Growth and Instability in Agriculture Production in Odisha, India

ABSTRACT

The performance of agriculture sector in any economy is better understood through the analysis of growth and instability in agriculture production. It is evident that the growth of agriculture in Odisha is very erratic in nature and huge instability is there in agricultural production. Instability in agriculture affects the trend and pattern of production which creates risk in farmers' ability to adopt new technologies. Therefore, this paper aims to study the growth and instability in agriculture production in Odisha where growth and instability on area, yield and production of twenty crops have been calculated. Instability in agriculture production is caused by various agricultural reforms, weather variation and price fluctuation. Therefore, in this study attempt has been made to analyse the contribution of agriculture and allied sector to GSVA in Odisha over the years, sectoral employment, and district wise crop intensity. To examine growth and instability in agriculture of twenty major crops, this study has undertaken decadal analysis by using secondary data. Total four decades i.e. 1970-80, 1980-90, 1990-00, 2000-10 and 2010-20 are considered. The results show that, agriculture sector is leading sector in providing employment and significantly contribute to GSDP in Odisha. However, the area under cultivation of all the crops area gradually decreasing due to the urbanization but the percentage of area under cereal cultivation is decreasing whereas percentage of area under pulses are increasing but the area under total food grains is decreasing showing farmers are switching towards non-food grain products. So far, the growth of production and yield of different crop areas shows erratic growth in agricultural crops, as evident from the high instability rate in the growth of different crops. The cropping intensity shows that it is lower than the national level and therefore the role of technology needs to be identified.

Keywords: [Agricultural Growth, Instability, Performance of Agriculture, Production)

1. INTRODUCTION

Agriculture is considered the backbone of the economy of Odisha. Odisha, which is located in the eastern part of India, is an agriculturally dependent state. Geographically, Odisha lies between 17.49'N and 22.34'N latitudes and 81.27'E and 87.29'E longitudes. Historically, agriculture has been the dominant sector in Odisha, and it absorbed 48.31 percent of the state's total workers in 2019–20 [1]. Agriculture is an important source of livelihood and acts as the backbone of the Odisha economy [2]. Although there is a sharp decline in its share of GSDP/GSVA, it plays a vital role in constructing the livelihood, employment, and income for the inhabitants of Odisha. However, by looking at the status of agriculture in Odisha, it is evident that the growth is very erratic in nature, which creates instability in agricultural production. While we are talking about performance in agriculture, it has two aspects, i.e., growth and instability in agriculture. Growth in agriculture is necessary to understand the performance of agriculture in Odisha. Instability in agriculture affects the trend and pattern of production, which creates a risk to farmers' ability to adopt new technologies. Instability in production affects consumers and price stability, and it also increases the vulnerability of

low-income households to the market [3].[4] observed that the area under different crops in Odisha is gradually declining, whereas the growth rate of different crops is highly irregular with high rates of instability. They attribute the source of instability to climate change and climate shocks.

Instability in agriculture after the liberalization era caused fluctuations in price stability and impacted the food supply process [5]. [6] studied the growth and instability in agricultural production in two different periods. One was a gloomy and depressing phase, and another decade was an improved one, because in the first decade there was regular instability due to the advent of the Super Cyclones, and in the second decade most of the government policies were undertaken. [7] analyzed growth and instability in oilseed production, especially groundnut production in Odisha. Instability in agricultural production is happening due to a number of agricultural reforms [8]. Weather variation and price risk are the key reasons for instability in agricultural production, but weather variation is the greatest contributor [9]. Patnaik and [10] observed the sluggish growth of area, yield, and production due to the low level of technology adoption and infrastructural development. Agricultural inputs and various economic reforms are the driving forces behind the growth and instability of agriculture [11]. On the other hand, various agricultural reforms, i.e., the green revolution, and various agricultural policies create instability in agricultural production [12]. Given the importance of growth and instability in the agriculture sector, here we have made a modest attempt to study the growth and instability of agriculture in Odisha.

Considering the research gaps and issues in the mentioned literature, this study aims to study the growth and instability in agriculture production in Odisha, where growth and instability on area, yield, and production of twenty crops have been calculated. Instability in agriculture production is caused by various agricultural reforms, weather variation, and price fluctuation. Therefore, in this study, an attempt has been made to analyze the contribution of agriculture and the allied sector to GSVA in Odisha over the years, sectoral employment, and district-wise crop intensity. Further, attempts have been made to analyze the growth and instability of agricultural areas, yields, and production during the last five decades in Odisha. A compound annual growth rate method has been used to calculate the growth in area, yield, and production of twenty crops in Odisha.

2. MATERIAL AND METHODS

Data compilation has been done on important variables like crop intensity, yield, area, and production of major crops, collected from various secondary sources, i.e., various rounds of five decades of Odisha agricultural statistics. For other essential variables, data have been collected from the Ministry of Agriculture and Farmers Welfare, the Government of India, and the RBI Handbook. To examine Odisha's growth and instability in agriculture for twenty major crops, this study has undertaken a decadal analysis. Total of four decades, i.e., 1970–80, 1980–90, 1990–00, 2000–10, and 2010–20. In each decade, analysis has been made on the growth and instability of the area, yield, and production of major crops in Odisha.

First of all, this study has converted the original secondary data into natural logarithmic form. Then, on the basis of linear regression analysis, for each crop, there are three variables related to area, yield, and production. For calculating the regression coefficient here, we

have taken twenty major crops. And for each of the of the sixty variables, we have run one regression with respect to independent variable time. For each crop there we find three regression coefficients. And total sixty regression coefficient we have got by running regression equations in STATA 15.0 software.

Initially, CAGR for area, yield and production was estimated as follows:

$X_t = A\beta t$

Where, X_t = Production, yield and area in t^{th} period.

β = 1+g and g = Compound growth rate of X.

A = Initial year production yield and area

t = Time in years

When log transformation will be done the equation will be

$\ln x_t = \ln A + t.\ln\beta$

After log transformation the CAGR (Compound Annual Growth Rate) can be calculated as follows[13]

g= {antilog (lnβ) – 1} *100

3. STATUS OF AGRICULTURAL PRODUCTION IN THE STUDY AREA

3.1 Percentage of Area Under Agricultural Cultivation of Different Crops in Odisha

Agriculture is one of the most important sectors in Odisha in terms of the gross value added and employment provided. It is very important to understand the significance of different crops cultivated in Odisha and therefore, it is required to know the percentage of area under cultivation of a crop to total gross crop area.Table1. shows the percentage of area to gross crop area under different crops in Odisha. It is evident from the Table 1. that, percentage of gross crop area under rice is highest among all the crops across the study period 1970-71 to 2018-19. However, percentage of the gross crop area under rice is gradually decreasing over the period of time. During 1970-71 approximately 66.13 percent of total cultivated area were under rice production, and then it decreases over the period of time and stood at 46.28 percent in 2018-19. Rice is the major cultivated cereal crop in Odisha and its declining percentage of area indicates that farmers are switching to other crops. Area covered under Ragi production decreases from 2.31 percent during 1970-71 to 1.41 during 2018-19. Further, the overall area under cereal production is almost three-fourth of the total area under agriculture but this has decreased from 72.4 percentduring 1970-71 to 51.25 percentduring2018-19. This is a clear indication that the farmers are switching from cereal production to other crops. In case of pulses the percentage of area covered under Moong production has increased from 4.78 to 10.04 percentage followed by Biri (Black Gram)production from 2.99 to 5.87 percentage. Area under Kulthi has decreased from 2.59 to 2.46 percentage. In case of total pulses there is overall increase in area under cultivation from 12.5 percentage to 23.4 percentage during 1970-71 to 2018-19. This shows that

farmers area switching crop production from cereals to pulses as pulses are more rewarding and considered as cash crop. Further, area under the production of total oilseed has been quite erratic during 1970-71 to 2018-19. One of the significant factors is that the total area under food grains that include cereals and pulses is gradually decreasing as farmers are switching to cash crops. So far as the area under Fibres is concerned, it was 1.15 percent during 1970-71 which increased to 2.08% during 2018-19. Besides this, the area covered by the production of Potato, Sugarcane, and Tobacco have also been decrease from 0.31, 0.44, and 0.21 percentage to 0.3, 0.3, and 0 percentage respectively.

Table1. Percentage of area to gross crop area under different crops in Odisha

CROP\ Year	1970-71	1980-81	1990-91	2000-01	2010-11	2018-19
Rice	66.13	47.92	45.89	56.28	46.54	46.28
Ragi	2.31	3.84	2.58	2.4	1.98	1.41
Small millets	2.4	4.13	0.74	0.51	0.17	0.39
Other Cereals	1.56	3.36	2.44	2.65	3.11	3.17
TOTAL CEREALS	**72.4**	**59.25**	**51.67**	**61.85**	**51.8**	**51.25**
Moong	4.78	7.88	7.66	5.96	9.21	10.04
Biri	2.99	4.69	5.97	5.42	6.8	5.87
Kulthi	2.59	3.92	4.23	3.44	2.69	2.46
Other pulses	2.14	3.24	4.35	2.81	4.21	5.04
TOTAL PULSES	**12.5**	**19.73**	**22.21**	**17.64**	**22.9**	**23.4**
TOTAL FOODGRAINS	84.9	78.98	73.89	79.49	74.7	74.65
TOTAL OILSEEDS	4.88	8.42	12.06	8.94	8.49	7.08
TOTAL FIBRES	1.15	1.14	0.94	1.12	1.19	2.08
Potato	0.31	0.09	0.09	0.1	0.15	0.3
Sugarcane	0.44	0.56	0.51	0.4	0.45	0.3
Tobacco	0.21	0.24	0.16	0.04	0.03	0
Other crops including fruits	8.11	10.57	12.35	9.91	14.99	15.6
GROSS CROPPED AREA	**100**	**100**	**100**	**100**	**100**	**100**

Sources: Five Decades of Odisha Agriculture Statistics - 2020 (DAFP, Odisha)

3.2 Cropping Intensity in Odisha vis-à-vis India

Besides the growth and instability, the cropping intensity is another indicator of the performance of agriculture in an economy. Higher the cropping intensity more is the agriculture production as the agricultural activities are intensified over the years. The cropping intensity is calculated by dividing the gross crop area by the net crop areas.Fig. 1. shows a comparative analysis of cropping intensity in Odisha vis-à-vis India during 2004-05 to 2019-20 which reveals that a cropping intensity at all India level is more than Odisha. Figure 2 reflects that, during 2004-05 Odiaha's cropping intensity washigher i.e. 151.9 in comparison to national copping intensity of 135.9 percent. But over the past decade the linear trend line shows that, the performance of Odisha in terms of its cropping intensity is continuously declining. In year during 2019-20 the cropping intensity of India was 152.2

percent outweighing cropping intensity of Odisha. 113.8. A close look of trend line in figure reveals that, all India's growth of cropping intensity was less fluctuating than in Odisha. The reason behind it can be various climate shocks and its impact on this coastal state. Another major reason which can be responsible is that, in districts like Bolangir, Cuttack, Ganjam, Nawapara, Nayagarh, and Subarnapur the cropping intensity is falling over the years.

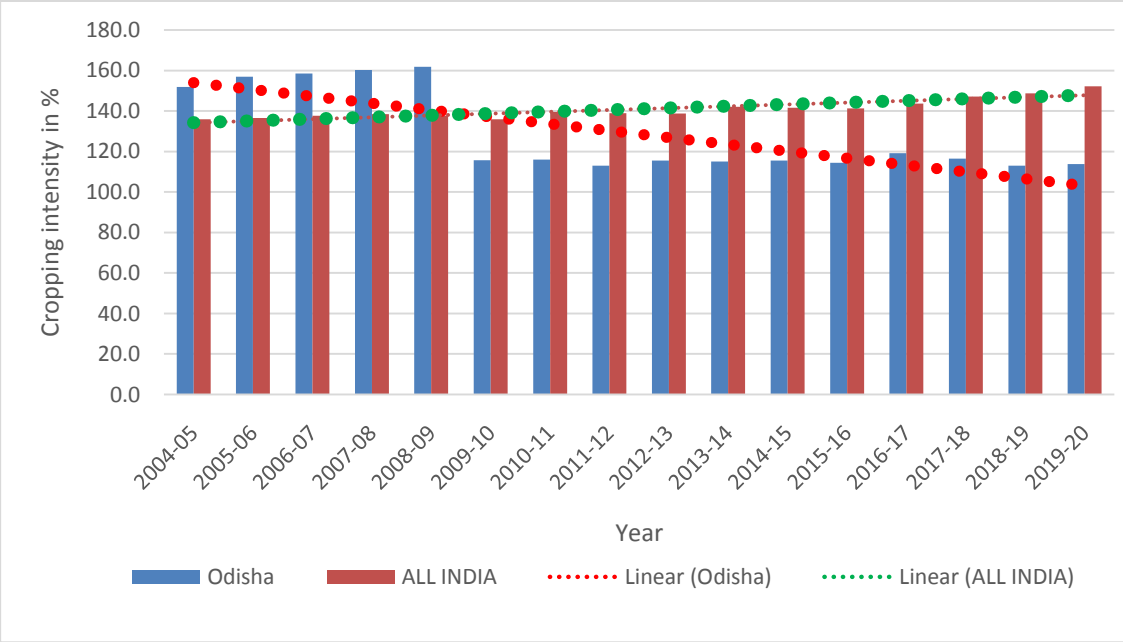

Fig.1. Cropping Intensity in Odisha Vs India

Source: Ministry of Agriculture and Farmers Welfare, Government of India

3.3 District wise Cropping Intensity in Odisha

To gauge the performance of agriculture, it is very pertinent to analyse the cropping intensityregion wise so that we can find out the lagging regions. Table 2 shows twenty-seven years data with five years of interval regarding cropping intensity of different districts of Odisha. The leading districts showing increasing cropping intensity are Anugul, Balasore, and Bargarh. The increasing cropping intensity of Anugul shows that, in reference years cropping intensity was144% during 1994-99 which has increased to 177% during 2014-20. Similarly, the cropping intensity of Balasore's has increased from 141 to160 during the reported years. So far as Cuttack district is concerned, its cropping intensity found to be highest among other districts but the intensity rate found to be varying over the years. Similarly, the performance of Bhadrak, Jagatsinghpur and Koraput found to be less

intensive.On an average district, like Bolangir, Cuttack, Ganjam, Nuapara, Nayagarh, and Subarnapur district reflects decline picture of cropping intensity over the years. In Gajapati, Sambalpur, Nabarangpur there is increase in cropping intensity i.e. from reference year1994-99 to 2014-20.

During 1994-99, the top five districts in which percentage of crop intensity was higherare Cuttack, Jagatsingpur, Ganjam, Puri, and Khurda. Similarly,fivelowest crop intensity districts were Bargarh, Kandhamal, Jharsuguda, Maurbhanj and Sundargarh and their cropping intensity during 1994-99 were 134, 132, 129, 125 and 123 percentage respectively.Similarly, during 2014-20, top five districts having higher crop intensity were Gajapati, Jajpur, Dhenkanal, Jagatsingpur, and Angulwhere the cropping intensity were 202, 185, 181, 179 and 177 percentage respectively. Five districts having lowest crop intensity during this periodare Boudh, Bargarh, Maurbhanj, Nawapara, and Sundargarh.

Table2.District wise cropping intensity (%)

DISTRICTS	1994-99	1999-04	2004-09	2009-14	2014-20
ANGUL	144	150	172	172	177
BALASORE	141	137	147	160	160
BARAGARH	132	130	141	147	139
BHADRAK	138	127	140	139	142
BOLANGIR	134	126	141	152	141
BOUDH	143	140	161	167	140
CUTTACK	181	176	191	207	175
DEOGARH	140	138	180	175	159
DHENKANAL	153	149	165	185	181
GAJAPATI	150	159	188	203	202
GANJAM	172	164	178	187	159
JAGATSINGPUR	174	175	191	200	179
JAJPUR	167	169	184	195	185
JHARSUGUDA	125	127	151	145	154
KALAHANDI	153	143	158	177	172
KANDHAMAL	129	138	159	177	155
KENDRAPARA	162	168	186	189	173
KEONJHAR	136	140	149	156	152
KHURDA	168	158	174	187	176
KORAPUT	145	133	135	147	148
MALKANGIRI	143	140	161	168	175
MAYURBHANJ	123	120	130	136	136
NAWAPARA	137	139	162	161	135
NAWARANGPUR	139	134	155	158	162
NAYAGARH	168	161	172	192	154
PURI	169	178	210	202	177
RAYAGADA	144	142	162	167	160
SAMBALPUR	135	132	165	157	170
SUBARNAPUR	158	153	183	186	155
SUNDARGARH	123	123	125	134	135

**Sources: Calculated by author*

3.4 Seed Replacement Rate of Paddy in Odisha

As it is evident from the abovethat, rice is the leading crop in Odisha but area under its cultivation is gradually declining, therefore, it is required to understand that whether any technological improvement is taking place in rice cultivation as it supports large part of the population. Hence, the following section shows the seed replacement rate of paddy in Odisha over the years. The paddy replacement rate shows that at what rate farmers is changing paddy towards high yielding varieties (HYV). This helps us to understand the technological intervention in Odisha's agriculture. Therefore, Figure 2. shows the seed replacement rate in terms of paddy in Odisha over the period 1995-96 to 2019-20.Figure 2. shows that seed replacement rate for paddy was 4.16 percent during 1995-96. Gradually, with all fluctuations it started increasing from 2006-07 to 2015-16, which is the highest in percentage of seed replacement rate of paddy.During 2019-20,it has been seen that the seed replacement rate of paddy is 28.39 percent. Therefore, fluctuation in the rate of seed replacement of paddy is observed, however, the rate of replacement is very rapid in the recent years. This shows that to increase the level of production and yield rate seed replacement is a better way for this purpose.

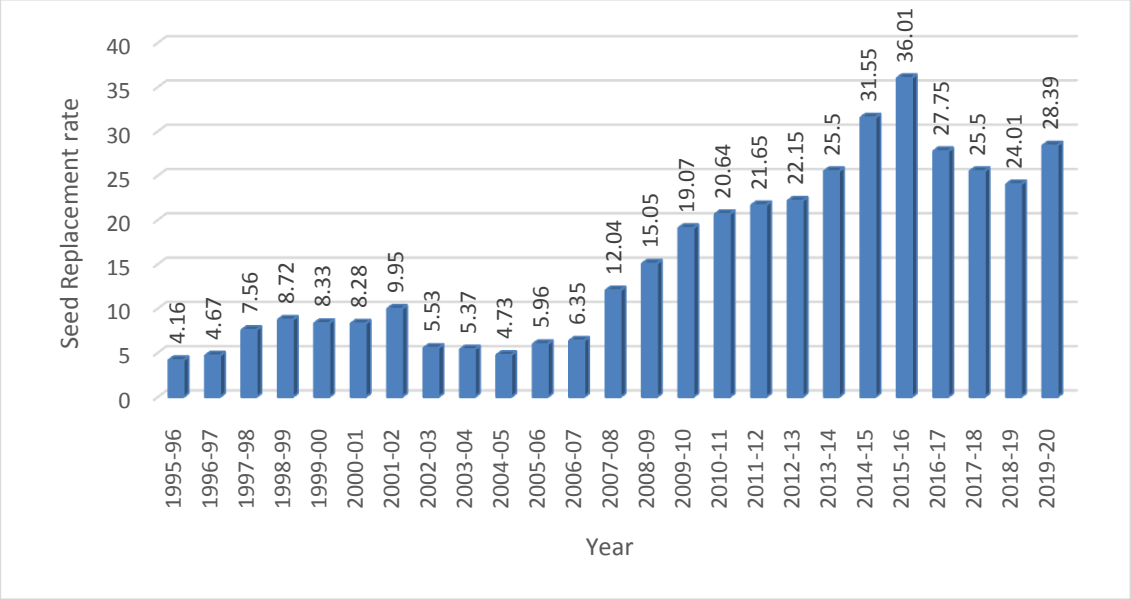

Fig. 2. Seed Replacement rate for Paddy

4. RESULTS AND DISCUSION

4.1. Average Area, Yield and Production of selected crops in Odisha during 1970-2020

After discussing thestatus of agriculture in Odisha, it is now, important to analyse the production and yield of different products along with the area under cultivation over the yearsto understand the growth and instability in production. This will help us to understand the performance of different crops in terms of production and yield over the time. Therefore, the performance of rice, wheat, Maize, Ragi, Jowar, Bajra, Small millets, Groundnut, Sesame (til), Castor, Niger, Sunflower, Safflower, Linseed, Mustard, Green gram, Black gram, red gram/ arhar, Horse gram (kulthi), Cowpea and Bengal gram (rabi) is represented inTable 3. This Table 3. presented decadal average of area, yield and production of twentycrops.

Table 3. Decadal average of area, yield and production of different crops in Odisha

Crops	Particulars	1970-80	1980-90	1990-00	2000-10	2010-20
Rice	Area	4471.8	4259	4494.8	4440.2	4005.7
	Yield	862.9	1064.5	1284	1433.3	1981.6
	Production	3866.3	4555	5773.7	6376.1	7937.2
Wheat	Area	48.997	55.538	21.856	17.769	8.335
	Yield	1692.1	1786.8	1571.7	1404.4	1744.4
	Production	83.906	100.432	34.997	25.066	14.263
Maize	Area	103.947	168.162	169.151	191.205	258.898
	Yield	824	1056.4	1164.4	1574.9	2744
	Production	85.819	177.334	196.535	311.452	709.066
Ragi	Area	216.527	289.38	219.354	189.073	148.047
	Yield	742.1	850.6	785.2	791.2	892.7
	Production	156.071	243.789	174.885	149.389	131.192
Jowar	Area	25.23	33.158	19.793	10.367	6.981
	Yield	655.2	811.4	643.3	589.6	626.1
	Production	16.483	26.948	13.062	6.084	4.365
Bajra	Area	5.576	8.826	5.592	3.222	2.439
	Yield	433.6	862.9	632.3	558.3	615.2
	Production	2.466	7.701	3.692	1.79	1.5
Small millets	Area	197.732	163.191	58.147	26.33	23.802
	Yield	424.2	546.2	489.8	453.6	505
	Production	83.729	90.625	28.789	11.712	12.069
Groundnut	Area	108.297	302.133	312.294	230.314	231.916
	Yield	1251	1325.2	1309.1	1493.5	1777.8
	Production	130.99	398.305	412.003	347.482	411.523
Sesamum(til)	Area	119.999	269.152	324.964	277.817	219.181
	Yield	447.2	514.6	407	336.2	400.4
	Production	52.26	139.085	134.92	94.45	87.716
Castor	Area	28.658	39.827	26.041	17.066	10.48
	Yield	606.3	561	498.2	550.5	633.7
	Production	16.845	22.307	13.079	9.409	6.635
Niger	Area	100.759	179.017	181.332	121.906	68.189
	Yield	404.8	423.8	406.3	287.9	368.6
	Production	39.602	75.886	75.178	34.539	25.261
Sunflower	Area	1.40125	1.964	5.279	10.781	19.649
	Yield	467	494.4	588.6	818.8	1195
	Production	0.6275	0.922	3.353	9.34	23.381
Safflower	Area	2.756667	4.065	2.49	1.576	0.578
	Yield	463.2222	430.2	415.6	553.3	599.7
	Production	1.262222	1.772	1.072	0.87	0.347
Linseed	Area	22.896	34.414	30.914	22.781	24.19
	Yield	404.2	409.2	418.3	399.9	474.7
	Production	9.262	14.072	13.038	9.217	11.064

Mustard	Area	90.71	133.025	144.925	108.093	115.984
	Yield	434.7	481.6	443	328.6	421.4
	Production	38.402	63.9	65.797	35.685	48.853
Green gram	Area	438.959	655.906	664.129	666.189	835.62
	Yield	479.1	531.7	448.1	370.3	466.8
	Production	207.662	348.024	303.267	250.789	390.326
Black gram	Area	258.922	499.234	541.945	550.022	546.235
	Yield	478.6	548.6	488.1	382.6	458.4
	Production	122.29	273.677	269.115	213.034	249.451
Red gram/ arhar	Area	56.453	128.787	153.944	133.064	137.956
	Yield	503.5	717.1	693.3	739.4	924.7
	Production	28.336	93.985	108.067	98.595	127.397
Horse gram (kulthi)	Area	239.413	369.53	354.697	254.674	222.013
	Yield	435.6	484.5	441.9	342	407.1
	Production	102.614	179.583	159.252	87.199	90.137
Cowpea	Area	18.698	13.876	25.238	56.463	55.577
	Yield	445.4	573.8	572	606.9	730.7
	Production	8.28	8.026	13.985	35.499	40.666
Bengal gram (rabi)	Area	29.817	47.154	34.604	32.627	38.732
	Yield	496.5	630.1	601.4	648	773.1
	Production	14.702	29.823	21	21.362	29.919

**Sources: calculated by Author from Five Decades of Agricultural Statistics, Odisha*

4.2. Growth Rates in Area, Production and Yield of Selected Crops in Odisha

The area, yield and production of different crops over last five decades reveal the performance of agriculture in Odisha. However, the actual performance of different crops is known from the growth rate and instability in it. Therefore, to understand the growth rates of different crops over last five decades, we have calculated annual compounded growth rates of different crops as shown in Table4. In Odisha Rice is the major crop among cereals and non-cereals group. Though, the area covered under rice production has decreased from 4471.8 thousand hectares to 4005.7 thousand hectares from 1970-80 to 2010-20 but there is tremendous increase in yield of rice from 862.9 kg/hectares to 1981.6 kg/hectares and production from 3866.3 thousand tones to 7937.2 thousand tones during 1970-80 to 2010-20. Major increase in production happened just after green revolution and various promoting activities devoted towards the production of rice. After rice wheat stands as a major produced crop. Yield of wheat increases from 1692.1 kg/hectares to 1744.4 kg/hectares during 1970-80 to 2010-20.

Besides these crops the production of Maize, ground nut, Sunflower, Mustard, Linseed, Black gram, Red gram/ arhar, Cowpea, and Bengal gram (rabi) havealso increased. On the other hand, there are the crops like; Ragi, Jowar, Bajra, Small millets, Castor and Niger that shows depressing picture of production in Odisha during 1970-80 to 2010-20.

Table- 4 Compound Decadal Average Annual Growth rate of Area, Yield and Production of Different Crops in Odisha

Crops	Particulars	1970-80	1980-90	1990-00	2000-10	2010-20
Rice	Area	-0.86101	0.404446	0.155711	-0.02702	-0.88191
	Yield	-0.26274	3.560241	-1.44613	4.989945	2.896156
	Production	-1.12596	3.978213	-1.29173	4.961392	1.989094
Wheat	Area	13.95644	-6.99101	-7.23358	2.049755	-23.5895
	Yield	1.141992	-1.75676	-3.48983	2.048142	1.017684
	Production	15.25675	-8.6251	-10.4666	4.140014	-22.8105
Maize	Area	8.240899	-0.2223	-0.32764	3.970623	-0.77907
	Yield	-0.78526	0.353353	1.569713	9.378242	2.462931
	Production	7.391441	0.125348	1.231764	13.7231	1.66628
Ragi	Area	7.911364	-3.29785	-2.77878	-0.41267	-5.35321
	Yield	-4.75458	2.102528	-3.61761	2.551456	1.668923
	Production	2.780247	-1.26963	-6.29246	2.130008	-3.7759
Jowar	Area	6.219891	-2.09009	-7.17087	-4.08687	-4.6056
	Yield	-13.6706	-1.21439	-3.74621	1.682477	0.348486
	Production	4.660553	-3.27892	-10.6435	-2.47982	-4.26376
Bajra	Area	11.12984	-3.16091	-8.66137	-4.93752	-6.85901
	Yield	1.653705	-0.04126	-4.79833	1.466043	0.090711
	Production	12.96116	-3.20327	-13.0417	-3.5438	-6.76333
Small millets	Area	4.022559	-12.2923	-6.28149	-9.6349	9.500814
	Yield	-1.95435	-0.21419	-2.21895	3.007241	0.619179
	Production	1.989165	-12.4836	-8.35479	-6.91555	10.17175
Groundnut	Area	1.989165	8.506577	-5.06527	2.063859	-3.57934
	Yield	-4.19987	-0.58356	-1.92552	4.718289	0.926879
	Production	4.562218	7.870689	-6.89202	6.879271	-2.68382
Sesamum(til)	Area	7.764446	5.94555	-2.81166	4.350329	-2.55385
	Yield	-4.13592	1.291792	-4.4771	3.858084	0.163834
	Production	3.284672	7.32182	-7.16108	8.371061	-2.40628
Castor	Area	5.724969	-4.0478	-2.83927	-0.33888	-8.35957
	Yield	-7.16187	0.486942	-2.68228	3.722969	0.11856
	Production	-1.85488	-3.57695	-5.43967	3.386127	-8.25648
Niger	Area	7.856181	1.999671	-3.39702	-4.3824	-5.76822
	Yield	-4.5624	1.486328	-5.2933	5.799256	-0.57923
	Production	2.940771	3.518929	-8.50019	1.165773	-6.30751
Sunflower	Area	0.601089	11.67795	6.201091	16.53299	-5.67601
	Yield	-3.65257	0.337839	3.284487	3.921799	1.418517
	Production	-3.06145	12.05117	9.699157	21.10531	-4.33806
Linseed	Area	9.747106	0.853381	-2.14804	3.900258	-16.5558

	Yield	-0.15013	0.640895	-2.43573	3.061509	1.083831
	Production	9.595354	1.502689	-4.53614	7.088178	-15.65
Mustard	Area	11.22091	0.361281	-4.97611	1.338316	-1.66714
	Yield	-3.47737	-0.04011	-5.62362	3.763014	1.17847
	Production	7.346282	0.306709	-10.3255	5.154951	-0.50521
Green gram	Area	7.827549	0.408402	-3.53977	5.48419	0.218849
	Yield	-2.60735	-1.89003	-3.45403	3.560086	1.401125
	Production	5.019567	-1.49034	-6.8597	9.232254	1.606091
Black gram	Area	7.073186	3.251936	-2.86783	3.82365	-3.3234
	Yield	-1.88611	-0.06428	-5.60675	3.075001	1.489717
	Production	5.048325	3.177869	-8.31612	7.014216	-1.88248
Red gram/ arhar	Area	3.600327	7.062094	-2.62906	0.272731	-0.32928
	Yield	-2.575	3.225032	-4.02168	3.732076	2.02953
	Production	0.927666	10.51676	-6.53924	4.01689	1.695056
Horse gram (kulthi)	Area	8.941211	2.002262	-3.34507	-0.497	-1.32024
	Yield	-2.66347	1.230114	-5.00069	3.678471	2.540894
	Production	6.036777	3.254817	-8.18256	4.187357	1.189448
Cowpea	Area	8.902718	-4.73346	13.5916	11.65623	3.607932
	Yield	-0.88546	0.022553	-2.39071	3.655198	0.469067
	Production	7.937654	-4.70701	10.86701	15.73912	4.100574
Bengal gram (rabi)	Area	8.859633	-1.77485	-2.31313	7.954213	-4.24816
	Yield	-1.9405	1.382682	-1.82353	1.446969	0.08992
	Production	6.737184	-0.426	-4.09529	9.526966	-4.15665

**Sources: calculated by Author from Five Decades of Agricultural Statistics, Odisha*

It is evident from the Table4. that, production of major crop like rice shows negative growth rate in area -1.12% that resulted in negative yield of -0.26% during 1970-80. During 1980-90 the compound annual growth rate of rice production was 3.97%. This resulted for the prevalence of great green revolution in India. Again, during the decade 1990-00,depressing phase of negative growth rate in production of ricewas observed i.e. -1.29% which resulted in negative yield rate of -1.44. Then gradually it is found that, the growth rate of rice production increased to 4.97 percent in next decade. On the other hand, growth rate of area under production of rice decreased continuously.

During 1970-80 the decadal growth rate of maize production was tremendous. The growth rate was 7.39 which increased to 13.73% in 2000-10. During thisdecade, 13.73 % growth in production rate caused a positive increase in the yield rate i.e. 9.37.

It is very interesting to address that, except green gram, small millets and cowpea, all other crops have maintained negative growth rate in this area during decade the 2010-20. During 1990-00, except Maize, Cowpea and Sunflower all other crops have shown negative

growth rate in production due to devastating impact of 1999 Super Cyclone. Negative growth rate in production creates negative yield rate. During 1970-80, except Rice, Castor and Sunflower all other crops have shown showing positive growth. This is the period of Green Revolution, which has impacted on the production of these crops.

This is evident from the above analysis that, the growth rate of crops in Odisha is highly fluctuating. In some decades there is negative growth in area used for production and resulted in negative yield rate.There are numerous causes responsible for it. Major one which can be addressed is changing climatic conditions in Odisha. As Odisha being situated at the head of the Bay of Bengal, its location and existence makes it the hub of cyclones, flood and inundation. Every year this state faces one cyclone and sometimes flood. So, a systematic analysis is required to check the instability in production, area and yield rate of these crops. Then we can suggest some policy suggestions. Therefore, in the following section an analysis of the instability in area, production and yield of the above selected crops produced in Odisha has been made.

4.3. Instability in area, production and yield of selected crops in Odisha

Instability in growth of area, production and yield rate is found in agriculture due to many reasons. Climate changes, different geographical divide, soil pattern, technology used for production, seed variation are the prominent reasons among them.Table5 shows instabilityinarea under cultivation, production and yield rate of nineteen major crops in Odisha. The purpose is here to show the variation in agricultural crop area, production and yield rate during 1970-2020. Among all the crops highest instability is found in production of Wheat, Bajra, Red gram and Bengal gram during 1970-2020.Further,instability is higher in case of Rice and Bengal-gram during 1970-2020.

During 1970-80 the instability in production was highest in case of Bajra (56.77%) followed by Linseed (35.79%), Bengali gram (34.12%), wheat (33.93%) and Red gram (33.29%). During overallperiod1970-2020, the instability in area covered under production is highest in case of Wheat, Bajra and Linseed during the period 10970-2020. Among all the crops instability in production of Bajra is found across the time period under study. During 2010-20 instability of rice production was 31.95 % which has resulted 32.03% of instability in yield rate of production. In the same decade wheat indicates 40.81% of instability which was 33.97% in initial decade of 1970-80. This shows thatmost of the crops are showing high instability during 2010-20.

During the period of 1990-00 all the crops were showing instability in area, production and yield rate which is almost greater than 30%. This shows erratic and unstable growth rate of

area, production and yield rate of major crops in Odisha. Thus, for different crops the intensity of instability is different from area, production and yield basis. Different geographical divide extents the instability rate. For all the crops, yield rate instability is above 30 %. For area, the instability rate is more than 35 % for selected crops and further high instability also found in case of production of different crops. The reason behind it is, climate change is regularly happening in Odisha, agricultural farmers are mostly illiterate, lack of modern technology use in agriculture and geographical divide of Odisha[13].

Table5. Instability of Area, Yield and Production of Different Crops in Odisha

Crops	Particulars	1970-80	1980-90	1990-00	2000-10	2010-20
Rice	Area	31.62667	31.63166	31.63648	31.61888	31.62864
	Yield	31.70587	31.87473	31.79017	32.09136	32.03319
	Production	31.70047	31.85602	31.76597	31.981	31.95354
Wheat	Area	33.97809	31.9641	32.2891	32.41752	40.81269
	Yield	31.67312	31.68353	31.70904	31.64165	31.63403
	Production	33.93005	32.01639	32.53259	32.4236	36.73311
Maize	Area	31.59318	31.65262	31.69299	31.58505	31.68677
	Yield	31.61868	31.79386	31.62971	31.57719	31.58931
	Production	31.75567	31.84435	31.68433	31.61219	31.63827
Ragi	Area	31.58044	31.70603	31.7392	31.63761	31.7132
	Yield	31.73975	31.71366	31.86359	31.60549	31.71811
	Production	31.81166	31.73397	32.42363	31.62321	31.85263
Jowar	Area	31.83784	31.7548	32.25533	31.74046	32.47917
	Yield	32.41857	31.83811	31.69193	31.61757	31.63507
	Production	32.78989	32.35042	33.19742	32.05667	33.21562
Bajra	Area	32.73267	32.56013	35.82427	33.60996	37.45202
	Yield	31.75122	31.84452	31.74349	31.60337	31.61845
	Production	56.77627	35.38072	47.27854	39.38325	98.10864
Small millets	Area	31.58818	32.26789	31.79105	31.9969	31.70043
	Yield	31.66665	31.80967	31.76337	31.76229	31.66239
	Production	31.78306	33.51925	32.2043	32.95156	32.00229
Groundnut	Area	32.22278	31.73868	31.65692	31.67567	31.73905
	Yield	31.69997	31.66858	31.85247	31.7009	31.64189
	Production	31.89874	31.71973	31.96326	31.94585	31.75698
Sesamum(til)	Area	31.74046	31.95071	31.71615	32.19883	31.62753
	Yield	31.69779	31.69606	31.78109	31.64953	31.65519
	Production	32.0459	32.14755	32.1742	33.00864	31.67871
Castor	Area	32.04233	31.87465	31.64486	31.82707	32.00685
	Yield	31.7475	31.75076	31.7324	31.60354	31.63952
	Production	32.94844	32.19523	32.43237	32.6201	32.25006

Niger	Area	31.73158	32.02516	31.74259	31.6152	31.67138
	Yield	31.6797	31.66223	31.82517	31.64028	31.6011
	Production	31.85612	32.08919	32.36063	32.11213	31.72448
Linseed	Area	33.19469	32.81602	32.82221	31.90989	35.27676
	Yield	31.75481	31.6787	31.73836	31.62926	31.67448
	Production	35.79654	34.223	35.744	33.12988	37.89261
Mustard	Area	32.15496	31.58743	31.90985	31.92293	31.8532
	Yield	31.64618	31.73023	31.81832	31.65672	31.66051
	Production	33.01644	31.74427	32.54589	32.53537	32.03461
Green gram	Area	31.73063	31.74558	31.80885	31.82518	31.62116
	Yield	31.61637	31.69521	31.74678	31.60472	31.64268
	Production	31.86289	31.83189	32.25361	32.00852	31.65686
Black gram	Area	31.73927	31.67598	31.71892	31.75142	31.61019
	Yield	31.61226	31.71723	31.72599	31.672	31.61944
	Production	31.77674	31.78119	31.97684	32.07447	31.61097
Red gram/ arhar	Area	32.01642	31.79713	31.75428	31.58385	31.6215
	Yield	31.66147	31.81832	31.7571	31.59397	31.6573
	Production	33.29936	32.46484	32.17287	31.60328	31.66583
Horse gram (kulthi)	Area	31.76026	31.66281	31.65833	31.67925	31.72473
	Yield	31.62605	31.66592	31.76296	31.74349	31.59069
	Production	32.0723	31.73891	32.00447	32.10909	31.74295
Cowpea	Area	31.76532	40.39565	32.0976	31.91628	31.66344
	Yield	31.56265	31.96969	31.66919	31.58646	31.63548
	Production	32.23186	42.26909	32.24755	32.21035	31.72469
Bengal gram (rabi)	Area	32.36077	32.18571	31.78897	32.41884	31.7682
	Yield	31.5926	31.77863	31.68698	31.66518	31.61816
	Production	34.12229	32.88679	32.35915	33.01765	31.77851

**Sources: calculated by Author from Five Decades of Agricultural Statistics, Odisha*

5. CONCLUSION

It is observed from the above that the agriculture sector is the leading sector in terms of providing employment and significantly contributing to GSDPof Odisha. However, the area under cultivation of all the crops is gradually decreasing due to urbanization. The percentage of area under cereal cultivation is decreasing, whereas the percentage of area under pulses is increasing, but the percentage under total food grains is decreasing, showing farmers are switching towards non-food grain products. So far as the growth of production and yield of different crops is concerned, it shows that there is erratic growth in agricultural crops, as evident from the high instability rate in the growth of different crops. The cropping intensity shows that it is lower than the national level, and therefore the role of technology needs to be identified to tackle the problems.

REFERENCES

1. Planning and Convergence Department, Directorate of Economics and Statistics. (2022). *Odisha Economic Survey 2021-22*. Bhubaneswar: Government of Odisha. Retrieved from https://pc.odisha.gov.in/publication/economic-survey-report.
2. Naik RK, Dash S, Das MK. Climate Change Vulnerability and Adaptation Strategies of Rice Cultivators in Odisha, India. Asian Journal of Agricultural Extension, Economics & Sociology. 2024 ;42(4):131-42.
3. Chand R, Raju SS. Instability in Indian agriculture during different phases of technology and policy.2009.
4. Das MK, Mishra P. Vulnerability of Agriculture to Climate Shocks in Odisha, India. International Journal of African and Asian Studie. 2017;40:27-35.
5. Chand R, Raju SS. Instability in Indian agriculture during different phases of technology and policy.2009.
6. Samal SP, Patra RN, Nanda BB, Das MK. Growth and Instability in Food Grains Production in Odisha: A district level analysis.2017; 4 (11): 2319 – 7714.
7. Samal SP, Patra RN, Nanda BB, Das MK. Growth and Instability in Food Grains Production in Odisha: A district level analysis.2017;4(11): 2393 – 9125.
8. Sihmar R. Growth and instability in agricultural production in Haryana: A district level analysis. International Journal of Scientific and Research Publications. 2014 Jul;4(7):1-2.
9. Paltasingh KR, Goyari P. Analyzing growth and instability in subsistence agriculture of Odisha: Evidence from major crops. Agricultural Economics Research Review. 2013;26(conf):67-78.
10. Pattanaik F, Mohanty S. Growth performance of major crop groups in Odisha agriculture: a spatiotemporal analysis. Agricultural Economics Research Review. 2016;29(2):225-37.
11. Jain A. Analysis of growth and instability in area, production, yield and price of rice in India. Social change and development. 2018;15(2):46-66.
12. Jena D, Mishra S. Growth, instability and decomposition of millets in Odisha: 1960-61 to 2017-18. Odisha economy discussion series. 2020.
13. Das MK. Weather Variability and Instability in Agricultural Production: Evidence from Odisha. Asian Journal of Agricultural Extension, Economics & Sociology. 2021 Aug 21;39(9):111-21.