Growth and Instability Performance of Major Agricultural Crops in India

Rohlupuii Ralte, Arjinder Kaur and Poonam Kataria

Department of Economics and Sociology, Punjab Agricultural University, Ludhiana, Punjab, India

Abstract

Indian economy is agrarian in nature with the second largest agricultural land in the world and nearly 58 per cent of rural population dependent on agriculture for their livelihood. Agricultural production scenario of the country has changed with adoption of new technology. Area under food grains showed an increase in the initial years which later declined overtime, while production and yield showed a positive and significant growth from 1950-51 to 2019-20. Instability in area, production and yield of food grains was found to be declining with the dissemination of technology and spread of irrigation facilities. Growth rates of area and production of oilseeds, sugarcane and cotton were found to be positive and significant during the study period except between 1960-61 to 1979-80. Instability has increased in area and production of oilseeds and cotton crop overtime. The growth rates of area, production and yield of vegetables were positive and significant for the country as a whole between 1990-91 to 2019-20. However, instability index has shown a declining trend for both fruits and vegetables during the last decade.

Keywords: Compound annual growth rate, Instability index, Decomposition analysis, Food grains, Commercial crops

JEL Classification: C80, Q12, C44

Introduction

Agriculture plays an important role in the Indian economy due to its contribution towards the country's Gross Domestic Product (GDP) as well as employment. The major crops cultivated before the Green Revolution were rice, wheat, millets, sorghum, maize and barley, but the production during the period of 1947-1960 was poor and there was risk of famines in the country. The subsistence farming gave way to commercial farming with new agricultural strategy or Green Revolution initiated in the decades of 1960's with the purpose of increasing food production to feed millions of people in the country, tackle malnourishment, decreasing dependence on food imports and alleviation of rural poverty. Green Revolution comprised of technologies including high yielding variety (HYV) seeds especially of dwarf wheat and rice, application of chemical fertilizers and agrochemicals, controlled water supply (involving irrigation), new methods of cultivation like mechanized type of farming systems. In 1980's the policy of Indian agriculture shifted to emphasize more on other agricultural products such as fruits, vegetables and oilseeds. Hence, the farmers started the adoption of improved technologies and techniques in dairying, fisheries, livestock and meeting the diversified food requirements of the population. So, Indian agriculture was fairly diversified as per the regions (Bhalla, 2007). Net irrigated area as percentage to net sown area has increased from nearly 18 per cent in 1950-51 to 49 per cent in 2016-17 due to government interventions by initiation of schemes on irrigation management like Central Water Commission (CWC), Central Ground Water Board (CGWB) etc. Also there was remarkable growth of total chemical fertilizers usage from 69.8 thousand tonnes in 1950-51 to 28969.9 thousand tonnes in 2019-20 throughout the decades due to new dwarf varieties developed especially of wheat and paddy requiring higher doses of chemical fertilizers. The

Corresponding author email: ralte.apuii11@gmail.com

consumption of pesticides was 24.30 thousand tonnes in 1970-71 which increased to 45 thousand tonnes during 1980-81 and reached its peak of 75 thousand tonnes during 1988-89 due to increased insect pest attacks in intensive agricultural practices over time. Among cereals and millets, rice showed consistent share in the cropping pattern over the study period whereas the share of maize and wheat showed decline in the initial two decades and started to cope up an increasing area from the period of 1970-71. Jowar, bajra and barley maintained a consistent decline in area after the Green Revolution era. Among pulses, gram showed a slight decline in area under the crop and among oilseeds, area under rapeseed & mustard increased whereas, groundnut and sunflower has declined. Among commercial crops, area, production and yield of sugarcane and cotton has increased throughout the period under whereas study jute & mesta and tobacco has started to shrink. Among horticultural crops, fruits and vegetables have expanded in area. Condiments and spices have also shown a gradual increased share over the study period. The farmers moved from low value crops to high value crops for sustaining the economic prosperity and generate alternate sources of income (Bhatia, 1965; Chand and Raju, 2008; Raju *et al*, 2014).

Data Sources and Methodology

The study is based on secondary data which was derived from various issues of the Statistical Abstract of India**,** Agricultural Statistics at a Glance**,** Handbook of Statistics on Indian Economy and RBI publications and websites such as *www.indiastat.com***,** *www.mospi. nic.in* and *www.rbi.org*. The data on area, production and yield of food grains and major commercial crops were collected for the for the period 1950-51 to 2019-20. In order to understand the decadal performance, the whole period was divided into seven decades viz.1950-51 to 1959-60 (Period I), 1960-61 to 1969-70 (Period II),1970-71 to 1979-80 (Period III),1980-81 to 1989-90 (Period IV), 1990-91 to 1999-00 (Period V), 2000-01 to 2009-10 (Period VI), 2010-11 to 2019-20 (Period VII) and 1950-51 to 2019-20 (overall) of food grains and commercial crops. In case of vegetables and fruits, due to insufficient availability of data, the data were collected and compiled for a period of 30 years and divided into three periods viz. 1990-91 to 1999-00 (Period I), 2001-01 to 2009-10 (Period II), 2010-11 to 2019-20 (Period III) and 1990-91 to 2019-20 (overall period).

Annual compound growth rates were estimated for area, production and yield of the crops as:

$$CAGR = [antilog (ln B)-1] *100$$

And variability coefficient has been calculated using the formula:

$$\text{Coefficient of Variation (CV \%)} = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100$$

Cuddy Della Valle Index was used to measure variation in area, production and yield of food grains, major commercial crops, vegetables and fruits.

The value of Cuddy Della Valle Index (CV*) was calculated by using the formula as:

$$`CV^* = CV \times \sqrt{(1-\overline{R}^2)}$$

To estimate the percentage contribution of area, yield and their interaction towards the production of food grains, vegetables and fruits the decomposition analysis has been adopted.

Decomposition analysis

To estimate the percentage contribution of area, yield and their interaction towards the production of food grains, vegetables and fruits the technique of decomposition has been adopted used by several researchers (Kalamkar *et al,* 2002, Roy *et al,* 2015). The change in production between any time periods can be expressed as:

Change in production=Area effect + Yield effect + Interaction effect.

$$\Delta P = Y_o \Delta A + A_o \Delta Y + \Delta A \Delta Y$$

Where,

$$\Delta P = P_n - P_o, \Delta Y = Y_n - Y_o, \Delta A = A_n - A_o$$

A_o, P_o and Y_o are area, production and yield in base year and An, Pn and Yn are area, production and yield in current year, ΔA, ΔP and ΔY represent change in area, production and yield respectively.

Results and Discussion

Area, production and yield of food grains

The area, production and yield of food grains has increased from 97 to 127 million hectares 50.82 to 285.01 million tonnes and 522 to 2235 kg/ha respectively from 1950-51 to 2019-20. Table 1 showed the compound growth rates of food grains in India

during the study period. The growth rate of area under food grains was found to be declining over time with positive and significant growth rates in the initial three periods and overall growing at 0.19 per cent per annum. The growth in production and yield declined during the second period but has shown positive and significant growth over the periods under study. It is necessary to study the instability index for different variables in order to assess the consistency of growth performance. It was observed that instability of area under food grains has declined after the second period due to wider dissemination of technology and spread of irrigation facilities whereas the instability of production and yield has shown irregular trend declining till the fifth period, increasing in the seventh period and again declining in the last decade but the overall instability is almost same as that of the initial period (Sidhu *et al,* 2011).The reason for instability could be traced to the stagnation in production technologies of food grains.

Area, production and yield of major commercial crops

The area, production and yield of major commercial crops like oilseeds increased from 66 to 237 thousand hectares, 52 to 332 thousand tonnes and 787 to 1398 Kg/ha respectively from 1950-51 to 2019-20.The area under oilseeds showed significant growth till 1960, but declined and was non-significant during the third period i.e., 1970-71 to 1979-80. However, it increased during next three decades, but declined during the last decade (Table 1). Growth rate of production of oilseeds depicted a more or less similar pattern, but growth rate

of yield has remained low during the study period. Lack of breakthrough in production technologies and initial shifting of area towards food grains since Green Revolution could be the reasons for this lower growth in yield. But overall the growth rates of oilseeds in terms of area, production and yield have been positive and significant. The instability of area under oilseeds was less in the second, third and fifth period, whereas production and yield instability has increased over the study period. The area, production and yield of sugarcane crop has widely increased from 1707 to 4603 thousand hectare, 69220 to 370500 thousand tonnes and 40550 to 80490 kg/ha from 1950-51 to 2019-20. For overall period, the growth rate of area under sugarcane was positive and significant, but has shown a fluctuating pattern during the periods under study. However production growth of sugarcane increased till the fifth period and was non-significant later on, while its yield has shown a significant growth between 1980-81 to 1999-00 and again in the last decade. The instability in area and yield of sugarcane declined from the second to fifth period and again in the seventh period, whereas the production instability declined till fifth period and increased again. The third major commercial crop taken for the study was cotton and the area, production and yield of cotton increased from 5882 to 13477 thousand hectare, 3044 to 36065 thousand bales and 88 to 455 kg/ha during the study period. The growth rate of area under cotton crop was significant only since 2000-01, though production showed a significant growth in between the periods under study with introduction American cotton variety. Yield of cotton showed a

Table 1. Compound growth rate and Instability index of area, production and yield of food grains, 1950-51 to 2019-20   (per cent per annum)

Period	CAGR of food grains			Instability index		
	Area	Production	Yield	Area	Production	Yield
Period I (1950-51 to 1959-60)	1.94***	4.25***	2.26***	2.42	7.30	5.30
Period II (1960-61 to 1969-70)	0.52**	1.85*	1.32*	1.86	9.68	7.94
Period III (1970-71 to1979-80)	0.46*	2.07**	1.60**	2.23	8.52	6.74
Period IV (1980-81 to 1989-90)	-0.23	2.73***	2.97***	2.39	6.19	4.25
Period V (1990-91 to 1999-00)	-0.07	2.09***	2.17***	1.59	3.14	2.44
Period VI (2000-01 to 2009-10)	0.29	1.90**	1.60**	2.43	6.51	4.45
Period VII (2010-11 to 2019-20)	0.26	1.87***	1.59***	1.89	3.54	3.35
Overall period (1950-51 to 2019-20)	0.19***	2.38***	2.19***	4.59	7.61	5.91

*Note: ***, ** and * significant at 1,5 and 10 per cent level of significance.*

positive and significant growth rate during third, fourth, sixth and seventh periods. The instability of area under cotton was found to be high during 1990-91 to 1999-00 due to insect pest attack which later improved with the introduction of Bt cotton varieties and production and yield has shown higher instability over the study periods except between 2010-11 to 2019-20 (Table 2).

Area, production and yield of vegetables and fruits

The persual of table 3 and table 4 provides information on the compound growth of vegetables and fruits in India during 1999-00 to 2019-20. The area, production and yield of vegetables was found to have increased from 4120 to 10316 thousand hectares, 48926 to 189464 thousand metric tonnes and 11.91 to 18.37

Table 2. Growth and instability indices of area, production and yield of major commercial crops, 1950-51 to 2019-20
(per cent per annum)

Crops	CAGR			Instability index		
	Area	**Production**	**Yield**	**Area**	**Production**	**Yield**
Period I (1950-51 to 1959-60)						
Oilseeds	3.83***	4.16***	0.31	5.45	7.35	8.06
Sugarcane	2.58*	3.90**	1.28*	10.55	11.46	5.43
Cotton	3.03***	4.29**	1.23	6.92	13.38	8.45
Period II (1960-61 to 1969-70)						
Oilseeds	0.63*	0.25	-0.38	3.49	10.41	9.84
Sugarcane	0.51	1.53	1.13*	10.43	13.24	6.31
Cotton	-0.13	0.40	0.56	3.36	7.32	7.61
Period III (1970-71 to1979-80)						
Oilseeds	0.36	0.73	0.36	3.11	10.84	10.22
Sugarcane	1.89*	2.55*	0.65	7.50	10.52	4.90
Cotton	0.41	3.67**	3.30**	4.90	11.67	9.29
Period IV (1980-81 to 1989-90)						
Oilseeds	2.96***	5.45***	2.42*	6.45	14.94	9.97
Sugarcane	1.46*	2.69**	1.21***	6.96	7.47	2.95
Cotton	-1.24**	2.81*	4.11**	5.50	17.71	12.90
Period V (1990-91 to 1999-00)						
Oilseeds	1.60***	2.24*	0.63	3.51	7.31	6.28
Sugarcane	1.67**	2.73***	1.04***	5.10	5.56	2.79
Cotton	2.71	2.98	-0.38	5.41	10.26	8.79
Period VI (2000-01 to 2009-10)						
Oilseeds	2.90***	5.13**	2.16*	6.53	14.44	12.13
Sugarcane	0.73	1.20	0.46	10.74	13.73	4.97
Cotton	2.03**	13.60***	11.34***	6.93	14.41	14.44
Period VII (2010-11 to 2019-20)						
Oilseeds	0.23	0.19	-0.04	4.95	11.58	10.66
Sugarcane	-0.69*	0.97	1.67**	4.12	7.19	4.62
Cotton	1.09*	-0.87	-1.93**	5.71	7.81	7.94
Overall period (1950-51 to 2019-20)						
Oilseeds	1.81***	2.92***	1.08***	8.97	14.24	10.89
Sugarcane	1.59***	2.63***	1.02***	8.78	11.23	6.22
Cotton	0.67***	3.29***	2.60***	13.19	26.54	17.22

*Note: ***, ** and * significant at 1,5 and 10 per cent level of significance.*

Table 3. Growth and instability indices of area, production and yield of vegetables in India ,1990-91 to 2019-20

(per cent per annum)

Period	CAGR of Vegetables			Instability index		
	Area	Production	Yield	Area	Production	Yield
Period I (1990-91 to 1999-00)	2.86***	5.92***	2.95***	6.93	5.42	6.04
Period II (2000-01 to 2009-10)	3.63***	5.29***	4.18**	3.47	5.74	11.07
Period III (2010-11 to 2019-20)	2.09***	2.65***	0.63**	2.40	1.73	2.43
Overall period (1990-91 to 2019-20)	3.04***	4.59***	1.59***	4.95	5.75	9.06

*Note: ***, ** and * significant at 1,5 and 10 per cent level of significance.*

MT/ha respectively during the period of study. The growth rate of area, production and yield of vegetables was positive as well as significant over the study period. The area, production and yield of fruits showed an increasing trend from 2567 to 6702 thousand hectares, 24502 to 100447 thousand metric tonnes and 9.00 to 14.98 MT/ha during the same period. The growth rate of area under fruits was positive and significant except in the third period where it was negative and non-significant. Whereas, growth rate of yield of fruits was positive and significant except in second period. For vegetables and fruits, it was observed that the instability of area, production and yield declined over the periods because of launching of several schemes by the central and state government in order to enhance the area and production of the horticultural crops like Mission for Integrated Development of Horticulture (MIDH),National Horticulture Mission (NHM 2005-06) etc.

Contribution of area, yield and their interaction in the production of food grains

With the help of additive decomposition model, the percentage contribution of area, yield and their interaction on production of food grains in India was estimated and shown in table 5. It reveals the effect of area, yield and their interaction to the production of food grains from 1950-51 to 2019-20. The yield effect contribution was found to be offsetting the area and interaction effect over the study period except in third period where it has a lower contribution to the production than the area effect.

Contribution of area, yield and their interaction in the production of vegetables and fruits

In case of vegetables as shown in table 6 the area effect has more contribution to the total production and offsetting the yield and interaction effect over the study period. In case of fruits, the area effect has offset the yield and interaction effect in all the periods except in the third period where yield effect has higher contribution to the production.

Conclusion and Policy Implications

The above results indicated that the growth of area, production and yield of food grains was positive and significant in the overall period and the instability was found to be higher in terms of production than area and yield. Among major commercial crops i.e., oilseeds, sugarcane and cotton, growth rates of area, production and yield are all positive and significant in the overall period, the instability was found to be more

Table 4. Growth and instability indices of area, production and yield of fruits in India ,1990-91 to 2019-20

(per cent per annum)

Period	CAGR of Fruits			Instability index		
	Area	Production	Yield	Area	Production	Yield
Period I (1990-91 to 1999-00)	3.80**	6.41***	2.82**	9.64	6.84	8.12
Period II (2000-01 to 2009-10)	6.31***	6.55***	0.26	5.22	4.49	6.12
Period III (2010-11 to 2019-20)	-0.19	3.36***	3.61***	4.97	2.35	4.20
Overall period (1990-91 to 2019-20)	3.35***	4.54***	1.18***	9.95	7.39	10.03

*Note: ***, ** and * significant at 1,5 and 10 per cent level of significance.*

Table 5. Contribution of area, yield and their interaction in the production of food grains in India, 1950-51 to 2019-20
(in per cent)

Particular	Factor	Period I	Period II	Period III	Period IV	Period V	Period VI	Period VII	Overall
Food grains	Area effect	37.37	32.43	60.63	0.24	19.57	2.13	3.38	6.40
	Yield effect	52.62	63.19	39.08	99.67	124.17	97.61	95.90	71.38
	Interaction effect	10.00	4.36	0.27	0.07	4.60	0.22	0.70	22.20

Table 6. Contribution of area, yield and their interaction in the production of vegetables and fruits in India, 1990-91 to 2019-20
(in percentage)

Particular	Factor	Period I 1990-91 to 1999-00	Period II 2000-01 to 2009-10	Period III 2010-11 to 2019-20	Overall period 1990-91 to 2019-20
Vegetables	Area effect	52.98	79.63	72.19	52.48
	Yield effect	32.32	6.34	22.89	18.97
	Interaction effect	14.69	14.02	4.91	28.53
Fruits	Area effect	49.28	84.40	14.48	48.11
	Yield effect	34.29	1.67	81.44	19.87
	Interaction effect	16.42	13.92	4.07	32.01

in cotton crop. In the overall period, the growth rate of area, production and yield of vegetables were found to be positive and significant. The instability in area and yield has increased than in the production. In case of fruits area, production and yield have shown positive growth rate in the overall period. The instability under area and yield in case of fruits were almost similar. Additive decomposition model attributed the growth in production of food grains more to the yield effect and contribution of area effect was found to be more in the production of vegetables and fruits in India.

References

Bhatia S S (1965) Pattern of Crop Concentration and Diversification in India. *Economic geography* **41**:40-56. https://doi.org/10.2307/141855.

Bhalla G S (2007) *Indian Agriculture since Independence*. National Book Trust, New Delhi, India.

Chand R and Raju S S 2008. *Instability in Indian Agriculture during Different Phases of Technology and Policy*, Discussion Paper: NPP 01/2008, National Professor Project, National Centre for Agricultural Economics and Policy Research. ICAR, New Delhi.

Kalamkar S S, Atkare V G and Shende N V (2002) An analysis of growth trends of principal crops in India. *Agricultural Science Digest* **22**:153-56. https://www.indianjournals.com.

Raju S S, Chand R and Chauhan S (2014) Instability in Indian agriculture: An inter-state analysis. *Economic Affairs* **59**:735-44. https://www.proquest.com.

Roy A, Singh N U, Dkhar D S, Mohanty A k, Singh S B and Tripathi A K (2015) Food Security in North-East Region of India- A State-wise Analysis. *Agricultural Economics Research Rev*iew **28**:259-66. https://doi:10.5958/0974-0279.2015.00041.5.

Sidhu R S, Vatta K and Kaur A (2011) Instability in Crop Yields and Variability across Different Farm Size Categories in Punjab. *Journal of Agricultural Development and Policy* **21**:9-20. https://www.researchgate.net.