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Total factor productivity growth of the crop sector in Kerala

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Abstract

Productivity growth in agriculture is both a necessary and sufficient condition for its development. Total factor productivity (TFP) is an important measure to evaluate the performance of any production system and sustainability of a growth process. There are several reports that total factor productivity growth is declining over the years in many parts of India even with the application of increased inorganic fertilisers. The cropping system is sustainable if it can maintain total factor productivity growth over time. The TFP growth rate showed stagnation in the crop sector (negative and very low TFP growth rate Annum^{-1}) in Kerala and a similar pattern was observed in all districts. A perspective of the TFP changes across the districts and state and the percentage share of total factor productivity in output growth of the crop sector in Kerala showed clear signs of unsustainability of the crop sector. The study revealed that all the districts (except Kollam, Idukki, Wayanad and Palakkad) and the state as a whole, the share of TFP in the output growth was negative during the time period 1980-81 to 2009-10. The period wise analysis also derived deceleration in the total factor productivity growth.

Keywords: Kerala, total output index, total input index, total factor productivity growth.

Productivity growth in agriculture is both a necessary and sufficient condition for its development. Total factor productivity is an important measure to evaluate the performance of any production system and sustainability of a growth process (Reddy, 2009). There are several reports that total factor productivity growth is declining over the years in many parts of India even with the application of increased inorganic fertilisers (Deshpande, 2000). The cropping system is sustainable if it can maintain total factor productivity growth over time. The studies by Kumar and Mruthyunjaya (1992), Kumar *et al*. (1998, 2004), Srinivas *et al*. (2007) and Reddy (2009) highlighted that the total factor productivity growth of important crops is decelerating in India. It is argued that if appropriate measures are not undertaken to address the problem of sustainability and natural resource degradation, the future growth of agriculture in such areas would be jeopardised (Chattopadhyay and Franke, 2006).

With this backdrop, the present study analysed the total factor productivity growth of the crop sector in Kerala, at the state level and district level, by measuring the total factor productivity indices. It also estimates the percentage share of total factor productivity in output growth of the crop sector in Kerala.

Materials and Methods

The study used secondary data and was collected from various publications of the Government of Kerala like Economic Review, Statistics for Planning, Cost of cultivation of important Crops, Season and Crop Reports and Agricultural Statistics.

Divisia-Tornqvist index has been widely used in the measurement of the total factor productivity index (McClellan, 2004) and is used in the present study for measuring the total factor productivity indices for the crop sector by districts and state. The total output,

total input and total factor productivity indices were computed for the three sub-periods (1980-81 to 1989-90, 1990-91 to 1999-2000 and 2000-01 to 2009-10) from 1980-81 to 2009-10.

In the study, seven crops (rice, coconut, arecanut, pepper, tapioca, ginger and banana) were included in the computation of total output, total input and total factor productivity indices at the state and district levels, where detailed cost of cultivation data is available. The farm harvest price and production of crops at district level (for the state as a whole the state level data) were used to compute the output index.

For constructing the total input index, eight inputs (human labour, animal labour, machine labour, farm yard manure, chemical fertilisers, irrigation, land and repair and maintenance) were included. Human labour input was measured as the total number of workers employed in agriculture, animal labour was measured as the number of adult bullocks and male buffalos, machine labour input as the number of four wheel tractors, farm yard manure input as the number of livestock, chemical fertiliser input was measured as the total NPK fertilisers, irrigation was measured as the area under irrigation, land was measured as gross cropped area and repair and maintenance charge as the number of pump sets. The data on these inputs were collected for individual districts and state. Cost share of each input was computed by dividing individual input cost by the total production cost for all the principal crops at the state level based on cost of cultivation data. These shares were used for the individual districts. Input cost share and input quantity data for each district were used for computing the input index. The total factor productivity index was computed by dividing the output index by the input index for each of the individual districts.

Total Factor Productivity measures the extent of increase in the total output, which is not accounted for by increases in the total inputs. Total Factor Productivity is defined as the ratio of an index of aggregate output to an index of aggregate input. 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). These under different heads are outlined below:

(i) Total Output Index (TOI)

$$TOI_t / TOI_{t-1} = \Pi_j (Q_{jt} / Q_{jt-1})^{½(R_{jt} + R_{jt-1})} = A_t \quad \text{..... (1)}$$

(ii) Total Input Index (TII)

$$TII_t / TII_{t-1} = \Pi_i (X_{it} / X_{it-1})^{½(S_{it} + S_{it-1})} = B_t \quad \text{..... (2)}$$

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 jth crop in year t,

Q_{jt-1} = Output of jth 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:

$$TOI\ (t) = A_1 A_2 \ldots\ldots A_t \quad \text{..... (3)}$$

$$TII\ (t) = B_1 B_2 \ldots\ldots B_t \quad \text{..... (4)}$$

Total Factor Productivity Index (TFP)

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

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

Total Factor Productivity Growth (TFPG) overtime has been widely accepted as an indicator of lack of sustainability of the production system. The farming system and the agrarian economy of any country or region are sustainable if it can maintain Total Factor Productivity Growth (TFPG) overtime (Kumar *et al*., 2008). In the study deceleration in TFPG has been taken as a proxy of unsustainability. The Total Factor Productivity Growth (TFPG) was classified into three categories, viz., (i) stagnant (less than zero% TFPG rate), (ii) less than one% TFPG rate and (iii) more than one% TFPG rate.

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-1)100

The F test has been applied to test the significance of b.

Results and Discussion

The total factor productivity growths in the crop sector in Kerala and in different districts are shown in Table 1. The TFP estimates indicates that Wayanad and Idukki districts show a growth rate of 4.702% and 2.325% respectively during the period 1980-81 to 1989-90. All other districts observed negative TFP growth rates.

As compared to that in 1980's during 2000-01 to 2009-10 almost all districts except Thiruvananthapuram, Kollam, Alappuzha and Palakkad observed negative and very low growth rates in the TFP growth rates in Kerala. All Kerala growth rates also presented the same picture during the different time periods. Table 1 clearly reveals deceleration in the growth of TFP in Kerala during the periods 1980-81 to 2009-10 (-0.116% Annum^{-1}). During the period Kollam, Idukki, Palakkad and Wayanad districts observed less than one% TFP growth in the crop sector in Kerala. All other districts and all Kerala level observed less than zero% total factor productivity growth Annum^{-1}. This clearly established deceleration and stagnation in the TFP growth in the crop sector in Kerala and this will adversely affect the profitability of the crop sector of the state.

Results of input, output and TFP growth over different time periods from 1980-81 to 2009-10 are presented in Table 2. Over the entire period of the study the crop sector output and input growth rate Annum^{-1} were positive and high in Kerala except in Alappuzha district. The TFP growth rate showed stagnation in the crop sector (negative and very low TFP growth rate Annum^{-1}) in Kerala and a similar pattern was observed in all districts.

Table 1. Total Factor Productivity Growth (TFPG) in the crop sector in Kerala (1980-81 to 2009-10) (% Annum^{-1})

Sl. No.	Districts	1980-81 to 1989-90	1990-91 to 1999-2000	2000-01 to 2009-10	1980-81 to 2009-10
1	Thiruvananthapuram	-3.398	0.740	1.832	-0.734
2	Kollam	-2.495	0.612	1.044	0.201
3	Pathanamthitta **	-0.957	-0.951	0.964	-0.567
4	Kottayam	-1.584	0.199 **ns**	-0.184	-0.895
5	Alappuzha	-2.141	-0.235 **ns**	1.138	-1.309
6	Ernakulam	-1.155	-0.666	0.912	-0.369
7	Idukki	2.325	0.105	-1.419	0.336
8	Trissur	-1.189	-0.360	0.854	-0.553
9	Palakkad	-1.683	-0.399	1.634	0.377
10	Malappuram	-0.917	0.397	0.727	-0.392
11	Kozhikkode	-2.461	-0.094 **ns**	-5.522	-1.159
12	Wayanad *	4.702	-1.353	-2.267	0.918
13	Kannur	-1.657	-2.084	-1.694	-0.387
14	Kasaragod **	-1.340	0.308	-0.489	-0.757
15	Kerala	-0.258	0.429	0.463	-0.116

* Period from 1981-82 onwards, ** Period from 1985-86 onwards, **ns** – Statistically non-significant TFPG.

Table 2. Average annual growth in Output, Input and TFP of the crop sector by Districts in Kerala

Districts	1980-81 to 1989-90			1990-91 to 1999-2000			2000-01 to 2009-10			1980-81 to 2009-10		
	Output (%)	Input (%)	TFP (%)	Output (%)	Input (%)	TFP (%)	Output (%)	Input (%)	TFP (%)	Output (%)	Input (%)	TFP (%)
TVM	-1.992	1.406	-3.398	1.586	0.846	0.740	1.458	-0.246	1.832	0.847	1.581	-0.734
KOL	-3.713	-1.218	-2.495	1.398	0.786	0.612	1.537	0.493	1.044	0.979	0.778	0.201
PTA**	2.234	3.191	-0.957	2.692	3.643	-0.951	2.198	1.229	0.964	3.096	3.663	-0.567
KOT	2.698	4.282	-1.584	3.718	3.519	0.19 ns	1.650	1.834	-0.184	3.175	4.070	-0.895
ALAP	-3.004	-0.863	-2.141	-1.352	-1.117	-0.24 ns	1.286	0.148	1.138	-1.742	-0.433	-1.309
ENK	1.824	2.979	-1.155	2.624	3.290	-0.666	1.710	0.798	0.912	2.596	2.965	-0.369
IDK	6.303	3.978	2.325	4.844	4.739	0.105	-0.615	0.804	-1.419	4.346	4.010	0.336
TSR	-0.02 ns	1.173	-1.189	1.128	1.488	-0.360	2.217	1.363	0.854	1.033	1.586	-0.553
PKD	-0.31 ns	1.369	-1.683	1.510	1.909	-0.399	5.027	3.393	1.634	2.608	2.231	0.377
MPM	1.274	2.191	-0.917	1.671	1.274	0.397	4.379	3.652	0.727	2.057	2.449	-0.392
KZD	-1.725	0.74 ns	-2.461	1.742	1.836	-0.09 ns	-3.028	2.494	-5.522	0.788	1.947	-1.159
WYD*	4.933	0.23 ns	4.702	5.672	7.025	-1.353	-2.383	-0.12 ns	-2.267	5.041	4.123	0.918
KNR	-3.235	-1.578	-1.657	-1.267	0.817	-2.084	1.783	3.477	-1.694	1.177	1.564	-0.387
KSD**	-0.868	0.472	-1.340	0.22 ns	-0.09 ns	0.308	0.622	1.111	-0.489	1.502	2.259	-0.757
Kerala	2.489	2.747	-0.258	2.916	2.487	0.429	1.481	1.018	0.463	2.779	2.895	-0.116

*Period from 1981-82 onwards, ** Period from 1985-86 onwards, ns - Statistically non-significant.

TVM - Thiruvananthapuram, KOL - Kollam, PTA - Pathanamthitta, KOT - Kottayam, ALAP - Alappuzha, ENK - Ernakulam, IDK - Idukki, TSR - Trissur, PKD - Palakkad, MPM - Malappuram, KZD - Kozhikkode, WYD - Wayanad, KNR - Kannur, KSD – Kasaragod.

Table 3. Percent share of Total Factor Productivity (TFP) in output growth of the crop sector by Districts in Kerala

Sl. No.	Districts	1980-81 to 1989-90	1990-91to 1999-00	2000-01 to 2009-10	1980-81 to 2009-10
1	Thiruvananthapuram	170.58	46.65	125.65	Neg
2	Kollam	67.19	43.78	67.92	20.53
3	Pathanamthitta **	Neg	Neg	44.09	Neg
4	Kottayam	Neg	Ns	Neg	Neg
5	Alappuzha	71.27	Ns	88.49	Neg
6	Ernakulam	Neg	Neg	53.33	Neg
7	Idukki	36.89	2.167	230.73	7.73
8	Trissur	Ns	Neg	38.52	Neg
9	Palakkad	Ns	Neg	32.50	14.46
10	Malappuram	Neg	23.75	16.60	Neg
11	Kozhikkode	142.66	Ns	182.36	Neg
12	Wayanad *	95.32	Neg	95.13	18.21
13	Kannur	51.22	164.48	Neg	Neg
14	Kasaragod **	154.38	Ns	Neg	Neg
15	Kerala	Neg	14.71	31.26	Neg

*Period from 1981-82 onwards, ** Period from 1985-86 onwards. Neg – Negative, Ns – Statistically non-significant

Table 4. Distribution of Districts according to Total Factor Productivity Growth (TFPG) in Kerala in Different Periods

Period	TFPG Category		
	Stagnation (< 0%)	< 1%	> 1%
1980-81 to 1989-90	Thiruvananthapuram, Kollam, Palakkad, Pathanamthitta, Kottayam, Trissur, Alappuzha, Ernakulam, Malappuram, Kannur, Kozhikkode, Kasaragod (12)	(0)	Idukki,Wayanad (2)
1990-91 to 1999-2000	Pathanamthitta, Alappuzha, Kannur, Ernakulam, Trissur, Palakkad, Wayanad, Kozhikkode (8)	Thiruvananthapuram, Kollam, Kottayam, Malappuram, Idukki, Kasaragod (6)	(0)
2000-01 to 2009-10	Kottayam, Idukki, Kozhikkode, Kannur, Wayanad, Kasaragod (6)	Pathanamthitta, Ernakulam, Trissur, Malappuram (4)	Thiruvananthapuram, Kollam, Alappuzha, Palakkad (4)
1980-81 to 2009-10	Thiruvananthapuram, Pathanamthitta, Kottayam, Alappuzha, Ernakulam, Trissur, Malappuram, Kannur, Kozhikkode, Kasaragod (10)	Kollam, Palakkad, Idukki, Wayanad (4)	(0)

Figures in bracket show number of Districts

A perspective of the TFP changes across the districts and state (Table 1) and the percent share of total factor productivity in output growth (Table 3) of the crop sector in Kerala showed clear signs of unsustainability of the crop sector. Table 3 shows that all the districts (except Kollam, Idukki, Wayanad and Palakkad) and the state as a whole the share of TFP in the output growth was negative during the time period 1980-81 to 2009-10.

In Kollam, Idukki, Palakkad and Wayanad districts also the% share of TFP to output growth was very poor during the time period. Table 4 reveal that only two districts Idukki and Wayanad observed more than one% growth in TFP during 1980-81 to 1989-90 time periods. All other 12 districts have less than zero% TFP growth in Kerala. In 2000-01 to 2009-10 periods more than 71% of the districts exhibited less than one% and zero% TFP growth in Kerala. Table 4, thus clearly indicates negative and low growth rates of TFP during the periods under study; showing stagnation in the crop sector has been a major cause of concern and is a threat to the sustainability of the agrarian economy of Kerala.

Conclusion

The performance of the crop sector in Kerala, at the state level and district level measured in terms of total factor productivity growth indicated that except Wayanad, Idukki, Palakkad and Kollam, all other districts and the state as a whole registered negative growth rates during the period 1980-81 to 2009-10. The period wise analysis also derived deceleration in the total factor productivity growth. The percentage share of total factor productivity in output growth of the crop sector is also negative in almost all districts and state.

Total factor productivity index in the state showed negative growth rate due to relatively high growth of input use compared to that of output index. This calls for better resource management strategy in the state. All the efforts in the state in the future have to be concentrated on accelerating the pace of total factor productivity growth and at the same time sufficient caution has to be exercised to conserve natural resources and promoting institutional infrastructure. It provides both physical inputs as well as induces technical change. More public investment in irrigation, infrastructure development (road, electricity, etc), research and extension, efficient use of water, micro, macro and plant nutrients, etc, are essential in the state for accelerating TFP growth.

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