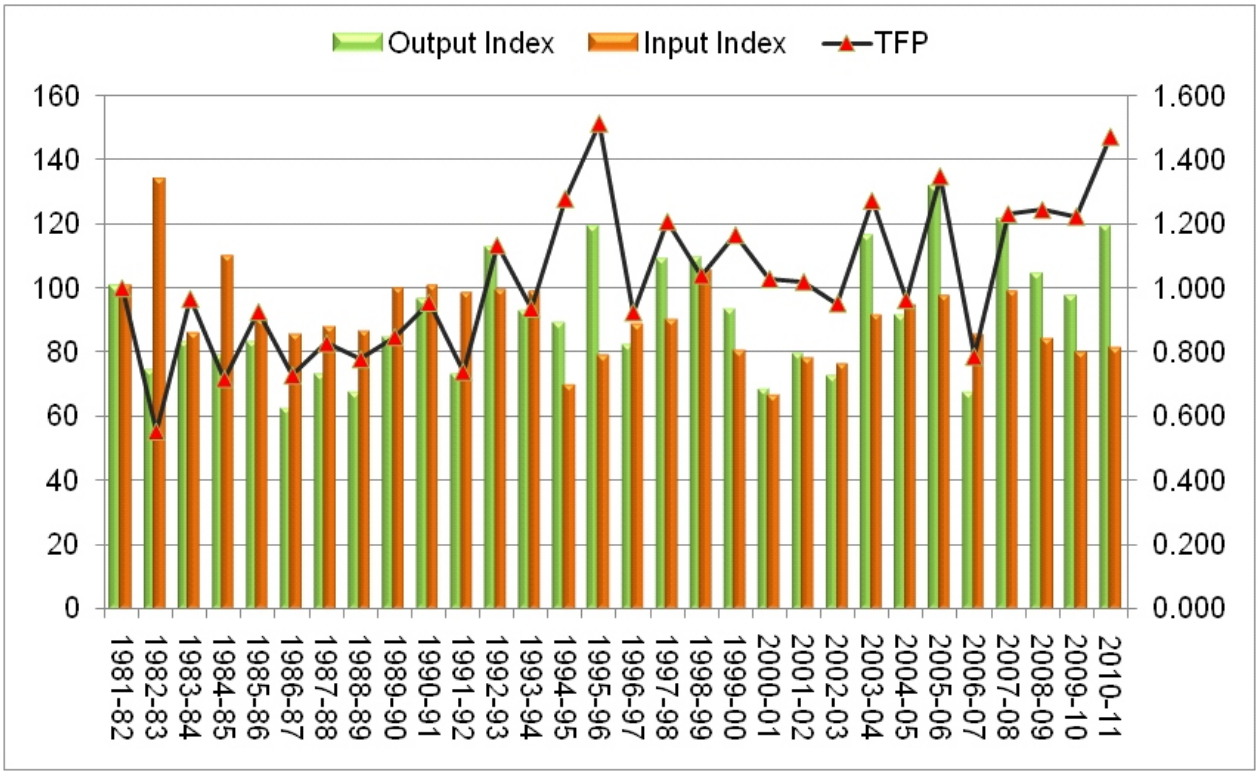

Fig. 1

Support Price (MSP) to get the value of the production. The considered inputs of production for the study were seed (kg), Fertilizers (kg.), yard manure (FYM) (quintals), human labour (hr) and animal labour (pair) per hectare.

Total Output Index (TOI)

$$TOI_t / TOI_{t-1} = {}_j(Q_{jt} / Q_{jt-1})^{(R_{jt} + R_{jt-1})^{1/2}} \quad A_t \qquad ....(1)$$

Total Inputs Index (TIT)

$$TII_t / TII_{t-1} = {}_j(X_{it} / X_{it-1})^{(S_{jt} + S_{jt-1})^{1/2}} \quad B_t \qquad ....(2)$$

Where,

R_{jt} = Share of the j^{th} crop output in total revenue in the year t,

R_{jt}-$_1$ = Share of the j^{th} crop output in total revenue in t-1 year,

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

Q_{jt}-$_1$ = Output of j^{th} crop in year t-1,

S_{it} = Share of input i in total input cost in year t,

S_{it}-$_1$ = Share of input i in total input cost in year t-1,

X_{it} = Quantity of input i in year t,

X_{it-1} = Quantity of input i in year t-1,

t = Time period.

Total output and input index in period t was computed from (1) and (2) as follows :

$$TOI\ (t) = A_1\ A_2\ .....A_t \quad .....(3)$$

$$TII\ (t) = B_1\ B_2\ .....B_t \quad .....(4)$$

Total Factor Productivity (TFP)

$$TFP_t = (TOI_t/TII_t) \quad ...(5)$$

Equations (3) to (5) provide the index of total output, total input and total factor productivity respectively for period 't'.

The input, output and total factor productivity growth rates for the specified period has been done by fitting the following exponential trend equation model to the input, output and total factor productivity indices respectively.

$$Y = ab^t$$

The growth rate (GR) has been computed using the formula:

$$GR = (Antilog\ b\text{-}1)100$$

Linear regression Model : Linear regression model which was used to estimate the Total Factor Productivity was of the following form:

$$Y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5$$

Where,

Y = TFP

a = Constant

b_1 to b_4 = regression coefficient

x_1 = Seed (Kg)

x_2 = Fertilizers (Kg)

x_3 = Manure (Qtl)

x_4 = Human labour (Hr)

x_5 = Animal labour (Hr.)

The reason behind such a low yield is that in in the states, maize is grown as a rain fed crop. Secondly, it is used mainly as a food crop, for which traditional or composite varieties are preferred.

RESULTS AND DISCUSSION

Growth rate of Input and Output Index and TFP : Total Factor Productivity of maize and Input-Output Index for different period of time given in Table-1. The data shows that output index was highest during 2002-2011 (3.047). TFP growth was positive during all the period of time and highest growth rate during 2002-2011(3.195). Overall growth rate of TFP during the study period 1982-2011 (1.600) positive & highly significant and output index was positive, while the growth of input index shown negative response.

Source of Growth in TFP : The source of growth rate in Total Factor Productivity of maize during different time period was worked out and presented in Table 2. The data presented in table depict that in maize crop seed as a source of growth during 1992-2001was highest (1.686), while during 1982-91 it was negative (-11.681), this revealed that the quality seed distribution and seed replacement of maize by new varieties over old varieties was higher during 1992-2001, while during 2002-2011 there was a setback due to drought in use of inputs because maximum input as a source of growth depict negative figure. In case of fertilizer as a source of growth was highest during all the period because high yielding varieties (HYV) of maize were introduced and adopted by the farmers of the Madhya Pradesh, which were more responsive to chemical fertilizer, earlier there was less response of chemical fertilizer due to rain fed condition in most of the rain fed growing area of the Madhya Pradesh.

Overall response of fertilizers as a source of growth was highest among all the input considered in the study for the maize crop. Manure as source of growth shown negative and less response in maize crop during the period 1982-91 and 2002-2011 because it's negligible use. As far as response of labour resources is concerned the growth was found negative during all the period of time because of substitution of human labours by mechanical power especially in the land preparation, harvesting and threshing of maize crop. Similarly with animal labour during all the period depict negative impact as a source of growth and it shows increasing over the period of time reflecting that rate of substitution of animal labour by mechanical power increased over the period of time at faster rate.

Factors affecting Total Factor Productivity (TFP) : The multiple regressions was fitted with the selected variables viz. seed, fertilizer, manure, human labour and animal labour as independent variables and Total Factor Productivity (TFP) as dependent variables (Table-3). The fitted function was found to be best fitted as R^2 value in all the equation of maize crop was found to be around 99 per cent, which shows that the selected variables contributed

99 per cent variability in dependent variables, while remaining 1 per cent was contributed by other variables. The maize in all the variables except maize seed was contributed positive and highly significant towards.

CONCLUSION

The overall analysis shows that input as a source of growth for maize crop declined in case of all the input revealing that the ratio of output to input declined over the period of time but still fertilizer is the principal source of growth for maize crop. This indicates that in future more fertilizer responsive varieties will determine the positive growth of maize. At overall level growth rate of TFP was found to be positive and highly significant indicating which shows that the TFP of maize crop in the state is increasing significantly due to favorable government policies and effective implementation of different programmes helped in enhancing productivity of normal/hybrid maize in the state, along with promotion of first programme on oilseeds production which was started as Technology Mission on Oilseeds (TMO), and later on oilseed, pulses, oil palm & maize were brought in as its ambit in the 1990s Integrated Scheme of Oilseeds, Pulses, Oil Palm and Maize (ISOPOM - w.e.f. 1st April, 2004) which ultimately resulted in enhancing purchase of inputs like hybrid seed, fertilizer etc.

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