



Research Article

TOTAL FACTOR PRODUCTIVITY OF COTTON AND SUGARCANE IN ANDHRA PRADESH

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Abstract: The present study of the trends in cotton and sugarcane productivity growth in Andhra Pradesh. For study, time-series data on cost of cultivation of selected crops were collected from the reports of Commission on Agricultural Costs and Prices for the period 1996-97 to 2014-15. The results revealed that in the case of cotton, the mean TFPch was 3.5 per cent. The entire improvement in the productivity was due to improvement in the TECHch or "innovation", whereas the EFFch did not show any effect on TFPch. In sugarcane, the highest performance could be seen in 2012-13 where TFPch was 127.6 percent solely influenced by TECHch.

Keywords: Cotton, Sugarcane, Total factor productivity, Malmquist Index, Efficiency change, Technological change

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Introduction

Growth in agricultural productivity also accounts for a large share of economic growth. Agriculture-led development is feasible in these rain-fed regions only by applying scientific knowledge to increase crop productivity and incomes. According to the estimates of Economic Survey of Andhra Pradesh, 2016-17, the food grains production was 156.85 lakh tonnes, and oilseeds production was 24.62 lakh tonnes, an increase of 9.09 percent and 12.9 percent respectively from the previous year. Among cash crops, the area under cotton declined drastically over time. However, sugarcane area increased considerably from 1960s to 2000s, but showed declining trend since 2001-02. Growth of total factor productivity provides society with an opportunity to increase the welfare of people. Therefore, accurate measurement of TFP is crucial for understanding changes in productivity growth. Keeping in view the importance of agriculture in the State economy, quantitative assessment of TFP and contribution of various factors to TFP growth at the State level was undertaken with the following specific objectives. These measures normally show higher rates of growth than TFP, because growth in land and labour productivity can result not only from increases in TFP but also from a more intensive use of other inputs (such as fertilizer or machinery). This will help in reorienting of the programmes and priorities of agricultural development so as to achieve higher growth of agriculture for economic prosperity [1-9].

Material and Methods

Estimation of total factor productivity for the state of Andhra Pradesh was based on the secondary data pertaining to cost of cultivation of the rice and maize were collected for a period starting from 1996-97 to 2014-15. The state level data were compiled from the unit level data on cost of cultivation. The unit level data on the cost of cultivation of the major crops were available for the above said period. The Malmquist model was selected to estimate total factor productivity in agriculture. They defined the TFP index using Malmquist input and output distance functions,

and thus, the resulting index came to be known as the Malmquist TFP index. The period 't' Malmquist productivity index is given by

$$M^t = \frac{D_o^t(x^{t+1}, y^{t+1})}{D_o^t(x^t, y^t)} \quad (1)$$

$$M^{t+1} = \frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^t, y^t)} \quad (2)$$

Fare, *et al.*, (1994) [3] attempt to remove the arbitrariness in the choice of benchmark technology by specifying their Malmquist productivity change index as the geometric mean of the two-period indices, that is,

$$M_o(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\left(\frac{D_o^t(x^{t+1}, y^{t+1})}{D_o^t(x^t, y^t)} \right) \left(\frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^t, y^t)} \right) \right]^{\frac{1}{2}} \quad (3)$$

Using simple arithmetic manipulation, the equation (3) can be written as the product of two distinct components- technical change and efficiency change.

$$M_o(x^{t+1}, y^{t+1}, x^t, y^t) = \frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o^t(x^t, y^t)} \left[\left(\frac{D_o^t(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^{t+1}, y^{t+1})} \right) \left(\frac{D_o^t(x^t, y^t)}{D_o^{t+1}(x^t, y^t)} \right) \right]^{\frac{1}{2}} \quad (4)$$

Where,

$$\text{Efficiency change} = \frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o^t(x^t, y^t)} \quad (5)$$

$$\text{Technical change} = \left[\left(\frac{D_o^t(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^{t+1}, y^{t+1})} \right) \left(\frac{D_o^t(x^t, y^t)}{D_o^{t+1}(x^t, y^t)} \right) \right]^{\frac{1}{2}} \quad (6)$$

An attempt was made in this section to decompose the productivity growth of the selected crops in the present study into various efficiency measures using the Malmquist productivity indices. The technique used in this purpose allowed decompose the productivity growth into two mutually exclusive and exhaustive components namely, efficiency change (EFFch) or shifts in technology over time and technical change (TECHch).

These two components of the productivity growth help in the identification of catching up and the identification of innovation respectively (Fare et al., 1994). As compared to the Tornqvist index as propounded by Caves et al., Malmquist indices are more general in the sense that it allows inefficient performances and does not presume the underlying functional form of the technology. Besides the Malmquist productivity index estimation unlike the parametric Tornqvist approach, requires data only on the quantities of output and inputs but does not require price data.

Non-parametric programming methods were used to calculate the component distance functions of the Malmquist index. This technique constructs a grand frontier over the data on all the regions and compares each of the regions to the frontier. How close a country is as compared to the frontier is termed as "catching up" and how much the grand frontier shifts at each region input mix is termed as "technical change" or "innovation". Any value of the indices so calculated, more than 1 implies an improvement in the performance and value less than 1 implies regress or deterioration in the performance. DEAP version 2.1 was used for the calculation purposes.

Technical change (TECHch) and efficiency change (EFFch) indexes are obtained under the assumptions of constant returns to scale (CRS), i.e., it is assumed that all the firms operate in an optimum scale. But in reality, the firms could face inefficiencies due to increasing and decreasing returns to scale (IRS and DRS). The TECHch index of the firms can further be decomposed into pure efficiency change (PEch) and scale efficiency change (SEch) by relaxing the assumptions of CRS to variable returns to scale (VRS). PEch component of TECHch measures the changes in closeness of the firm to the grand frontier, devoid of the scale effects. Whereas the SEch index indicates if the movement inside the frontier is in the right direction to attain the scale efficiency or CRS point. From the foregoing discussion it can be generalised that,

$$TFPch = TECHch \times EFFch$$

$$EFFch = PEch \times SEch$$

So,

$$TFPch = TECHch \times PEch \times SEch.$$

Pure technical inefficiency of a firm is also called as the "managerial inefficiency" which occurs due to inefficient management of the inputs to produce certain level of output. SEch reflects the efficient levels of input and output.

Malmquist productivity index or the total factor productivity change (TFPch) as well as the efficiency-change (EFFch), technical-change (TECHch), pure efficiency change (PEch) and scale efficiency change (SEch) components for the state as a whole were estimated and summary presentation of the annual level performance was given in this study.

Results and Discussion

Malmquist Productivity Indices of Cotton

The productivity growth of cotton in the State of Andhra Pradesh was estimated and decomposed using the Malmquist approach and the results are presented in [Table-1]. The average performance of cotton over the period of time had improved as was evident from [Table-1] when the mean TFPch was 3.5 percent. The entire improvement in the productivity was due to improvement in the TECHch or "innovation", whereas the EFFch did not show any effect on TFPch. The highest improvement in the performance was observed in 1999-2000 where TFPch was 55.1 percent solely contributed by TECHch.

The highest fall in the performance was observed in the year 2004-05 (-14.8 percent) followed by 2010-11 (-46.8 percent) and 2003-04 (-31.7 percent) all due to large deterioration in TECHch in the respective years. Although the efficiency change (EFFch) or the "catching up" remained stable over the years, the average value of TFPch for the State was 3.5 percent. This amply demonstrates that the productivity gains in the State was completely due to improvement in innovation i.e., TECHch. Mukherjee et al., (2017) [5] estimated the performance of TFP growth of cotton crop and its determinants in Telangana State and found that the significant increase in the growth of production of cotton was made possible due to area expansion and productivity gain with introduction of Bt.

Table-1 Malmquist index summary of annual means of cotton in Andhra Pradesh from 1997-98 to 2014-15

SN	Year	EFFch	TECHch	PEch	SEch	TFPch
1	1997-98	1.000	1.190	1.000	1.000	1.190
2	1998-99	1.000	1.022	1.000	1.000	1.022
3	1999-00	1.000	1.551	1.000	1.000	1.551
4	2000-01	1.000	1.018	1.000	1.000	1.018
5	2001-02	1.000	1.034	1.000	1.000	1.034
6	2002-03	1.000	1.681	1.000	1.000	1.681
7	2003-04	1.000	0.683	1.000	1.000	0.683
8	2004-05	1.000	0.852	1.000	1.000	0.852
9	2005-06	1.000	1.007	1.000	1.000	1.007
10	2006-07	1.000	1.698	1.000	1.000	1.698
11	2007-08	1.000	3.305	1.000	1.000	3.305
12	2008-09	1.000	0.389	1.000	1.000	0.389
13	2009-10	1.000	1.259	1.000	1.000	1.259
14	2010-11	1.000	0.532	1.000	1.000	0.532
15	2011-12	1.000	0.985	1.000	1.000	0.985
16	2012-13	1.000	1.368	1.000	1.000	1.368
17	2013-14	1.000	2.391	1.000	1.000	2.391
18	2014-15	1.000	0.201	1.000	1.000	0.201
	Mean	1.000	1.035	1.000	1.000	1.035

Technical change (TECHch), Efficiency change (EFFch), Pure efficiency change (PEch), Scale efficiency change (SEch)

Malmquist Productivity Indices of Sugarcane

It is revealed from the [Table-2] that on an average the performance of the crop over the years regressed. The mean TFPch index of the crop in the State was 5.2 percent over the years of study. The TFPch index was due to improvement in TECHch index. The highest performance could be seen in 2012-13 where TFPch was 127.6 percent solely influenced by TECHch. The TFPch index of the crop raised in most of the years like 1999-2000, 2001-02, 2002-03, 2003-04, 2006-07, 2010-11, 2011-12, 2012-13 and 2013-14. Variation in the technical efficiency change has been the main influencing factor for improvement or deterioration of total factor productivity. Efficiency change or the "catching up" did not affect the change in productivity of the crop over the years.

Table-2 Malmquist index summary of annual means of Sugarcane in Andhra Pradesh from 1997-98 to 2014-15

Year	EFFch	TECHch	PEch	SEch	TFPch
1997-98	1.000	0.950	1.000	1.000	0.950
1998-99	1.000	0.991	1.000	1.000	0.991
1999-00	1.000	1.068	1.000	1.000	1.068
2000-01	1.000	0.836	1.000	1.000	0.836
2001-02	1.000	1.373	1.000	1.000	1.373
2002-03	1.000	1.497	1.000	1.000	1.497
2003-04	1.000	1.411	1.000	1.000	1.411
2004-05	1.000	0.499	1.000	1.000	0.499
2005-06	1.000	0.823	1.000	1.000	0.823
2006-07	1.000	1.776	1.000	1.000	1.776
2007-08	1.000	0.978	1.000	1.000	0.978
2008-09	1.000	0.843	1.000	1.000	0.843
2009-10	1.000	0.785	1.000	1.000	0.785
2010-11	1.000	1.187	1.000	1.000	1.187
2011-12	1.000	1.013	1.000	1.000	1.013
2012-13	1.000	2.276	1.000	1.000	2.276
2013-14	1.000	1.581	1.000	1.000	1.581
2014-15	1.000	0.504	1.000	1.000	0.504
Mean	1.000	1.052	1.000	1.000	1.052

Conclusion

In the case of cotton, the mean TFPch was 3.5 percent. The entire improvement in the productivity was due to improvement in the TECHch or "innovation", whereas the EFFch did not show any effect on TFPch. In sugarcane, the highest performance could be seen in 2012-13 where TFPch was 127.6 percent solely influenced by TECHch. This implied that there was significant improvement in the "innovation" in this year.

Application of research: The area under Cotton and sugarcane has been found to be increasing and farmers are well acquainted with the adoption of new

techniques and use of modern inputs for the cultivation of these crops in the state of Andhra Pradesh.

Research Category: Agricultural Economics

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Cultivar / Variety / Breed name: Cotton and Sugarcane

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