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Review Article

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Advances in Agricultural, Biological and Applied Science for Sustainable Future (ABAS-2018)

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ABSTRACT

The sustainability issue of the crop production and productivity is fast emerging. The post-Green Revolution era is characterized by high input-use technology and decelerating total factor productivity growth (TFPG). The agricultural productivity attained during the 1980s has not been sustained during the 1990s and the millennium this has posed a challenge for the researchers and the government to shift the production function upward by improving the technology index. It requires for an examination of issues related to the trends in the agricultural productivity, particularly with reference to major food grain crops grown in the major states of India. Temporal and spatial variations of TFPG for major crops of India have also been examined.

Key words: *Major food grains, Total factor productivity, Sustainability,*

INTRODUCTION

India has made impressive marks on the agricultural front during the past four decades. Much of the credit for this success ultimately goes to the several million small farming families that form the backbone of Indian agriculture and Indian economy for continuing so many years. Policy support system, production strategies, public investment in infrastructure, research & development and extension for crop, livestock and fisheries have significantly helped in increasing the agricultural production & productivity, food production and its availability. Now withstanding these achievements, producing additional food with limited land, resources and providing economic access & food at the household level for ensuring food security would continue to be a major challenge for the nation. India has experienced exceptional changes in the crop mix, yield and production since the inception of the Green Revolution. The Green Revolution phase displayed a high yield growth per unit of input. The first post-Green Revolution phase (from late-1960s to mid-1980s) was marked by the continued growth in returns from land through the intensification in use of chemical inputs and machine labour. The second post-Green Revolution phase (beginning the mid-1980s) was characterized by high input-use and decelerating productivity growth.

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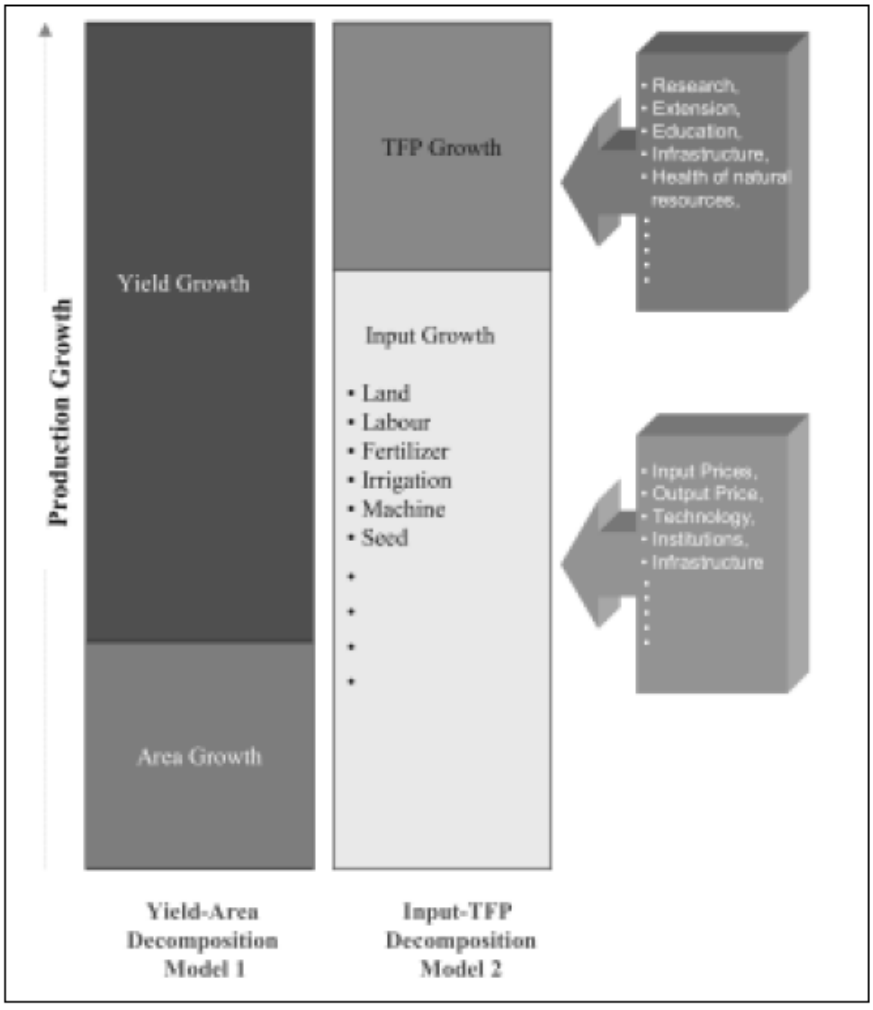
The third decade beginning with the millennium calls for an examination of the issues related to the trends in agricultural productivity, particularly with reference to major food crops in recent years. In the present paper, the temporal and spatial variations and the productivity status of major food grain crops in India have been analyzed using the Total factor productivity growth (TFPG) estimates. Some policy implications have also been suggested for sustaining TFP of the crops.

The Decomposition Approach

Decomposition of growth in agricultural output in India has always attracted the interest of researchers and policymakers from a very long. Various attempts have been made to explain the growth in agricultural output in terms of area and yield components, beginning with the first systematic study of Minhas and Vaidyanathan[27]. Later, work on the decomposition of growth in agricultural output became more refined and invoked the total productivity concept.



Contributions of Evenson and Jha[13], followed by Dey and Evenson[8], Sindhu and Byerlee[35], Kumar and Mruthyunjaya[19], Rosegrant and Evenson[32], Dholakia and Dholakia[9], Kumar and Rosegrant[21], Evenson *et al.*[14], Fan *et al.*[9], Ali and Byerlee[2], Coelli and Rao[7], Rozelle *et al.*[34], and few others have been the important parts of this genre. A comparison of the yield-area decomposition model and productivity growth accounting model has been depicted in figure 1.

The sources of productivity growth of agriculture can be spilt into two major components:

(a)The efficiency gains ,i.e. the growth in the factor of production, indicating the movement along the best practice production frontier, and

(b)The technological gains, i.e. shifting of the production frontier outward (inward) in case of technological progress (regress)

Based upon Farell's original idea on technical efficiency, later studies are extended to focus on the methods of estimation of production functions. The level between actual production level of a firm and the frontier measures its technical efficiency. The frontier can be fixed or stochastic and the estimation methodology can take a parametric or non-parametric approach. Thus, both parametric and non-parametric approaches differ in the assumptions they make regarding the shape of the efficient frontier and the existence of the random error.

Review of Studies

A number of studies on the measurement of productivity have been carried out for India (Table1). These studies can be classified into two groups: (i) agriculture sector, and (ii) crop specific analysis. Indian agriculture has made substantial gains in productivity with the introduction of highyielding varieties, as measured by index of TFP[32,9,14,15]. These studies have shown that the TFP growth in agriculture has been the prime driving force behind the acceleration of overall growth in the Indian economy achieved during the 1980s.

The Data

The total input index was constructed by, ten inputs (human labour, bullock labour, machine labour, farm yard manure (FYM), nitrogen, phosphorus, and potassium fertilizers, irrigation, plant protection and land) were included. Cost share of each input was computed by dividing the individual input-cost by the total production-cost for all principal crops at the state level, based on the cost of cultivation data collected under the "Comprehensive Scheme for the Study of Cost of Cultivation of Principal Crops,"(CACP) of the Directorate of Economics and Statistics (DES), Ministry of Agriculture, Government of India (GoI). These data were used for computing the TFP for major food grain crops of the state. The data on quantity and price of important inputs and crop output were compiled for the available years, covering the period 2000-2017.

Productivity Trends for Major food grain crops Examining the TFP growth of major food crops grown in different states of India, given in Table 1, one could see a strong perception that (a) technological gains have not occurred in a number of crops, notably in paddy and wheat (b) crops and areas, where these gains occurred during early years of Green Revolution, have an increasing trend. To validate these observations, we had undertaken the analysis with more disaggregated perspective on changes in output, input and TFP for major crops across states of India. The results presented for 2000-17 reveal that all crops have benefited from the technological change in some parts of the country, but there are some exceptions in pulses, coarse cereals and oilseeds where only a few states has performed well.

Several states have recorded positive TFP growth. Paddy and wheat, the major staple food crops, have performed well in productivity gains. TFP growth of pulse in the southern India is performing well whereas in the same region the coarse cereals are trending a negative way.

The Sustainability Issues

At the farmers' level, sustainability concerns are being expressed that the input levels have to be continuously increased in order to maintain the yield at the old level. This poses a threat to the economic viability and sustainability of crop production. A sustainable farming system is a system in which natural resources are managed in such a way that potential yield and the stock of natural resources does not decline over the time. However, each of the components of sustainable agriculture is a little complex and some quantifiable measures are required to check whether a farming system is sustainable or not. Due to the multidimensional nature of the concept of sustainability and the difficulties in determining specific threshold values for these dimensions it may be even too ambitious to seek the absolute level of sustainability. We should probably be satisfied

with the relative ranking. Lynam and Herdt[26], had proposed a non-positive trend in TFP as an indicator of lack of sustainability of the production system. This has been widely accepted and used as an indicator of non sustainability of production[12,4,22]. The farming system is sustainable if it can maintain the TFP growth over time.

Table 1. Annual growth rate in input, output, TFP of food grain crops grown in different regions of India: 2000-2017

Crop	Region	Period	Input	Output	TFP	Share of TFP in output
Paddy (Rice)	East	2000-17	2.83	2.89	1.28	52.80
	West	2000-17	2.74	4.70	1.95	49.70
	North	2000-17	3.82	3.68	0.11	59.62
	South	2000-17	2.68	3.59	1.16	62.87
	India	2000-17	2.42	3.88	1.88	54.43
Wheat	East	2000-17	3.68	2.94	2.72	36.80
	West	2000-17	4.28	5.22	2.88	57.62
	North	2000-17	3.22	4.93	2.96	41.02
	India	2000-17	3.91	4.63	2.74	52.36
Coarse Cereals	West	2000-17	1.41	1.95	1.45	57.34
	North	2000-17	1.88	1.02	1.76	75.65
	South	2000-17	-1.29	-4.55	-1.82	57.87
	India	2000-17	1.02	1.32	1.68	54.58
Pulses	East	2000-17	-20.91	-24.14	4.22	42.81
	West	2000-17	4.31	4.31	-1.12	Negative
	North	2000-17	-4.02	-4.02	1.36	37.46
	South	2000-17	4.47	4.47	1.52	30.83
	India	2000-17	2.65	2.25	1.45	45.63
Oilseed	East	2000-17	-4.56	-5.62	2.63	20.86
	West	2000-17	3.66	3.78	3.93	36.56
	North	2000-17	3.56	2.45	2.65	27.89
	South	2000-17	2.82	2.11	2.98	23.15
	India	2000-17	1.97	2.01	1.25	36.54

*East: Includes states of Bihar, Orissa, Assam and West Bengal of India
West: Includes states of Rajasthan, Madhya Pradesh, Maharashtra and Gujarat
North: Includes states of Punjab, Haryana, Uttar Pradesh and Himachal Pradesh
South: Includes states of Andhra Pradesh, Tamil Nadu, Karnataka and Kerala

Table2. Distribution of crop area according to TFP growth in India: 2000-17

(per cent share of crop area)

Crop	Period	Stagnation less than 0%	Less than 1% annual TFP growth	More than 1% annual TFP growth
Paddy (Rice)	2000-17	25	42.8	32.2
Wheat	2000-17	12.8	64.7	22.5
Coarse cereals	2000-17	72.4	24.2	3.4
Pulses	2000-17	65.8	32.6	2.8
Oilseed	2000-17	42.8	28.6	28.6

As can be seen in Table 2, the area under rice with more than 1 per cent TFP growth is 48 per cent. However, as per previous reports the area under stagnant TFP for paddy declined from 31 per cent in 1971-86 to 15 per cent in 1987-2000. Even for wheat, the stagnated TFP area declined from 10 per cent in 1971-86 to 3 per cent in 1987-2000but for the current session it has been estimated to be about 12.8. The coarse cereals in the past experienced more than one per cent TFP growth on 71 per cent of the total crop area during the 1980s,

which increased rapidly to 72.4 percent. About 60 per cent of the area under coarse cereals is facing stagnated TFP. Similarly, the productivity gains which occurred for pulses and s during the early years of Green Revolution, have now exhausted their potential. About 70 per cent area under pulse sand 90 per cent area remain stag fled. The sign of improvement in productivity gains has been observed for oilseeds, in the recent years. Thus, there is strong evidence that technological change has generally pervaded the entire crop sector. The crops and states where technological stagnation or decline is apparent need to be focused on research, extension and natural resource management strategies[15,24].

CONCLUSIONS AND POLICY IMPLICATIONS

The sustainability issue of the crop productivity is fast emerging. The productivity attained during the 1980s has not been sustained during the 1990s and has posed a challenge before the researchers to shift the production function by improving the technology index. It has to be done by appropriate technology interventions, judicious use of natural resources and harnessing biodiversity. During the Green Revolution era, large investments were made on research and development for the irrigated agriculture. The promotion of HYV seed - fertilizer - irrigation technology had a high pay-off and rapid strides of progress were made in food production. However, in recent years, agriculture has been experiencing diminishing returns to input-use and a significant proportion of the gross cropped area has been facing stagnation or negative growth in TFP. The studies suggest that investment in public sector research is an important determinant for total factor productivity. Thus India will be benefited from its investments on research and development. This calls for increasing research and extension programs but such a development should be supported by careful review of existing projects and programs.

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