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Trends in India`s Agricultural Growth: Challenges and Prospects

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Abstract*— This study examines the current trend in agricultural growth and development in India. Although agriculture and allied activities provide a livelihood for more than 50 percent of the population in India, it continues to experience agrarian challenges. This paper attempts to study the prevailing challenges and prospects for Indian agriculture. Secondary data on area, farm production, productivity, and input use data for selected crops is used for the trend analysis. The secondary data are collected from various reports such as Agricultural Statistics at a Glance, Economic Survey of India, Planning Commission, Directorate of Economics & Statistics, and various websites. The study's time frame is from the start of the early economic reforms 1990-91 to 2021-22. This study reveals that there was a shift in the cropping pattern over time. A shift towards fruits, vegetables, and commercial crops like cotton and sugarcane was observed. We observed that, there was more diversification in TE 2020-21 as compared to the initial period. the decomposition analysis reveals that the yield growth was responsible for a change in the production of all the selected crops except sugarcane.

Index Terms: Agricultural Growth; Decomposition Analysis; Diversification; Crops.

I. INTRODUCTION

Agriculture is considered as the backbone of the Indian economy. It provides food to the nation, and by providing raw materials to the industry it supports various industrial sectors. The agriculture sector in India is considered very significant for two main reasons. First, even though our nation has attained self-sufficiency in food production at a larger level, but it is still regarded as a food-deficient country with a high rate of malnourished children. Which put pressure on agriculture to produce more. Second, most of the rural workers depend on agriculture for their livelihood [1]. According to the Registrar General of India, India has a total working population of 481.9 million people and out of that 54.6% of the population is engaged in agricultural activities where 118.8 million are cultivators and 144.3 million are agricultural labourers. Agriculture in India is heavily dependent on rainfall, out of 211.36 million hectares of the total cropped area, only 35.70% area is irrigated. Land fragmentation, changing climate, declining soil fertility and inefficiencies in technological use are some of the challenges before Indian agriculture.

An attempt is made in the present study to examine India's agricultural growth for the period of 1990-91 to 2020-21. The specific objectives of this study are given below

1. To examine the growth of agriculture area, production, and productivity of principal crops in India.
2. Decomposition of agricultural production growth into its component factors.
3. To analyze the degree of crop diversification and changing crop patterns in India's agriculture.

II. DATA & METHODOLOGY:

The study uses secondary data on area, production, yield, irrigated area, and land use data. The present study is conducted for India and the time frame is from 1990-91 to 2021-22. This study used time-series data collected from the Agricultural Statistics at a glance, Ministry of Agriculture, Directorate of Economics & Statistics, and The Economic Survey of India. The study covers all the major crops grown in India, such as Rice, Wheat, Total Foodgrains, Total Pulses, Cotton, Sugarcane, etc. The study period has been divided into three sub-periods to analyze the impact of economic reforms and various structural adjustment programs. The sub-periods are Period I: the early economic reform period from 1990-91 to 1999-00; Period II: 2000-01 to 2009-10; Period III: 2010-11 to 2020-21 and the overall period from 1990-91 to 2020-21.

A. Compound growth rate estimation:

The agricultural development of a nation can be assessed by measuring the growth rate in its area, production, and productivity. In this study, compound growth rates of area, production, and crop yield were estimated using the semi-log formula to analyze the trends in the growth of crops for three sub-periods. The CGR was estimated by fitting the following formula:

$$\ln Y = a + bt \quad (1)$$

Where, Y is the time series data of area, production, and yield of principal crops grown in India i.e. rice, wheat, total foodgrains, total pulses, cotton, and sugarcane for the year t. a is the constant term and b is the growth coefficient. We calculated the compound growth rate using the following

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formula:

$$(\mathrm{CGR}) = \mathrm{Antilog(b)} - 1 * 100 \quad (2)$$

The significance of 'b' was examined by applying the student's 't' test.

B. Decomposition of output growth into component analysis:

Minhas (1964) decomposition analysis model was used to measure the relative contribution of area and crop yield to the total output change for the principal crops. Many researchers used this model to examine the growth performance of crops on national and state level [2], [3], [4], [13].

$$\Delta P = A \circ \Delta Y + Y \circ \Delta A + \Delta A\, \Delta Y \quad (3)$$

Change in Production = Yield effect + Area effect + Interaction effect

Where,

$A \circ$ = Area in the base year

ΔA = Area in the current year minus area in the base year

$Y \circ$ = Yield in the base year

ΔY = Yield in the current year minus yield in the base year

ΔP = Production in the current year minus production in the base year

Thus, the three effects- yield, area, and interaction- account for the change in production, which can be attributed to area and yield.

C. Changes in Cropping Pattern and Crop Diversification:

Crop diversification has been beneficial for farmers to adapt to climate variability and reduce income uncertainty [3], improve soil health, increase crop productivity and income [5], [6]. On the other hand, some studies show that specialization in a single crop has a greater effect on aggregate land productivity due to the advantages of economies of scale [7], [8], [12]. Various methods have been used by researchers to study the diversification and specialization of crops over time and space. This study uses the Herfindahl Index and the Simpson Index (Gibbs-Martin) analysis.

Herfindahl Index of crop diversification is calculated as follows:

$$HI = \sum_{i=1}^{n} P_i^2 \quad (4)$$

Where, N is the total number of crops and Pi is the proportion of $i^{th\ crop}$ in the gross cropped area. The Herfindahl Index would tend to decrease with the increase in diversification. Simpson Index also known as the Gibbs-Martin Index of crop diversification is estimated using the following formula:

$$GMI = 1 - \sum_{i=1}^{n} P_i^2 \quad (5)$$

Where the Simpson Index ranged between 0 and 1. When there is complete specialization it takes a value 0 and approaches 1 when there is a high crop diversification.

III. RESULTS AND DISCUSSION

A. Growth Rates of Area, Production and Yield of Principal Crops:

The growth rates of the area, production and yield for the principal crops were calculated over time using semi-log area. The results of CGR of the area are given in Table I. In period I (1990-91 to 1999-00), which is the early liberalization period, except Total Foodgrains and Total Pulses all the other crops recorded a growth in the area under crop. In period II (1999-00 to 2009-10) the growth rate of rice, wheat, cotton and sugarcane recorded a decline in area. In period III (2010-11 to 2019-20 the area under sugarcane has recorded a negative growth rate, area under cotton has also declined as compared to period II. For overall period, crops like cotton, sugarcane, pulses and wheat have recorded a significant growth rate in the area. The growth in area of pulses, rice and wheat was due to the various government programs like National Pulses Development Project, National Food Security Mission-Pulses (2007-08). Table II represents the growth rates of production of principal crops. It gives an idea of the rate of development in agriculture. For overall period the production of wheat, total pulses and cotton has grown at a significant rate. The rate of growth in rice, wheat, cotton and total foodgrains was significant in period I. In second period the growth rate of rice declined to 1.58 percent. Whereas, total pulses and cotton production increased in second period. The rate of growth of production was negative in third period for cotton, and lower for sugarcane except these two crops other crops were grown at a higher rate. the shift towards cash crops as a result of favorable trade conditions of trade and pricing after the reform period however these factors turned unfavorable, which had negative impact on the production growth [9]. Table III presents the growth rate of yield for principal crops produced in India. For cash crops like cotton and sugarcane the growth rates of yield was higher in second period than period I and III. For overall period the growth in yield of cotton, rice and total foodgrain was significant.

Table I: Compound growth rates of Area for principal crops in India (percent)

Crop	Period I	Period II	Period III	Overall Period
Rice	0.67**	-0.02	0.17	0.08
Wheat	1.71**	1.19**	0.29	0.87**
Total Foodgrains	-0.07	0.28	0.23	0.07
Total Pulses	-0.6	1.15*	2.19*	0.75**
Cotton	2.71**	2.03*	1.08	1.95**
Sugarcane	1.66*	0.73	-0.69	1.07**

*Note: ** and * indicate significance at the 1 percent and 5 percent levels, respectively*

Source: Compiled from Agricultural Statistics at a Glance 2022 Calculated by Author

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Table II: Compound growth rates of Production for principal crops in India

Crop	Period I	Period II	Period III	Overall Period
Rice	2.02**	1.58	1.86**	1.54**
Wheat	3.56**	1.89**	1.85**	2.11**
Foodgrain	2.08**	1.89*	1.87**	1.78**
Total Pulses	0.65	2.70*	3.71**	2.01**
Cotton	2.29	13.66**	-0.86	5.38**
Sugarcane	2.73**	1.20*	0.97	1.51**

*Note: ** and * indicate significance at the 1 percent and 5 percent levels, respectively*

Source: Compiled from Agricultural Statistics at a Glance 2022 Calculated by Author

Table III: Compound growth rates of crop yield for principal crops in India

Crop	Period I	Period II	Period III	Overall Period
Rice	1.33**	1.60*	1.69**	1.46**
Wheat	1.82**	0.69	1.55	1.22**
Total Foodgrains	2.16**	1.60*	1.63**	1.70**
Total Pulses	1.25	1.54*	1.52	1.24**
Cotton	-0.4	11.34**	-1.93	3.36**
Sugarcane	1.04**	13.91	1.68**	0.89

*Note: ** and * indicate significance at the 1 percent and 5 percent levels, respectively*

Source: Compiled from Agricultural Statistics at a Glance 2022 Calculated by Author

B. Decomposition of output growth of principal crops:

The general pattern of growth and direction of change in area, production and yield were examined by analyzing the growth of principal crops in the above section. However, it is important to study the drivers of production growth. Therefore, we breakdown the output growth into three component effects Area effect, yield effect and interaction effect. Table IV. presents the decomposition analysis employed for four periods. Period I is considered an early economic reform period from 1990-91 to 1999-00, Period II is from 2000-01-09-10 period III is from 2010-11 to 2019-20 and period IV is an overall period from 1990-91 to 2019-20. The decomposition analysis shows that the growth in production of total foodgrains, rice, wheat, total pulses and cotton was mainly due to yield effect. About 38.89 to 96.47 per cent growth in output was due to yield effect. For sugarcane area effect was a major force for output growth which was 46.10 percent. There was a minimal impact of area and yield factors on the change in production, hence the interaction effects were also low. During the early economic reform period i.e. period I, a decline in output was observed in total pulses mainly due to yield. About -299.58 percent growth in total pulses was due to the yield effect which even offset the positive area effect. For crops like total foodgrains, rice and wheat the major force of output growth was the yield effect. Whereas the growth in output of cotton and sugarcane was due to area effect which was 99.38 and 59.41 percent respectively. In period II, the main driver of output growth of total foodgrains (97.74%), rice (243.63%), total pulses (48.92%) and cotton (73.60%) was due to yield effect. While the area effect was the major factor of output growth of wheat (66.48%). A decrease in output of sugarcane was observed mainly due to yield effect (-74456.2%). However, the impact of the interaction effect was minimal for all the selected crops in period II. During period III, the yield effect was the main source of the increase in production of total foodgrains (98.69%), rice (90.45%), wheat (62.60%), total pulses (72.49%), sugarcane (180.76%). For cotton crop the increase in production was due to the area effect (214.29). Hence, the decomposition analysis reveals that the yield growth was responsible for a change in the production of all the selected crops except sugarcane.

Table IV: Decomposition of Output Growth of Principal Crops (%)

Crop	Effect	Period I	Period II	Period III	Overall Period
Foodgrain	Area	-19.5753	2.137277	1.165144	2.012916
	Yield	123.1897	97.7407	98.6952	96.47064
	Interaction	-4.56758	0.226083	0.249329	1.479055
Rice	Area	27.92946	-129.025	7.826593	10.70263
	Yield	65.19441	243.6356	90.45404	83.29355
	Interaction	3.772082	-15.2034	1.688363	6.009466
Wheat	Area	35.67617	66.48539	32.60227	29.16094
	Yield	43.72428	30.3128	62.60589	55.05101
	Interaction	6.005984	3.216243	4.931802	15.8525
Total Pulses	Area	243.6971	44.56151	22.93414	21.27187
	Yield	-299.58	48.92787	72.74199	67.62574
	Interaction	43.00538	7.044651	4.381052	11.29838
Cotton	Area	99.3892	12.31516	214.2186	30.44902

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Crop	Effect	Period I	Period II	Period III	Overall Period
	Yield	23.28994	73.6029	-94.7824	38.89702
	Interaction	3.975568	13.80594	-18.889	30.58435
Sugarcane	Area	59.41712	280.7757	-69.8604	46.10723
	Yield	30.77517	-74456.2	180.7651	40.75414
	Interaction	4.420281	2585.283	-10.3718	12.8116

Source: Computed by Authors

C. Crop Diversification:

Crop diversification is an effective approach to improve the income of farmers it influences the economic growth of the rural agriculture sector [3], [10], [11]. Therefore, it is important to study crop diversification and specialization. Table V. Represents cropping pattern, we observed that in TE 1993-94, the area under total foodgrains was 67.34% which declined to 60.70% in TE 2020-21. Percentage area of rice was increased from 22.96 in TE 1993-94 to 23.90 in TE 2003-04 thereafter it declined in 2020-21 it was 21.25%. area under wheat was continuously increased from 13.01% in TE 1993-94 to 15.12% in TE 2013-14 however in TE 2020-21 it declined to 14.60%. area under total pulses increased from 13.01% 14.60% however in TE 2003-04 it decreased to 11.49%. The area under coarse cereals, nine oilseeds and jute decreased by 7.63%, 0.75% and 0.23%, respectively. However, the area under fruits, vegetables, cotton and sugarcane increased by 1.8%, 2.18%, 2.17% and 0321%, respectively. A shift towards fruits, vegetables, and commercial crops like cotton and sugarcane illustrates change in cropping pattern, as supported by the following diversification indices.

Table V: Cropping pattern

CROP	TE 1993-94		TE 2003-04		TE 2013-14		TE 2020-21	
	Area	%	Area	%	Area	%	Area	%
Total Foodgrains	124.29	67.34	119.23	65.36	124.07	63.28	127.19	60.70
Rice	42.37	22.96	43.60	23.90	43.21	22.04	44.53	21.25
Wheat	24.01	13.01	25.76	14.12	29.64	15.12	30.60	14.60
Total Pulses	23.19	12.56	20.95	11.49	24.64	12.57	28.64	13.67
Coarse Cereals	34.72	18.81	28.92	15.86	26.51	13.52	23.42	11.18
Nine Oilseeds	25.09	13.60	22.30	12.22	26.66	13.60	26.92	12.85
Fruits	2.74	1.48	4.01	2.20	6.69	3.41	6.88	3.28
Vegetables	5.14	2.79	6.17	3.38	8.90	4.54	10.41	4.97
Cotton	7.55	4.09	8.44	4.63	11.80	6.02	13.13	6.26
Sugarcane	3.70	2.00	4.42	2.42	4.97	2.54	4.84	2.31
Jute	1.02	0.55	1.04	0.57	0.88	0.45	0.68	0.32
GCA	184.56	100.00	182.41	100.00	196.05	100.00	209.55	100.00

Source: Authors Calculation

It was observed from Table VI that there was more diversification in TE 2020-21 as compared to initial period. The Herfindahl index declined from 0.59 to 0.49, showing a continuous increase in diversification over the period. However, the extent of diversification was small. An increase in the Gibbs-martin index from 0.40 in TE 1993-94 to 0.50 in TE 2020- 21 also supports the increase in diversification. Herfindahl index declined by -17.67% between 1993-94 and 2020-21 while the Gibbs-Martin index increased by 26.05%.

Table VI: Crop Diversification Indices

Indices	TE 1993-94	TE 2003-04	TE 2013-14	TE 2020-21	% change in 2020-21 over 1993-94
Herfindahl Index	0.59588852	0.561950547	0.532009	0.490593006	-17.67
Gibbs-Martin Index	0.40411148	0.438049453	0.467991	0.509406994	26.05

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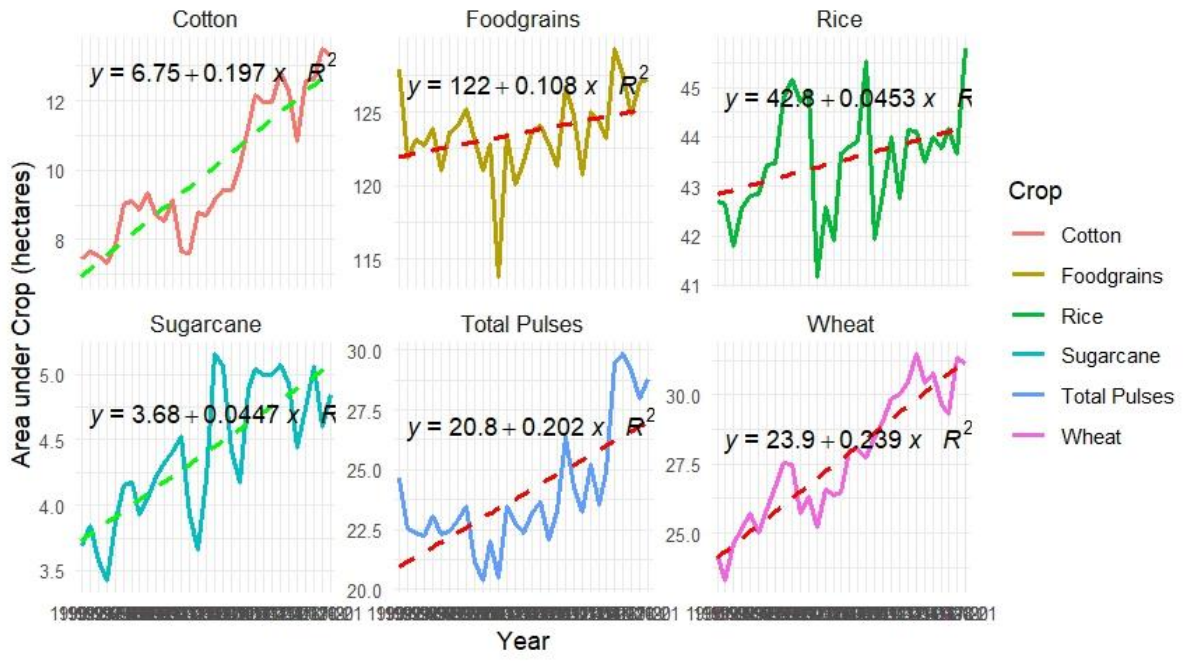

Fig. 1. Changes in cropping pattern over 31 years

IV. CHALLENGES AND PROSPECTS

The growth rate of crop productivity was very low over the last three decades. Agriculture in India is heavily dependent on rainfall, out of 211.36 million hectares of the total cropped area, only 35.70% area is irrigated. Land fragmentation, changing climate, declining soil fertility and inefficiencies in technological use are some of the challenges before Indian agriculture. With the changing climate, there is a need to adopt climate-resilient practices, such as minimizing use of chemical pesticides to improve soil fertility and shifting towards organic farming. Research and development of genetically modified (GM) crops that are resilient to climatic conditions and diseases could help increase yields. There is also a need to increase investment to support farmer-producer companies, which would create jobs, add value, and result in increased farmer income. As Indian agriculture faces water shortages, the promotion of watershed management programs, and water user associations can help ensure water availability for crop production. Policy support through subsidies for inputs like seeds, fertilizers, and machinery can assist farmers in adopting to new farming techniques.

V. CONCLUSION

From the above analysis, we can conclude that the growth in productivity of principal crops such as cotton, rice and total foodgrain was significant. The decomposition analysis for examining the sources of output growth shows that for crops like foodgrains, total pulses, rice, wheat, oilseeds and cotton was mainly due to yield effect. However, the area effect was the main factor for output growth in sugarcane. Hence, the decomposition analysis reveals that the yield growth was responsible for a change in the production of all the selected crops except sugarcane. It was observed that there was more diversification in TE 2020-21 as compared to initial period. A shift towards fruits, vegetables, and commercial crops like cotton and sugarcane illustrates change in cropping pattern. The Herfindahl index declined from 0.59 to 0.49, showing a continuous increase in diversification over the period. However, the extent of diversification was small.

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