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An Analysis of Productivity of Food grains in India

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Abstract

The present study makes an attempt to analyze the trends in area, production and productivity of major food grain crops in India for the period 1990-91 to 2019-20. To study the behavior of the data, the statistical techniques like trend analysis, analysis of variance (ANOVA) and line charts have been used. To measure the variability in area, production and productivity of major food grain crops, coefficient of variation (CV) has been computed. Theresultsofthe studyrevealupward trends in production and productivity during the reference period. The area under rice is experiencing a declining trend.Theproduction-wisescenariooffood-grainshasindicatedthat, majorcerealslikerice,wheatandmaize showed consistent improvement, but pulses production was not consistent. As a coarse cereal, maize standsinanimportantpositionnexttoriceandwheat. The growth trend fortotalfoodgrainsinIndiahas beenfound positiveandsignificant.

Keywords: Growth rates, Productivity, Compound annual growth rate (CAGR), ANOVA,Food-grains.

Introduction

Agriculture is central to the Indian Economy. It not only contributes 13-14 % to the GDP of the nation but also provides direct or indirect employment to around 60% of the population, meaning thatthe lives and livelihoods of a great number of people depend on agriculture. It contributes to capital formation and provides raw materials to a wide range of industries. Infact the agro based industries thrive on agriculture as their base. It provides market to industrial products and enormous benefits to the entire economy through its backward and forward linkages. It contributes to the development of the tertiary sector by providing the basis for agro related services. More important than everything else, it supports the second largest population in the worldirrespective of whether it is engaged in the agricultural sector or the non-agricultural sectors by providing food to the people. International trade can also serve as a source of the agricultural products including food, but too much dependence on imports of food related items can adversely affect the autonomy of a nation in the international political arena, particularly at crucial junctures. India has witnessed such incidents in the past. Moreover, for a nation like India having enormous land and human resources, dependence on international trade for agricultural products seems to be an unpragmatic approach. Agricultural production can be classified into foodgrains and non food grains production. The production of foodgrainsisimportant from the perspective of the food security challenge faced by most of the developing countries.Given the size of the population, the rate of growth of the population and the percentage of the population classified as poor, increases in the production of foodgrains and food security acquires increased importance in the Indian context. Cereals and pulses are the two most important components of the Indian meal. Rice and wheat are the staple food of almost the entire population. Coarsecereals support the poorest of the poor and pulses are the cheapest source of protein and are an inevitable part of any Indian's diet. This holds true for almost the entire population.Agricultural production can be increased either by increasing the area under cultivation or by increasing the agricultural productivity. Increasing agricultural output via extensive measures is an option in the initial years of agricultural expansion. After saturation is reached in this respect, reliance on only the intensive measures can help increase the agricultural productivity.Growth in the productivity levels of foodgrains benefits an economy by ensuring food security, increasing the income as well as the welfare of farmers, helping in eradicating poverty and addressing hunger and malnutrition, reducing rural-urban migration, reducing the import bill (pulses) and enhancing foreign earnings.

Agricultural productivity is measured as the amount of agricultural output relative to an input or a set of inputs. The measures can be partial productivity measures like output per unit land or labour or total factor productivity (TFP) measures that study the quantity of output relative to a set of inputs. In this paper our analysis is based on a partial measure of productivity that measures foodgrain output in Kgs per hectare of land. The data on foodgrains productivity is taken from the RBI's Databaseon Indian Economy. The present study attempts to find how the productivity of rice, wheat, coarse cereals, pulses, total cereals and total foodgrains has changed in the period from 1990-91 to 2019-20.

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Review of Literature

Tremendous amount of literature aiming at studying the growth in the agricultural output over time and analysing the determinants of this growth is available both at the national as well as the international level. Among the studies that have tried to explain the contribution of different factors to the growth in the agricultural output, Minhas and Vaidyanathan (1965) have decomposed agricultural growth in terms of two components namely area and yield. This study tries to estimate how much of the increase in output can be attributed to the increase in area and how much of it can be attributed to increase in productivity or yield. In subsequent years there was a shift towards the concept of total Factor productivity and agricultural growth came to be decomposed into contribution of input and contribution of total factor productivity. The difference of approaches has been very nicely explained by Kumar and Mittal (2006). They have also explained the concept of Total Factor Productivity and have viewed Growth in TFP as a measure of the contribution of improved technology. They have further decomposed TFP into factors such as education, research, infrastructure, health of natural resources, extension etc. They have argued that input growth itself is determined by factors like input-output prices, technological innovations, institutions, infrastructure, policy initiatives, etc. Some of the studies that use the concept of TFP are Evenson and Jha (1973), Sindhu and Byerlee (1992), Kumar and Rosegrant (1994), Rozelle et al. (2003) and Coelli and Rao (2003).

Apart from this literature that attempts to decompose agricultural growth into different components there is literature that aims at measuring and analyzing agricultural productivity. Initial studies in this direction are Schultz(1953) and Solow(1957). In most of these studies three methods of measurement have been used namely the parametric Method, the accounting method and the non-parametric method. Of these three methods the one that is most convenient to implement is the accounting method as it involves construction of productivity indices and does not involve estimation. The studies that measure productivity include studies that measure productivity for the entire agricultural sector or those which measure productivity for particular crops for the entire country or for specific states or regions in the country.

Evenson et al. (1999) have calculated the share of Total Factor Productivity (TFP) in the growth of the total crop output and the annual growth in Total Factor Productivity over the periods 1956-65, 1966-76 and 1977-87. They have placed the share of TFP in the total crop output growth at 46.8 %, 50.2 % and 48.8 % over these periods respectively. Fan et al. (1999) have constructed input and output indices for calculating Total Factor Productivity for the agriculture sector in India and for some of the states for the period 1970 to 1995. Joshi et al. (2003) have studied the share of TFP and the annual growth in TFP for rice and wheat in the Indo Gangetic Plains for the periods 1980-90 and 1990-99.

Kumar et al. (2004) have computed the share of total factor productivity and the annual growth in the total factor productivity for the crop sector in the Indo Gangetic Plains over the periods 1981-90, 1990-96 and 1981-96. They have conducted research at a disaggregated level also by computing the share of TFP and annual growth in TFP for Lower Gangetic Plains, Upper Gangetic Plains, Mid Gangetic Plains and Trans Gangetic Plains. There is no dearth of literature related to productivity of agriculture or specific crops but a mention of such literature here is not quite relevant as the objective of the present study is not to decompose the growth in agricultural output into different components or to measure the productivity of any individual factor or the total factor productivity. The current study aims to analyze the trend and measure the variability in the productivitylevels of major food grains crops over the period from 1990-91 to 2019-20.

Objectives of Study

1. To analyze the growth trendsin the productivity levels ofmajorfood grain crops inIndia.
2. To measure the variability in area, production and productivity of major food grain crops in India during the period 1990-91 to 2019-20

Methodology and Data Source

The statistical tools like mean, standard deviation, coefficient variation (CV) and have been used. Analysis of variance (ANOVA) has been applied for testing significant difference between means ofarea, production and productivity of major food grain crops.

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Estimation of Growth Rate

By applying log-lin model the Compound annual growth rates (CAGR) have been computed for examining trends in area, production and productivity of major food grain crops by fitting to the time series data an exponential function of the following form:

$$Y = ab^t$$

Taking the log $LnY = Ln\ a + bt$

Where, Y= area, productionandproductivityof food-grainscrops
t =Time (years) a = constant
b = regression coefficient which provide the estimate of growth rate

Compound growth rate in per cent (r) was thus estimated as under:

$$r = (b - 1) \times 100$$

The significance of growth rate was tested by applying Student's-test statistics.

Coefficient of Variation (C.V.)

Coefficient of variation has been used for finding the variability in area, production and productivity of major food grain crops.

(Standard Deviation / Mean) * 100

Co-efficient of variation = σ/ x 100, where
σ = Standard deviation X =Arithmetic Mean

To meet the objective of this study, data on different variables such as area, production and productivity of major food grains in IndiawerecollectedfromDirectorateofEconomics andStatistics(DES), MinistryofAgriculture(MoA), Government of India, New Delhi and the RBI Database on Indian Economy.

Analysis and Discussion

The productivity levels of wheat, coarse cereals and pulses were almost stagnant in the pre Green Revolution years. The productivity levels of wheat though had fluctuated a little bit but had never reached the 1000 Kg per hectare mark in this period. The only foodgrain that was witnessing some increase in the productivity levels during the pre-Green Revolution Phase was rice. It was only because of these increases in the productivity level of rice that the productivity levels of cereals and foodgrains had shown somewhat upward trends in the pre Green Revolution phase. The productivity of rice increased from 1032 Kg per hectare in 1967-68 to 2705kg per hectare in 2019-20, and the productivity of wheat increased from 1103kg per hectare to 3421 kg per hectare over the same period.

The productivity levels of wheat that were below the productivity levels of rice in the pre Green Revolution phase not only surpassed the productivity levels of rice in the post Green Revolution period but have been persistently, significantly higher than those of rice over the entire post revolution period. This is in line with the fact that wheat has been the mainstay of the Green Revolution in India. However, the contribution of the rise in the productivity levels rice to increases in the productivity levels of cereals and food grains in the post Green Revolution phase cannot be denied and the significant upward trend in the productivity levels of cereals and food grains has to be attributed to the increases in the productivity levels of wheat and rice both.

Table 1 gives the coefficient of variation for yield levels of different category of foodgrains in India over the period from 1990-91 to 2019-20. The value of coefficient of variation in the production of pulseswas23.56% followed by wheat, coarse cereal,total cereal andtotal food grains; with the values 19.32%, 16.89%, 16.37% and 16.71% respectively. Higher C.V value for pulses shows higher risk in the production of pulses compared to other crops with

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lesser coefficient of variation.

Table 1 Production of Food-grains in India (1990-91 to 2019 -20) (in Lakh Tonne)

Year	Rice	Wheat	Coarse Cereals	TotalCereals	Pulses	Total Food grains
1990-91	742.9	551.4	327	1621.3	142.6	1763.9
1991-92	746.8	556.9	259.9	1563.6	120.2	1683.8
1992-93	728.6	572.1	365.9	1666.6	128.2	1794.8
1993-94	803	598.4	308.2	1709.6	133	1842.6
1994-95	818.1	657.7	298.8	1774.6	140.4	1915
1995-96	769.8	621	290.3	1681.1	123.1	1804.2
1996-97	817.3	693.5	341.1	1851.9	142.4	1994.3
1997-98	825.4	663.5	304	1792.9	138.3	1931.2
1998-99	860.8	712.9	313.3	1887	149.1	2036.1
1999-00	896.8	763.7	303.4	1963.9	134.1	2098
2000-01	849.8	696.8	310.8	1857.4	110.7	1968.1
2001-02	933.4	727.7	333.7	1994.8	133.7	2128.5
2002-03	718.2	657.6	260.7	1636.5	111.3	1747.8
2003-04	885.3	721.6	376	1982.8	149.1	2131.9
2004-05	831.3	686.4	334.6	1852.3	131.3	1983.6
2005-06	917.9	693.5	340.7	1952.2	133.8	2086
2006-07	933.6	758.1	339.2	2030.8	142	2172.8
2007-08	966.9	785.7	407.5	2160.1	147.6	2307.8
2008-09	991.8	806.8	400.4	2199	145.7	2344.7
2009-10	890.9	808	335.5	2034.5	146.6	2181.1
2010-11	959.8	868.7	434	2262.5	182.4	2444.9
2011-12	1053	948.8	420.1	2422	170.9	2592.9
2012-13	1052.4	935.1	400.4	2387.9	183.4	2571.3
2013-14	1066.5	958.5	432.9	2457.9	192.5	2650.4
2014-15	1054.8	865.3	428.6	2348.7	171.5	2520.2
2015-16	1044.1	922.9	385.2	2352.2	163.5	2515.7
2016-17	1097	985.1	437.7	2519.8	231.3	2751.1
2017-18	1127.6	998.7	469.7	2596	254.2	2850.1
2018-19	1164.8	1036	430.6	2631.4	220.8	2852.1
2019-20	1188.7	1078.6	477.5	2744.8	230.3	2975
Average	924.57	777.70	362.25	2,064.53	156.80	2221.33
Std. Deviation	135.08	150.28	61.18	337.92	36.94	371.18
Minimum	718.2	551.4	259.9	1563.6	110.7	1683.8
Maximum	1188.7	1078.6	477.5	2744.8	254.2	2975
Skewness	0.281	0.380	0.201	0.386	1.239	0.467
Kurtosis	-0.930	-0.905	-1.029	-0.982	0.849	-0.898
Coefficient of Variation CV)	14.61%	19.32%	16.89%	16.37%	23.56%	16.71%

Source: Authors' calculations based on data collected fromRBI's Database on Indian Economy

To study the behavior of the data we have used the statistical techniques like trend analysis, Analysis of Variance (ANOVA) and line charts. A look at the results of ANOVA presented in table 2 indicates that there is significant difference between the means of area, production and yield of food grains.

Table 2ANOVAand Post-hoc Analysis

			ANOVA table				
	Mean	Std. Dev	Source	SS	MS	F	p-value
Area	116.52	11.761	Treatment	6420.215	3210.1075	18.63	0.000000
Production	134.35	17.678	Error	13960.648	172.3537		

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Yield	115.17	8.137	Total	20380.863			
Total	122.01	15.670					

Post hoc analysis

p-values for pairwise t-tests

		Yield	Area	Production		
		115.17	116.52	134.35		
Yield	115.17					
Area	116.52	0.7022				
Production	134.35	4.94E-07	2.34E-06			

Tukey simultaneous comparison t-values (d.f. = 81)				
		Yield	Area	Production
		115.17	116.52	
Yield	115.17			
Area	116.52	0.38		
Production	134.35	5.47	5.08	134.35
critical values for experiment wise error rate:				
		0.05	2.39	
		0.01	3.01	

Source: Authors' calculations

Table 3 Variability in Production of Food-grains in India

	Min.	Max.	Mean		Std. Deviation	Skewness	Kurtosis
			Statistic	Std. Error			
Rice	718.20	1188.70	924.5767	24.66381	135.08927	.281	-.930
Wheat	551.40	1078.60	777.7000	27.43879	150.28842	.380	-.905
Coarse Cereals	259.90	477.50	362.2567	11.17061	61.18395	.201	-1.029
Total Cereals	1563.60	2744.80	2064.5367	61.69655	337.92593	.386	-.982
pulse	110.70	254.20	156.8000	6.74541	36.94611	1.239	.849
Foodgrains	1683.80	2975.00	2221.3300	67.76899	371.18602	.467	-.898

Source: Authors' calculations

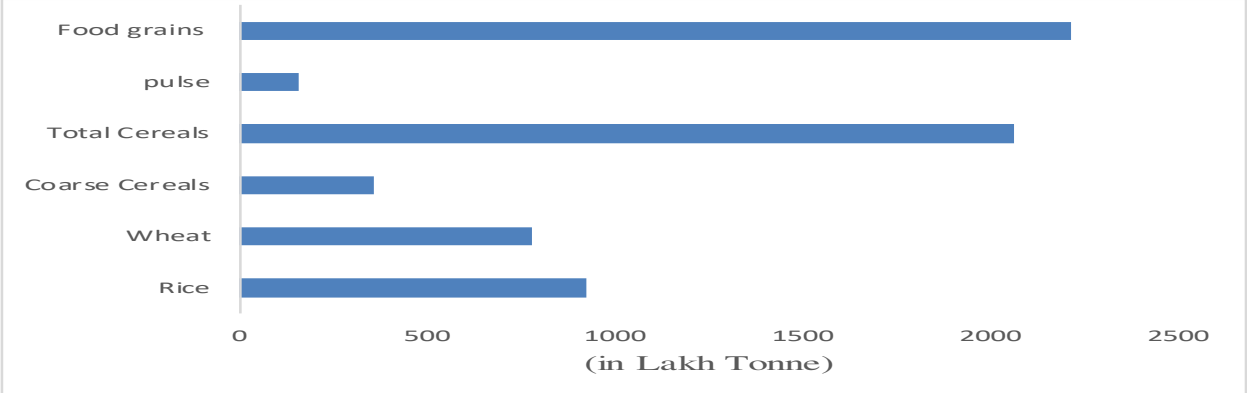

Fig. 1 Average production of major food grain crops

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Table4Trends in Production of Food-grains in India (1990-91 to 2019-20)

Year	Rice	Wheat	Coarse Cereals	TotalCereals	Pulses	Total Food grains
1991-92	0.52	1.00	-20.52	-3.56	-15.71	-4.54
1992-93	-2.44	2.73	40.78	6.59	6.66	6.59
1993-94	10.21	4.60	-15.77	2.58	3.74	2.66
1994-95	1.88	9.91	-3.05	3.80	5.56	3.93
1995-96	-5.90	-5.58	-2.84	-5.27	-12.32	-5.79
1996-97	6.17	11.67	17.50	10.16	15.68	10.54
1997-98	0.99	-4.33	-10.88	-3.19	-2.88	-3.16
1998-99	4.29	7.45	3.06	5.25	7.81	5.43
1999-00	4.18	7.13	-3.16	4.08	-10.06	3.04
2000-01	-5.24	-8.76	2.44	-5.42	-17.45	-6.19
2001-02	9.84	4.43	7.37	7.40	20.78	8.15
2002-03	-23.06	-9.63	-21.88	-17.96	-16.75	-17.89
2003-04	23.27	9.73	44.23	21.16	33.96	21.98
2004-05	-6.10	-4.88	-11.01	-6.58	-11.94	-6.96
2005-06	10.42	1.03	1.82	5.39	1.90	5.16
2006-07	1.71	9.32	-0.44	4.03	6.13	4.16
2007-08	3.57	3.64	20.14	6.37	3.94	6.21
2008-09	2.58	2.69	-1.74	1.80	-1.29	1.60
2009-10	-10.17	0.15	-16.21	-7.48	0.62	-6.98
2010-11	7.73	7.51	29.36	11.21	24.42	12.09
2011-12	9.71	9.22	-3.20	7.05	-6.30	6.05
2012-13	-0.06	-1.44	-4.69	-1.41	7.31	-0.83
2013-14	1.34	2.50	8.12	2.93	4.96	3.08
2014-15	-1.10	-9.72	-0.99	-4.44	-10.91	-4.31
2015-16	-1.01	6.66	-10.13	0.15	-4.66	9.36
2016-17	5.07	6.74	13.63	7.13	41.47	3.60
2017-18	2.79	1.38	7.31	3.02	9.90	0.07
2018-19	3.30	3.73	-8.32	1.36	-13.14	4.31
2019-20	2.05	4.11	10.89	4.31	4.30	2.76

Source: Authors' calculations

Table5Productivity of Food-grains in India (1990-91 to 2019-20)(In Kg / hectare)

Year	Rice	Wheat	Coarse Cereals	TotalCereals	Pulses	Total Food grains
1990-91	1740	2281	900	1571	578	1380
1991-92	1751	2394	778	1574	533	1382
1992-93	1744	2327	1063	1654	573	1457
1993-94	1888	2380	939	1701	598	1501
1994-95	1911	2559	929	1763	610	1546
1995-96	1797	2483	940	1703	552	1491
1996-97	1882	2679	1072	1831	635	1614
1997-98	1900	2485	986	1775	567	1552
1998-99	1921	2590	1068	1856	634	1627
1999-00	1986	2778	1034	1925	635	1704
2000-01	1901	2708	1027	1844	544	1626
2001-02	2079	2762	1131	1980	607	1734
2002-03	1744	2610	966	1753	543	1535

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2003-04	2077	2713	1221	1983	635	1727
2004-05	1984	2602	1153	1903	577	1652
2005-06	2102	2619	1172	1968	598	1715
2006-07	2131	2708	1182	2021	612	1756
2007-08	2202	2802	1431	2151	625	1860
2008-09	2178	2907	1459	2183	659	1909
2009-10	2125	2839	1212	2075	630	1798
2010-11	2239	2988	1531	2256	691	1930
2011-12	2393	3177	1590	2415	699	2078
2012-13	2461	3117	1617	2449	789	2129
2013-14	2424	3075	1677	2438	764	2101
2014-15	2390	2872	1729	2373	744	2070
2015-16	2400	3034	1579	2392	656	2056
2016-17	2494	3200	1750	2525	786	2129
2017-18	2576	3368	1934	2657	853	2235
2018-19	2638	3533	1944	2752	757	2286
2019-20	2705	3421	1976	2756	817	2325
Average	2125.43	2800.37	1299.67	2074.23	650.03	1796.83
Std. Deviation	288.54	327.87	352.45	351.66	88.27	278.58
Minimum	1740	2281	778	1571	533	1380
Maximum	2705	3533	1976	2756	853	2325
Skewness	0.41	0.53	0.54	0.47	0.79	0.35
Kurtosis	-0.95	-0.34	-0.97	-0.87	-0.35	-1.04
Coefficient of Variation (CV)	13.58%	11.71%	27.12%	16.95%	13.58%	15.50%

Source: Authors' calculations

Table6 Trends in Productivity of Food-grains in India (1990-91 to 2019-20)

Year	Rice	Wheat	Coarse Cereals	TotalCereals	Pulses	Total Food grains
1991-92	0.63	4.95	-13.56	0.19	-7.79	0.14
1992-93	-0.40	-2.80	36.63	5.08	7.50	5.43
1993-94	8.26	2.28	-11.67	2.84	4.36	3.02
1994-95	1.22	7.52	-1.06	3.64	2.01	3.00
1995-96	-5.97	-2.97	1.18	-3.40	-9.51	-3.56
1996-97	4.73	7.89	14.04	7.52	15.04	8.25
1997-98	0.96	-7.24	-8.02	-3.06	-10.71	-3.84
1998-99	1.11	4.23	8.32	4.56	11.82	4.83
1999-00	3.38	7.26	-3.18	3.72	0.16	4.73
2000-01	-4.28	-2.52	-0.68	-4.21	-14.33	-4.58
2001-02	9.36	1.99	10.13	7.38	11.58	6.64
2002-03	-16.11	-5.50	-14.59	-11.46	-10.54	-11.48
2003-04	19.09	3.95	26.40	13.12	16.94	12.51
2004-05	-4.48	-4.09	-5.57	-4.03	-9.13	-4.34

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2005-06	5.95	0.65	1.65	3.42	3.64	3.81
2006-07	1.38	3.40	0.85	2.69	2.34	2.39
2007-08	3.33	3.47	21.07	6.43	2.12	5.92
2008-09	-1.09	3.75	1.96	1.49	5.44	2.63
2009-10	-2.43	-2.34	-16.93	-4.95	-4.40	-5.81
2010-11	5.36	5.25	26.32	8.72	9.68	7.34
2011-12	6.88	6.33	3.85	7.05	1.16	7.67
2012-13	2.84	-1.89	1.70	1.41	12.88	2.45
2013-14	-1.50	-1.35	3.71	-0.45	-3.17	-1.32
2014-15	-1.40	-6.60	3.10	-2.67	-2.62	-1.48
2015-16	0.42	5.64	-8.68	0.80	-11.83	-0.68
2016-17	3.92	5.47	10.83	5.56	19.82	3.55
2017-18	3.29	5.25	10.51	5.23	8.52	4.98
2018-19	2.41	4.90	0.52	3.58	-11.25	2.28
2019-20	2.54	-3.17	1.65	0.15	7.93	1.71
Average	1.70	1.51	3.46	2.08	1.64	1.94
C.V	13.58	11.71	27.12	16.95	13.58	15.50
CAGR	1.53	1.41	2.75	1.96	1.20	1.82

Source: Authors' calculations

All the cereals including rice, wheat and coarse cereals witnessed volatility in the annual growth rate in the productivity levels for the entire period It is because of the volatility in the annual growth rate in the productivity levels of all the cereals and pulses that the annual growth in productivity levels of total cereal as well as foodgrains has also shown considerable volatility. The annual growth rate for cereals varied in the range -11.46% to 13.42% and that for foodgrains varied in the range -11.48% to 12.51%. Although the volatility is quite high but still the dampening of the fluctuations for cereals and foodgrains category as compared to the individual categories of cereals and pulses can be explained in terms of the simple 'average effect'. Although productivity for all the foodgrains has increased over the years but the growth rate in the productivity levels have definitely not been steady. This high level of volatility in the annual growth of the productivity levels across all the categories of foodgrains can be attributed to the 'base effect'. The 'base effect' i.e. very high and very low variable values in alternate years signify the monsoon dependence of Indian agriculture. Even till date only less than 50% of the land in the country is irrigated. This exposes the agriculture as well as the farmer to the vagaries of monsoon, thereby creating uncertainities not only in the prices of agricultural commodities and income of farmers but also for the entire economy.

The yield per hectare or productivity of pulses remained between 400 to 500 Kg per hectare till the early eighties. There were occasional episodes of marginal increases above 500 Kg per hectare or marginal dips below 400Kg per hectare in the entire 30year period ranging from 1950 to 1980. It was only after the mid-eighties that the productivity of pulses was maintained above 500kg per hectare. But for the next two decades it fluctuated in the narrow range of 500 Kg per hectare to 600 Kg per hectare It is only after the year 2002-03 that some upward trend in productivity can be noticed. Whereas the productivity of rice more than quadrupled in the period from 1950-51 to 2019-20 and that of wheat increased to more than five times the level in 1950-51 in 2019-20, the productivity of pulses has only less than doubled in these 70years. It increased from 408 Kg per hectare in 1950-51 to 817 Kg per hectare in 2019-20. This brings out the neglect of pulses in the agricultural policies over the entire planning period. Though India is self- sufficient in food grains after Green Revolution, it still depends on imports for to fulfilling its domestic demand of pulses.

According to FAO India is the largest producer as well as consumer of pulses in the world with 25% of the

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global production and 27% of world consumption to its credit. India is also the largest importer of pulses in the world accounting for 14% of the world imports in pulses. This can be better understood if we have an idea of the food habits in India. Pulses and lentils are an important part of the Indian meal for the rich and the poor alike and are the most important source of protein for the Indian people, particularly for the poor. This explains India's position as the largest producer as well as the largest consumer of pulses in the world. However, for understanding the position of India as the largest importer of pulses we need to look at some additional aspects of the Indian economy. Firstly, India has experienced a population explosion after independence. Secondly, over the entire planning period the area under pulses has remained constant at 20% of the total area under food grains. Thirdly, in this entire planning period the productivity of pulses has only doubled.Notwithstanding the various efforts being made and also no technological come through in pulses has been possible. The productivity of pulses was very low around 656 Kg/ hectare in 2015-16. The reason behind the low productivity is that the pulses are mainly grown by the marginal and small farmers on minor lands under rain fed conditions. Although there has been significant increase in the MSP for pulses but due to poor marketing facilities, rising burden of credit, farmers did not agree to increase the land under the pulses. Given these conditions and the importance of pulses as far as the typical Indian meal is concerned India is bound to be a major importer of pulses. It is thus the largest importer of pulses in the world. The increasing population, constancy of the area under cultivation and the insufficient rise in the productivity levels has also led to a decline in the per capita availability of proteins in India. This also explains the persistent rise in the prices of pulses in the country in the last few decades. The productivity of coarse cereals remained stagnated in the pre Green Revolution phase. It increased in the post Green Revolution phase and has increased to more than 4 times in the planning period. However significant achievements in this regard have been made only after the mid 80's.

Table 7ANOVA

Source	SS	MS	F	p-value	
Treatments	82624055.89	16524811.179	1316.95		0.0000
Blocks	13377863.23	461305.629	36.76		0.0000
Error	1819424.27	12547.754			
Total	97821343.39				

Post hoc analysis

p-values for pairwise t-tests

		Coarse Cereals	Total Food grains	Total Cereals	Rice	Wheat
		1299.667	1796.833	2074.233	2,125.433	2,800.367
Pulses	650.033					
Coarse Cereals	1299.667					
Total Food grains	1796.833	8.32E-37				
Total Cereals	2074.233	5.34E-58	3.57E-17			
Rice	2125.433	2.16E-61	8.59E-22	.0788		
Wheat	2800.367	1.57E-95	4.17E-72	1.19E-54	5.94E-51	

		Coarse Cereals	Total Food grains	Total Cereals	Rice	Wheat
		1299.66	1796.83	2074.23	2125.43	2800.36
Pulses	650.033					

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Coarse Cereals	1299.667					
Total Food grains	1796.833	17.19				
Total Cereals	2074.233	26.78	9.59			
Rice	2125.433	28.55	11.36	1.77		
Wheat	2800.367	51.89	34.70	25.11	23.34	

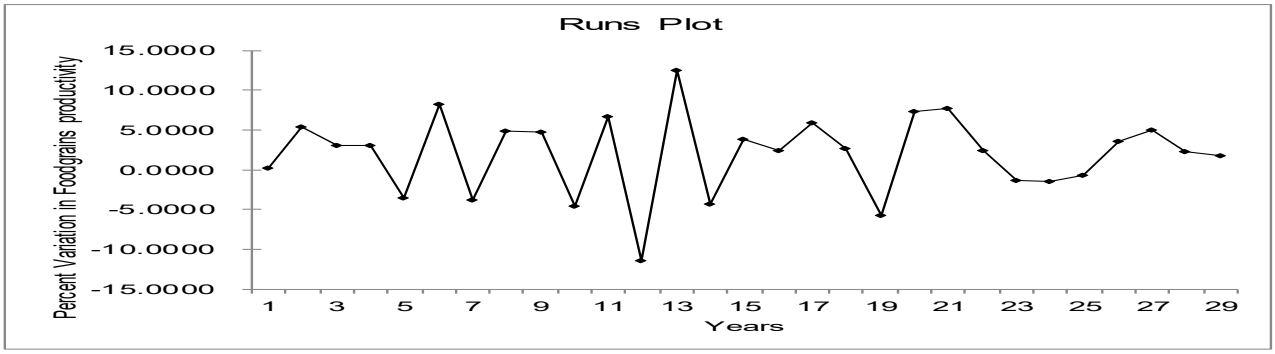

Fig. 2 Trends in total food-grain productivity

The analysis of variance is used for testing significant difference between group of means. It is observed from the ANOVA table (Table 7) that the significance value is 0.000 (i.e., p = 0.000), which is less than 0.05. That is the factors means are differing at 5% level of significance. To verify, which of the specific groups have differed significantly the Tukey post hoc test is used. Here we obtained the Multiple Comparisons table which contains the p values of each pair and homogeneous groups of non-significant variables.

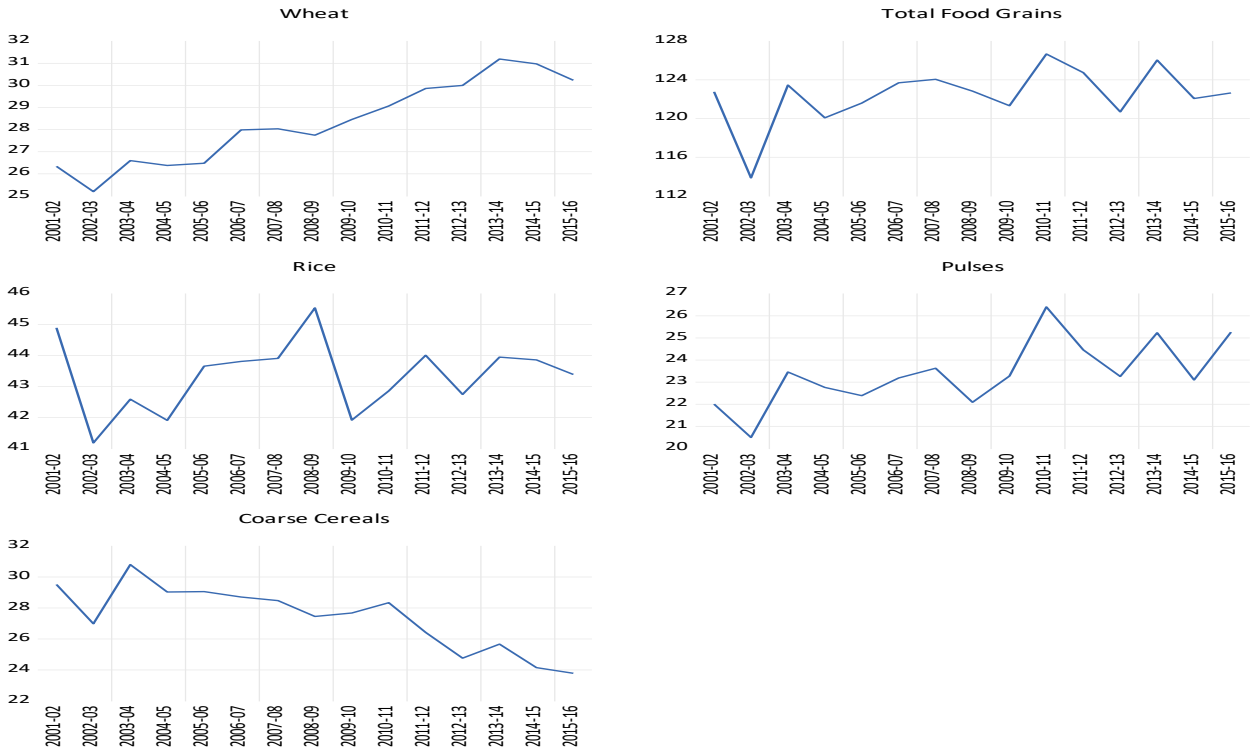

Fig. 2 Trends in major food-grain crops productivity

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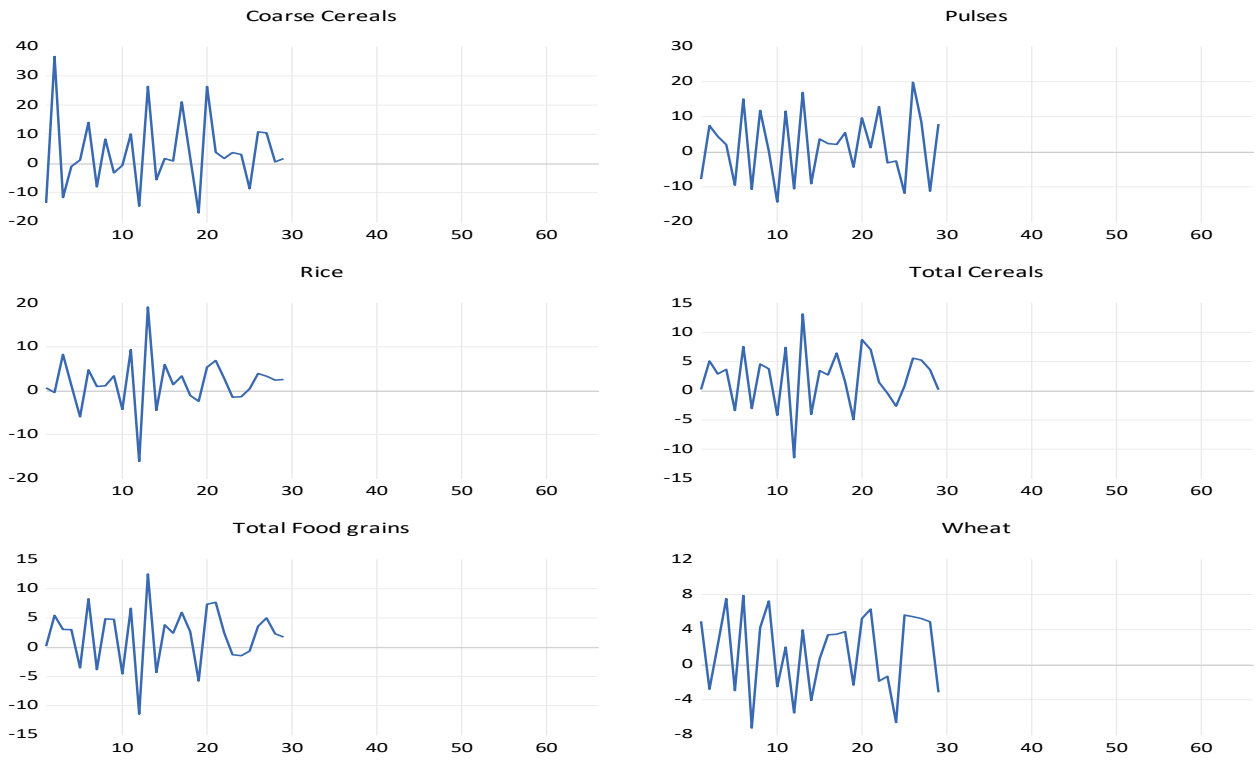

Fig.3 Trends in food-grain production

Table 8Trends in Area under Cultivation in India (2001-02 to 2015-16) (Million hectares)

Year	Rice	Wheat	Coarse Cereals	Pulses	Total Food Grains
2001-02	44.90	26.34	29.52	22.01	122.77
2002-03	41.18	25.20	26.99	20.50	113.87
2003-04	42.59	26.60	30.80	23.46	123.45
2004-05	41.91	26.38	29.03	22.76	120.08
2005-06	43.66	26.48	29.06	22.39	121.60
2006-07	43.81	27.99	28.71	23.19	123.70
2007-08	43.91	28.04	28.48	23.63	124.06
2008-09	45.54	27.75	27.45	22.09	122.83
2009-10	41.92	28.46	27.68	23.28	121.33
2010-11	42.86	29.07	28.34	26.40	126.67
2011-12	44.01	29.86	26.42	24.46	124.75
2012-13	42.75	30.00	24.76	23.26	120.70
2013-14	43.95	31.19	25.67	25.23	126.04
2014-15	43.86	30.97	24.15	23.10	122.07
2015-16	43.39	30.23	23.78	25.26	122.65
Average	43.35	28.30	27.39	23.40	122.44
S.D	1.16	1.87	2.07	1.48	3.00
C.V	2.68	6.61	7.56	6.32	2.45
LSGR	0%	1%	-1%	1%	0%

Source: Hand book of Statistics on Indian Economy, publication of RBI

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Table 9Food grains: Per Capita Availability (Kgs. per)

1990-91	172.5	2005-06	154.2
1991-92	186.2	2006-07	162.5
1992-93	171.1	2007-08	161.6
1993-94	169.4	2008-09	159.2
1994-95	172	2009-10	162.1
1995-96	180.8	2010-11	159.5
1996-97	173.5	2011-12	170.9
1997-98	183.6	2012-13	169.3
1998-99	163.2	2013-14	179.5
1999-00	170	2014-15	178.6
2000-01	165.9	2015-16	169.8
2001-02	151.9	2016-17	177.7
2002-03	180.4	2017-18	178.4
2003-04	159.7	2018-19	180.1
2004-05	168.9	2019-20	179.6

Source: Hand book of Statistics on Indian Economy, publication of RBI

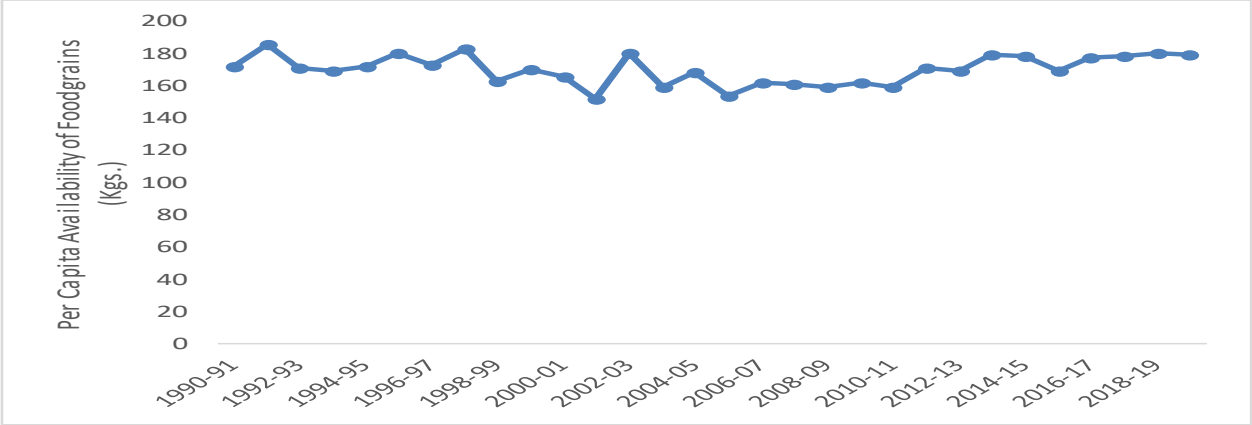

Fig.4 Per capita availability of food.

The agriculture sector faces many challenges like; decline in the land holding size for all classes of farmers (marginal, small, medium and large). The pressure on land is increasing due to urbanization, modernization, industrialization, infrastructure development and over-population. As a result agricultural land is being transferred to non-agriculture uses.

The area under cultivation for wheat and rice has increased but has declined for coarse cereals and pulses due to shift of area towards high yielding crops another the exhaustion of the possibilities of extensive agriculture. To arrive at a steady rate at which the productivity levels of the foodgrains have grown during the planning period the CAGR during different five year plans has been calculated. It is evident that the CAGR is characterized by volatility over the entire Planning period.Though the fluctuations are not as sharp as in the case of the annual growth in the productivity levels but are not too small either to deny any attention. The relative smoothening of fluctuations in case of CAGR is because of the basic difference in the nature of the concepts of Annual Growth and CAGR.

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Table 10 Index Numbers of Area, Production and Yield of Food grains

Year	Area	Production	Yield	Year	Area	Production	Yield
(Base: Triennium ending 1993-94=100)				(Base: Triennium ending 2007-08=100)			
1993-94	127.4	135.1	106.0	2007-08	101.2	105.4	104.2
1994-95	128.8	141.0	109.5	2008-09	100.9	106.5	105.5
1995-96	125.4	131.4	104.8	2009-10	100.0	100.6	100.6
1996-97	128.4	145.1	113.0	2010-11	104.4	114.3	109.5
1997-98	128.7	140.9	109.5	2011-12	104.1	119.5	114.9
1998-99	130.0	150.0	115.4	2012-13	102.0	119.4	117.1
1999-00	127.8	152.9	119.6	2013-14	105.6	123.3	116.8
2000-01	125.7	141.9	112.9	2014-15	105.4	115.9	110.0
2001-02	127.5	155.3	121.8	2015-16	103.9	115.7	111.3
2002-03	118.2	126.6	107.0	2016-17	109.0	131.1	120.3
2003-04	128.2	155.1	121.0	2017-18	107.4	136.8	127.4
2004-05	124.7	144.2	115.6	2018-19	105.6	134.4	127.3
2005-06	126.3	152.5	120.8	2019-20	108.6	139.6	128.5
2006-07	128.5	158.8	123.6				
2007-08	128.8	168.6	130.9				

Source: Ministry of Agriculture & Farmers Welfare Government of India.

Table 11Compound Annual Growth Rate (CAGR) of Food-grainsin India (Plan Period)

Five Year Plans	Rice	Wheat	Coarse Cereals	Total Cereals	Pulses	Total Foodgrains
First(1951-56)	5.18	2.04	2.05	3.49	1.53	3.07
Second(1956-61)	4.18	5.19	2.79	3.19	2.15	3.07
Third(1961-66)	-3.26	-1.82	-1.78	-2.98	-2.52	-2.85
Annual Plans(1966-69)	3.20	14.80	1.12	9.20	14.01	10.12
Fourth(1969-74)	1.76	-0.75	1.89	1.50	-5.30	0.68
Fifth(1974-80)	3.00	1.42	1.47	1.60	-3.29	1.23
Sixth(1980-85)	6.80	3.49	3.42	2.99	2.69	2.95
Seventh(1985-90)	0.03	0.90	8.55	3.70	0.09	3.51
Plan Holiday(1990-92)	2.47	4.95	-13.56	0.19	-7.79	0.14
Eighth(1992-97)	1.57	3.58	0.21	2.57	2.60	2.59
Ninth(1997-2002)	-4.31	2.68	3.49	2.77	1.72	2.81
Tenth(2002-07)	-1.88	0.93	5.17	3.62	3.04	3.42
Eleventh(2007-12)	-0.02	3.19	2.67	2.94	2.84	2.81
Twelfth(2012-17)	-0.05	0.66	2.00	0.77	-0.10	0.28
Post Plans(2017-2020)	5.63	0.78	1.08	1.85	-2.13	1.99

Source: Ministry of Agriculture & Farmers Welfare Government of India.

Whereas Annual Growth Rate gives the percentage rise in the value of the variable in the current year taking the previous year value as the base, the CAGR gives a steady rate of growth between two points in time thereby giving a uniform rate of growth during the period under consideration and smoothening the annual fluctuations in growth, if any. It can be observed that except a few volatile episodes the CAGR during the different five year plans has been in the range 0% to 5 %. There was negative CAGR for all the cereals as well as for the pulses during the third five-year plan. The negative CAGR during the third five-year plan was -3.26% for rice, -1.82% for wheat and 1.72% for coarse cereals both. It was -2.98% for all the cereals combined, 2.52% for pulses and 2.85% for all foodgrains

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combined. This was the time when the enchantment with Mahalanobis strategy of development had started fading away and it came to be increasingly realized that agriculture cannot be completely ignored while attempting to develop through industrialization. This was the warning signal of the likely implications of the unbalanced growth strategy adopted by us.

During the plan holiday from 1966 to 1969 the CAGR for all the categories of foodgrains except coarse cereals crossed saw a significant jump. The CAGR for rice, wheat and pulses were 3.20, 14.80 and 14.01 percent respectively. The CAGR for the cereals and foodgrains category were 9.20 and 10.12 percent respectively. These are the highest ever CAGRs registered under each of the individual as well as combined categories during the entire planning period. This can probably be attributed to the Green Revolution and good rainfall (monsoon) during these three years. The CAGR for coarse cereals for this period was only 1.12 %. This can probably be explained by the shift in the focus on wheat as the mainstay of Green Revolution, non-introduction of high yielding varieties of seeds of coarse cereals. Pulses and coarse cereals have been outliers as far as trends in CAGR over the planning period are concerned. Pulses witnessed negative CAGR in the fourth and the fifth five year plans, the period of plan holiday from 1990-92 and also in the recent years after the twelfth five-year plan. Except the plan holiday from 1966 to 1969 when the CAGR for pulses was 14.01%, the CAGR for pulses has stayed below 3% and has been negative for some years. This explains the neglect of pulses in our agricultural policy. The CAGR trends of total cereals and foodgrains mimic the trends of rice and wheat because rice and wheat account for most of the foodgrains production in India. Rice and wheat also account for a very large proportion of the area under cultivation. Infact the area under cultivation of coarse cereals has considerably declined over the planning period and that under pulses has more or less remained constant.

The CAGR of the coarse cereals remained less than modest in both the pre and the post Green Revolution phase before picking up in the sixth plan and reaching its peak in the seventh five-year plan. The CAGR of coarse cereals was as high as 8.55% in the seventh five-year plan. However, it fell to -13.56% in the period 1990-92 (plan holiday) and was 0.21% during the eighth five-year plan. It witnessed some upward trend after the eighth plan but is again facing a down trend in the recent years. An interesting fact about the CAGR of individual cereals, pulses, total cereals and food grains category is that except the three years of plan holiday from 1966 to 1969 the CAGR for each category has mostly been less than 5% during the entire 70year period and coarse cereals and pulses have even witnessed negative CAGR during some of the plans. Moreover, the CAGR has neither been uniform nor has it seen any persistent upward or downward trend. It has actually been fluctuating in a range 0% to 5% during the planning period. This range extends in the negative direction for pulses and coarse cereals. What better than monsoon dependence of Indian agriculture can explain this volatility even in the CAGR.

Conclusion

There is no doubt that the productivity levels of all the foodgrains have increased in the planning period. The productivity of rice more than quadrupled, of wheat increased to more than five times the initial level, of coarse cereals increased to more than 4 times the initial level and that of pulses almost doubled during the period from 1950-51 to 2019-20 but given the population that we already have, the growth rate of population and the percentage of the poor in our population we face a major food security challenge. In the wake of this challenge such increases in the productivity levels seem to be inadequate for meeting the challenge. The improvements in productivity can at best be termed modest and well below the potential for improvement. There is no room for complacency in this regard and there is a need for continuous efforts in this direction. The productivity levels are quite low as compared to many developed as well as developing countries. The CAGR has, during most of the plans been in the range 0% to 5%. The fluctuations in the annual growth in the productivity levels and the CAGR testify the belief that Indian agriculture still remains a gamble of monsoon. If we wish to have a steady and significant growth in the productivity levels in agriculture the expansion of irrigation facilities should receive utmost priority in the agricultural policy. Pulses have been neglected by the planners. Given the facts thatpulses form an inevitable part of the Indian meal, even after being the largest producer of pulses we import large quantities to fulfill our consumption needs and the per capita availability of proteins in India has declined in the recent past, pulses should receive greater attention in our agricultural policy.

References

Coelli, T. J. & Rao, D.S.P. (2003) Total Factor Productivity Growth in Agriculture: A Malmquist Index Analysis of 93 Countries, 1980-2000. International Association of Agricultural Economics Conference held in Durban, August.

ISSN- 2394-5125 VOL 07, ISSUE 01, 2020

Dev, M. S. (2012). Policies for Raising Agricultural Growth and Productivity in India. Prepared as part of the project 'Policy Options and Investment Priorities for Accelerating Agricultural Growth in India' IGIDR Mumbai, India.

Dev, M. S. (2012). Policies for Raising Agricultural Growth and Productivity in India. Prepared as part of the project 'Policy Options and Investment Priorities for Accelerating Agricultural Growth in India' IGIDR Mumbai, India.

Fuglie, K., & Schimmelpfennig, D. (2010). Introduction to the special issue on agricultural productivity growth: a closer look at large, developing countries. J Prod Anal,33, 169-172.

Fulginiti, L. E., & Perrin, R.K. (1998). Agricultural Productivity in Developing Countries. Agricultural Economics,19, 45-51.

Hayami, Y., & Ruttan, V.W. (1970). Agricultural Productivity Differences among Countries. The American Economic Review,60(5) 895-911.

Kumar, P., & Mittal, S. (2006). Agricultural Productivity Trends in India: Sustainability Issues. Agricultural Economics Research Review 19, 71-88.

Mozumdar, L. (2012). Agricultural Productivity and Food Security in the Developing World. Bangladesh J. Agric. Econs,35(2), 53-69.

Priyardarsini, B. T., & Nayak, C. (2017). Determinants of Agricultural Productivity in India: An Econometric Analysis. Manthan: Journal of Commerce and Management,4(2), 41-53.

Evenson, R.E. &. Jha, D. (1973) The contribution of the agricultural research system to agricultural production in India. Indian Journal of Agricultural Economics, 28(4),212-230.

Fan, S., HazellP.B.R.& Thorat,S. (1999) Linkages between Government Spending, Growth, and Poverty in Rural India. Research Report No. 110. Washington, D.C: International Food Policy Research Institute.

Fuglie, K., & Schimmelpfennig, D. (2010). Introduction to the special issue on agricultural productivity growth: a closer look at large, developing countries. J Prod Anal,33,169-172.

Fulginiti, L. E., & Perrin, R.K. (1998). AgriculturalProductivity in Developing Countries. Agricultural Economics,19,45-51.

Hayami, Y., & Ruttan, V.W. (1970). AgriculturalProductivity Differences among Countries. The American Economic Review,60(5) 895-911.

Joshi, P.K., Joshi, L., Singh, R.K., Thakur, J., Singh K, & A.K. Giri, (2003) Analysis of Productivity Changes and Future Sources of Growth for Sustaining RiceWheat Cropping System. National Agricultural Technology Project ((PSR 15; 4.2), New Delhi: National Centre for Agricultural Economics and Policy Research (NCAP).

Kumar, P. &. Rosegrant, M.W. (1994) Productivity and sources of growth for rice in India. Economic and Political Weekly, 29(52), 183-188.

Kumar, P., Kumar, A. & Mittal, S. (2004) Total factor productivity of crop sector in the Indo-Gangetic Plain of India: Sustainability issues revisited. Indian Economic Review, 39(1),169-201

Kumar, P., & Mittal, S. (2006). Agricultural Productivity Trends in India: Sustainability Issues.Agricultural Economics Research Review 19, 71-88.

Minhas, B.S. & Vaidyanathan,A. (1965) Growth of crop output in India, 1951-54 to 1958-61: An analysis by component elements. Journal of the Indian Society of Agricultural Statistics, 17(2), 230-252.

Mozumdar, L. (2012). AgriculturalProductivity and Food Securityin the Developing World. Bangladesh J. Agric. Econs,35(2),53-69.

Priyardarsini, B. T., & Nayak, C. (2017). Determinants of AgriculturalProductivity in India: An Econometric Analysis. Manthan: Journal of Commerce and Management,4(2),41-53.

Rozelle, S. Jin, J. Huang and R. Hu, (2003) The impact of investments in agricultural research on total factor productivity in China. Crop variety improvement and its effect on productivity. In: The Impact of International Agricultural Research, Eds: R.E. Evenson and D. Gollin. UK: CABI Publishing.

Schultz, T.W. (1953) Economic Organization of Agriculture, New York: McGrawHill Co.

Sindhu, D.S. and D. Byerlee, (1992) Technical Change and Wheat Productivity in the Indian Punjab in Post-GR Period. Working Paper 92-02, Economics, Mexico: CIMMYT

Solow, R.M., (1957) Technical change and aggregate production function.Review of Economics and Statistics, 39(3), 312-32