Indian Journal of Agriculture Business
Volume 6 Number 1, January - June 2020
DOI: http://dx.doi.org/10.21088/ijab.2454.7964.6120.1

Orignal Article

Total Factor Productivity Growth in Pomegranate Crop of Maharashtra

DB Yadav[1], DJ Sanap[2], VG Pokharkar[3]

How to cite this article:
DB Yadav, DJ Sanap, VG Pokharkar. Total Factor Productivity Growth in Pomegranate Crop of Maharashtra. Indian Journal of Agriculture Business. 2020;6(1):9–14.

Author's Affiliation
[1]Head, [2]Junior Research Assistant,
[3]Agricultural Research Officer,
Department of Agricultural Economics,
Mahatma Phule Krishi Vidyapeeth,
Rahuri 413722, Ahmednagar, India.

Coressponding Author:
DB Yadav, Head, Department of Agricultural Economics, Mahatma Phule Krishi Vidyapeeth, Rahuri 413722, Ahmednagar, India.

E-mail: hodecon_mpkv@rediffmail.com

Abstract

Looking to the importance and scope of the pomegranate crop in Maharashtra this study has been undertaken to identify the growth in Total Factor Productivity of the Pomegranate crop in Maharashtra. An attempt has been made to study the Total Factor Productivity Growth in Pomegranate crop of Maharashtra. The data on area, production and productivity of pomegranate for Maharashtra and India was collected from the various published sources viz: Director of horticulture, Maharashtra state, Pune, Economic Survey of Maharashtra, National Horticulture Database (NHB) etc.

The information on expenditure on research, extension, salary, contingency etc. was availed from the office record of AICRP on Arid Fruits, Central Campus, MPKV Rahuri. The information on sale of University released Bhagwa variety were taken from the office record of Chief Seed office, MPKV, Rahuri, Seed Council Reports from 2000-2001.

The time series data on costs and returns of pomegranate crop for the year 2000-01 to 2016-17 were collected and compiled from the quick estimate reports of State cost of Cultivation Scheme, Department of Agril. Economics, MPKV, Rahuri. Maharashtra state ranks first in area and production of pomegranate in India contributing 65 to 70 percent of area and production of the country. The production of pomegranate was increased through both area expansion and productivity improvement for the entire period. There is a contribution of technology and input in TFP growth even though the input indices decreasing. Research investment (0.08), N to P ratio (0.66) and area under drip (0.99) have significantly contributed to TFP growth in pomegranate. The contribution of research and rainfall was significant in TFP growth for pomegranate in Maharashtra. Hence the Government should allocate substantial funds to public research in pomegranate for productivity improvement of pomegranate crop.

Keywords: Pomegranate, input index, Output Index, total factor productivity factor share, future prospects.

Introduction

India has diverse and varied agro-climatic conditions i.e. temperate to tropical, which are highly favorable and conducive to the production of horticultural crops. Horticultural crops form an essential part of the total agricultural produce.

Recently the pomegranate crop has obtained great economic significance in raising the income of even marginal farmers too. That also indicated its sustainability for small holdings for replacing subsistence farming as well as its significance

in alleviating poverty levels of rural areas. Now growers of study region are taking pomegranate crop as livelihood and a good source of earning. The net return from orchards up to ₹ 5 lakh ha-1 annum-1 have been demonstrated by some growers. Overall, this crop has contributed in increasing rural economy and provided a good earning source especially for unemployed rural youths. As well as it revolutionized agricultural economy to a large extent in drier tracts of the district.

This undoubtedly makes it necessary to go into the details of the economical aspects of pomegranate crop grown in the study area. The study of the economics of pomegranate is indispensable since there is no proper farm business data on its cost of production and marketing.

India produces about 50 percent World's production of pomegranate. The area under pomegranate in India was 2.33 lakh hectares and production was 28.44 lakh tonnes with productivity of 12.16 MT/ha during 2017–18. In India, Maharashtra is the leading pomegranate growing state. In Maharashtra, the area under pomegranate was 1.47 lakh ha and production was 17.89 lakh tonnes with productivity of 12.10 tonnes/ha, during 2017-18. (NHB Database, 2017–18). Maharashtra contributes 63 percent area and production of the country.

Looking to the importance and scope of the pomegranate crop in Maharashtra this study has been undertaken to identify the growth in Total Factor Productivity of the Pomegranate crop in Maharashtra.

Methodology

Collection of data

The data on area, production and productivity of pomegranate for Maharashtra and India was collected from the various published sources viz: Director of horticulture, Maharashtra state, Pune, Economic Survey of Maharashtra, National Horticulture Database (NHB) etc.

The information on expenditure on research, extension, salary, contingency etc. was availed from the office record of AICRP on Arid Fruits, Central Campus, MPKV Rahuri. The information on sale of University released Bhagwa variety were taken from the office record of Chief Seed office, MPKV, Rahuri, Seed Council Reports from 2000–2001.

The time series data on costs and returns of pomegranate crop for the year 2000–01 to 2016–17 were collected and compiled from the quick estimate reports of State cost of Cultivation Scheme, Department of Agril. Economics, MPKV, Rahuri.

Analytical tools

Compound growth rate

The compound growth rates were computed based on time series data on area, production and productivity of pomegranate for Maharashtra and India for study period viz., 2000–01 to 2016–17 using log-linear function.

Compound growth rate was estimated to study the percentage increase or decrease in the selected parameter. The following exponential growth function was used

$$Y = ab^t e$$

Where,

Y = Dependent variable for which growth was estimated

(i.e. area, production and productivity)

a = Intercept or constant

b = Regression/trend coefficient

t = Periods in years (1, 2, 3…n)

e = Error terms with zero mean and constant variance

Log linear production function

The TFP in influenced by research, extension, human capital, intensity of cultivation, application of plant nutrients, infrastructural development and climatic factors. As an input to public investment decisions, it is useful to understand the relative importance of these productivity-enhancing factors in determining productivity growth. In order to assess the determinants of TFP, the TFP index was regressed against the following variables.

$$Y = ax_1^{b1}X_2^{b2}x_3^{b3}x_4^{b4}x_5^{b5}x_6^{b6}e^u$$

Where,

Y = Total factor productivity index (TFP)

a = Constant term

x_1= Agricultural research investment (Rs./Ha)

x_2= Rural Literacy (%)

x_3= N to P ratio

x_4= Rainfall(mm)

x_5= Road density (km per 100 Sq.km)

X_6 = Area under drip (%)

T = Time variable (years 1, 2, 3….n)

u = Error term

(b_1 to b_6) are regression coefficients of respective variables).

Total Factor Productivity approach

Analysis of Total Factor Productivity (TFP)

Total factor productivity concept implies an index of total output per unit of total factor inputs. TFP growth measures the increase in output i.e. not accounted for by the increase in total inputs. Thus total factor productivity index that measure the growth in net output i.e. not accounted for by the growth in basic factor input such as land, labour, capital superior to partial approach as it is composite measure of productivity, which related of output all inputs, simultaneously.

TFP measures the extent of increase in the total output, which is not accounted for by increases in the total inputs. TFP is defined as the ratio of an index of aggregate output to an index of aggregate input. One of the most defensible methods of aggregation in productivity measurement is Divisia aggregation. Divisia indices have two important attractive properties: (i) they satisfy the time reversal and factor reversal tests for index numbers, and (ii) it is a discrete of the components, so that aggregate could be obtained by the aggregation of sub aggregates. For discrete data, the most commonly used approximation to the (continuous) Divisia index is the Tornqvist approximation. The Divisia Tornqvist or translog index of TFP is commonly used for computing the total output, total input and TFP indices by commodity/farm system/sector, etc. under different locations as outlined below.

For the productivity measurement over a long period of time, chaining indexes for successive time periods is preferable. With chain-linking, an index is calculated for two successive periods, t and t-1, over the whole period 0 to T (sample from time t=0 tot=T) and the separate indexes are then multiplied together.

The output index, input index and TFP index are constructed separately for pomegranate crop. To construct output index the time series data (2000–01 to 2015–16) on main product, by product and prices used, where as to construct input index, the time series data with regard to per hectare input use like seeds, manure, chemical fertilizer (NPK), human labour, bullock labour, machine labour, plant protection chemicals, irrigation and prices of inputs are used. Finally the TFP index is computed by dividing output index by input index. We have specified that the index is equal to 1.00 in a particular year i.e. here we considered 2001–02 as base year and TFP chain index constructed as it provides annual changes in productivity over a period of time.

The Chain base- linking index takes into account the changes in relative values/costs throughout the period of study. This procedure has the advantage that no single period plays a dominant role in determining the share weights and biases are likely to be reduced. The TFP indices computed using the software TFPIP version 1.0, which developed by Tim Coelli, Centre for Efficiency and Productivity Analysis, University of Queensland, Australia. Time series data on costs and returns of pomegranate crop for the years 2000–01 collected and compiled from the state cost of cultivation scheme, Department of Agricultural Economics, MPKV, Rahuri. All the data was calculated in real terms by deflating the time series data on investment using the consumer price index with 2001–02 as a base year.

TFP indices computed as follows:

Total output index:

$$(TOI) = TOI_t/TOI_{t-1}=\prod_j(Q_{jt}/Q_{jt-1})^{(Rjt+Rjt-1)1/2}$$

Total input index:

$$(TII) = TII_t/TII_{t-1}=\prod_j(Xjt/Xjt-1)^{(Sjt+Sjt-1)1/2}$$

Total factor productivity index (TFPI) of t^{th} year is 100 times the ratio of TOI, to the TII, and is given by,

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

Input price index is given by,

$$\frac{IPI_t}{IPI_{t-1}} = \prod_j \left[\frac{P_{it}}{P_{it-1}}\right]^{(S_{jt}+S_{jt-1})\frac{1}{2}}$$

Where,

R_{jt} = Share of jth output in total revenue

Q_{jt} = Output 'j'

S_{jt} = Share of ith input in total input cost

X_{it} = input 'i'

P_{it} = Price of ith in period t

By specifying TOI t-1, TIIt-1 and IPIt-1 equal to 100 in the initial year, the above equation provides the total output, total input, total factor productivity and input price indices for the specified period't'.

Results

Table 1: Area, production and productivity of pomegranate in major states and India.

[Area (In '000 Ha) Production (In '000 MT), Productivity (In T/Ha)].

Sr. No.	State	2015–16			2016–17			2017–18		
		Area	Production	Productivity	Area	Production	Productivity	Area	Production	Productivity
1.	Maharashtra	128.40	1480.10	11.53	140.72	1616.50	14.49	147.91	1789.46	12.10
		(65.18)	(64.18)	(98.47)	(65.13)	(61.86)	(120.05)	(63.22)	(62.91)	(99.51)
2.	Karnataka	13.20	138.50	10.49	26.58	378.14	14.23	25.97	268.23	10.33
		(6.70)	(6.01)	(89.63)	(12.30)	(14.47)	(117.90)	(11.10)	(9.43)	(84.95)
3.	Gujarat	18.54	278.10	15.00	23.18	350.82	15.14	30.51	461.75	15.13
		(9.41)	(12.06)	(128.14)	(10.73)	(13.43)	(125.43)	(13.04)	(16.23)	(124.42)
4.	Andhra Pradesh	5.60	56.40	10.07	7.95	119.9	14.99	9.47	139.02	14.69
		(2.84)	(2.45)	(86.04)	(3.68)	(4.59)	(124.19)	(4.05)	(4.89)	(120.81)
Total	India	197.00	2306.00	11.71	216.03	2612.82	12.07	233.93	2844.52	12.16
		(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

Source: NHB database, 2017–18.

Area, production and productivity of pomegranate in major states and India

The information on area, production and productivity of pomegranate during the year 2015–16 to 2017–18 in major producing states and India is presented in Table 1. It is revealed from the table that, Maharashtra state ranks first in area and production of pomegranate in India contributing 65 to 70 percent area and 64 to 70 percent production of the country. However, Maharashtra state ranks third in productivity of country. In general Gujarat ranks first in productivity in India. The four major pomegranate producing states of India viz., Maharashtra, Karnataka, Gujarat and Andhra Pradesh contributes more than 90 percent area and production of pomegranate of the country.

Compound Growth rates

The compound growth rates of area, production and productivity of pomegranate during the period 2000–01 to 2016–17 for India and Maharashtra have been estimated and presented in the Table 2.

The time series data on area(A), production(P) and productivity(Y) of Maharashtra and India were divided into two sub periods as period I(2000-01 to 2009–10), period II (2010–11 to 2016-17), and overall period (2000-01 to 2016-17).

It is revealed from the Table that the area, production and productivity of pomegranate have fluctuated widely during the period under study in Maharashtra and India. The growth rates of area and production of pomegranate for state was observed to be positive and highly significant at 1 percent level of significance for the entire period of 16 years. The area and production of pomegranate increased at the rate of 2.91 percent and 6.24 percent per annum respectively, during the entire period. However, the productivity of pomegranate has also increased by 2.35 percent per annum at 5 percent level of significance. It clearly indicates that the production of pomegranate was increased by both area expansion and productivity improvement for the entire period in the state.

The area, productivity and productivity of pomegranate has increased at higher rates during the period II as compared to period I. It may be due to the release of Bhagwa variety (2003–04) and Phule Bhagwa Super variety (2013–14) and introduction of Nation horticultural Mission (NHM) in the year 2005–06. The similar trend was observed at national level. The area and production of pomegranate was increased at the rate of 4.71 and 7.76 percent and highly significant at 1 percent level of significance for entire period in the country. The production of pomegranate has also increased at the rate of 2.91 percent per annum at 5 percent level of significance in the country. It indicates that the production of pomegranate has increased by both area expansion and productivity improvement in the country.

Table 2: Annual compound Growth rates of area, production and productivity of pomegranate in Maharashtra and India.

Period	Maharashtra			India		
	A	P	Y	A	P	Y
Period-I (2000–01 to 2009–10)	2.95***	2.99***	0.02	4.03***	5.07***	0.99*
Period-II (2010–11 to 2016–17)	11.35***	27.98***	14.99***	5.07***	27.16***	17.11***
Overall (2000–01 to 2016–17)	2.91***	6.24***	2.35**	4.71***	7.76***	2.91**

*, ** and *** indicate significance at 10,5 and 1 % level.

Table 3: Input, Output, TFP index and Share of input and TFP in output of pomegranate.

Year	Input index	Output index	TFP index	Input share	TFP Share	Total
2001-02	1.00	1.00	1.00	99.94	0.06	100.00
2002-03	0.88	1.20	1.36	73.26	26.74	100.00
2003-04	0.90	1.22	1.35	73.77	26.23	100.00
2004-05	0.98	0.99	1.00	98.99	1.01	100.00
2005-06	0.72	1.03	1.45	69.17	30.83	100.00
2006-07	0.91	1.23	1.35	74.31	25.69	100.00
2007-08	0.78	1.56	2.01	49.82	50.18	100.00
2008-09	0.95	1.38	1.45	68.94	31.06	100.00
2009-10	0.42	1.56	3.71	26.94	73.06	100.00
2010-11	0.69	0.97	1.40	71.23	28.77	100.00
2011-12	0.57	1.00	1.76	56.68	43.32	100.00
2012-13	0.86	1.65	1.92	52.04	47.96	100.00
2013-14	0.66	1.21	1.83	54.75	45.25	100.00
2014-15	0.74	1.76	2.37	42.24	57.76	100.00
2015-16	0.72	1.38	1.92	52.17	47.83	100.00
Mean	0.78	1.28	1.75	63.70	36.30	100.00
CGR (%)	-2.56	2.16	4.86			

Total factor productivity growth and its share in pomegranate

The output, input and TFP indices of pomegranate fruit crop are presented in Table 3.

From the Table 3 it is observed that the TFP for pomegranate increased from 1.36 in 2002–03 to 1.92 in 2015–16. The highest TFP index was observed in 2009–10 (3.71). The average TFP index for 15 years was 1.75.

The output index of pomegranate increased from 1.20 in 2002–03 to 1.38 in 2015–16. The output growth fell to increase in 2010–11 and reached the lowest (0.97). It was may be due to severe drought conditions and incidence of oily spot disease in Maharashtra. The highest output index was observed in 2014–15 (1.76). The average output index for fourteen years was 1.28. In the case of input index, there were heavy fluctuations, decreasing from 0.98 in 2004–05 to 0.42 in 2009–10. The average input index of pomegranate for fourteen years was 0.78. Total factor productivity measures the efficiency of all the inputs to a production process. Increase in TFP results usually from technological innovations or improvements. TFP is the output per unit of non-input. Pomegranate is a high value crop. Hence, farmers always give attention towards the input use. In Table 3, it is noted that TFP is increasing indicating that technology plays a significant role in pomegranate. TFP increasing at the rate of 4.86 percent per annum. Share of input calculated by dividing input index to output index.

When we subtract input share from m 100 it gives TFP share. The average share of input in output estimated to be 63.70 percent and TFP share in total output was 36.30 percent.

Sources of Total Factor Productivity (TFP) growth in pomegranate

The growth rate in TFP was analyzed to quantify the contributions of various factors to TFP growth such as research expenditure, rural literacy, rainfall, road density, N to P ratio, net irrigated area etc. (Table 4).

Table 4: Estimated parameters of TFP for pomegranate for the period 2000–01 to 2015–16.

Variables	Coefficients	Standard Error
Intercept (a)	0.43	13.13
Research Investment(x_1) (Rs./ha)	0.08**	0.03
Rural literacy (x_2) (%)	0.84	4.60
N to P ratio (x_3)	0.66***	0.20
Rainfall (x_4) (mm)	0.06	0.55
Road Density (x_5) (km per 100 sq. km)	1.05	1.90
Area under drip (x_6) (%)	0.99*	0.51
R^2	0.64	
F value	5.49**	
N (No. of observations)	15	

*, ** and *** indicate significance at 10,5 and 1% level.

The results indicate that research investment (0.08), N to P ratio (0.66) and area under drip (0.99) have significantly contributed to TFP growth in pomegranate. The ratio of nitrogen to phosphorous nutrient (0.66) was taken as proxy for the balance use of fertilizers. This coefficient was highly significant indicating that if farmers used correct N to P ratio, the output will be increased. Road density (1.05) was taken as a proxy for rural infrastructure. It is also non-significant but positive. The estimated R^2 value was 0.64 indicating that 64 percent of variation in TFP explained by the factors included in the model. The F value was significant at 5 percent level indicating good fit of the model.

Conclusions

1. Maharashtra state ranks first in area and production of pomegranate in India contributing 65 to 70 percent of area and production of the country.
2. The production of *pomegranate* was increased through both area expansion and productivity improvement for the entire period.
3. There is a contribution of technology and input in TFP growth even though the input indices decreasing.
4. The contribution of research and rainfall was significant in TFP growth for pomegranate in Maharashtra. Hence the Government should allocate substantial funds to public research in pomegranate for productivity improvement of pomegranate crop.

References

1. Anonymous, (2015–16) Report published by National Horticultural Board, Ministry of Agriculture, Government of India, New Delhi (ON941).
2. Boehlije MD, and Eidman VR. Farm Management: An overview of farm business analysis. American Journal of Agricultural Economics 1985;67(2):446–47.
3. Kumar K, Nandia BS, and Prakash TN. Economic impact of Aerobic rice technology in Karnataka. Indian Journal of Agricultural Economics 2011;47(3):451–57.
4. National Horticultural Board. (2017–18). Annual report. National Horticultural Board, Ministry of Agriculture, Government of India, New Delhi (ON941).
5. Patil AV, and Karale AR. Pomegranate. In TK Kose and SK Mitra (Eds.) Fruits: Tropical and Subtropical. Calcutta: Naya Prokash 1990;614–31.
6. Suresh K, and Chandrakant MG. Total factor productivity and returns to investments in Ragi (Finger millets) crop research in Karnataka state, India. Indian Journal of Economics and Development. 2015;3(3): 199–205.

****