

Growth Instability of Major Crops in Odisha

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Abstracts

The goal of the current study is to discuss the rate of growth in Odisha's area, yield, and productions. To support the current study, secondary data from numerous published sources were used. It makes estimates for 34 major crops grown in Odisha over a long period of time, from the years 1970–1971 to 2019–20. The analysis showed that Odisha's cropping patterns are becoming more varied. Over time, Odisha's cropping pattern has undergone significant change. Moreover, area, yield, and production growth rates in Odisha were incredibly slow and unstable. With the exception of rice, all crop areas were low positive from 1970–1971 to 1980–1981 period. The annual average growth rates between the second time periods, from 1981–1982 to 1990–1991, were mixed, with some crops experiencing positive growth and others experiencing negative growth. The concerning fact is that, aside from a select few crops like rice, cowpea, fibres, spices, and condiments, the growth rate of area for the majority of crops from the third period of 1991–1992 to 2000–01 was negative. Therefore, the area, yield, and production of various crops in Odisha are growing at an unstable rate. The expansion of the gross cropped area as well as the net shown area, better irrigation facilities, agricultural extension services, better-improved inputs, and capital formation are thus part of the future agricultural strategy for accelerating the growth rate of Odisha's agricultural development.

Key Words: Average Annual Growth Rate, Cropping Pattern, Gross Cropped Area, Net Shown Area

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I. Introduction

The state of Odisha, in eastern India, covers an area of more than 15.6 million hectares and is home to about 3.2 percent of the 44.7 million people in the entire nation. Over 36% of the state's rural residents live in poverty, higher than the national average of 26 percent, making it one of the poorest states in the union. Additionally, 83 percent of the population of Odisha lives in rural areas, compared to 69 percent of all of India, making it a state with a primarily rural economy (Hoda et al.). The structural transformation has taken place in Odisha as well as the rest of the nation. Agriculture's contribution to the state's gross domestic product has significantly decreased over time. However, over time, the proportion of the industry and services sectors to the overall gross domestic product has increased. The contribution of agriculture to the total gross state domestic product in the fiscal year 1980–1981 at constant prices (2004–2005 base year) was 42.17 percent, but it fell to 13.99 percent in the fiscal year 2011–12. While the proportions of the industrial and service sectors were 21.4 and 26.85 percent, respectively, they increased to 34.21 and 48.59 percent during the same time period. In 2020–21, the gross state valued added (GSVA) at constant prices was 14.65, with agriculture, forestry, and fishing contributing 14.65 percent of that total (Base year 2011-12). Even though the sector's contribution to total gross state products is decreasing, it still provides the majority of the state's jobs and income. Approximately 62 percent of the workforce is employed in agriculture directly or indirectly, compared to the national average of 55 percent (Census, 2011).

The majority of the population in Odisha depends heavily on agriculture. The growth of the agriculture sector thus played a crucial role in the states' overall development. According to the World Development Report, the gross domestic product growth rate of agriculture is at least twice as effective at reducing poverty as the gross domestic product growth rate of industries other than agriculture (2008). Furthermore, Odisha's agricultural sector is growing at a very low and unstable rate. This might be because Odisha has experienced numerous natural disasters over the past 50 years, from 1970–1971 to 2019–20. Given the significance of agriculture, the current study attempts to investigate the nature and development of agriculture in Odisha. Therefore, an effort was made to look at the growth rate of agriculture over a long period of time (1970–1971 to 2019–20), looking at 34 different crops. Additionally, the productivity growth rate of various crops in various districts was also looked at. The main objective of the study is to estimate the average annual growth rate of the production, yield, and area of the various important crops in Odisha.

II. Review of Literature

The economic development was significantly influenced by the agricultural sector. As a result, the country's food needs are met, surplus labour is released, the domestic market for industrial output is expanded, the domestic saving rate is increased, and foreign exchange is generated by exporting agricultural products, according to (Johnston and Mellor) . To perform at a high level, Indian agriculture still requires a comprehensive reform package. Although it is obvious that gradual and uneven transformation will no longer be effective in a business-as-usual environment. Reforms in agriculture should not be the only focus. Add other facets of the agroecosystem, like logistics, processing, and marketing, which are all parts of the supply chain for inputs. This will call for changing current incentive structures and lowering institutional barriers to encourage investment, which is essential for the creation of novel ideas. These developments have the potential to alter the course of history. Millions of people who work in agriculture had a better standard of living as a result of increased agricultural growth (Chand and Parappurathu). In other studies, the significance of growth rate in developing nations like India was also emphasised. There is strong evidence that since 1980–1981 regional differences in agricultural output and income have grown, and the gap between developing and underdeveloped, as well as poor and rich, countries, has widened. This has happened despite deliberate efforts to lessen interstate conflict. Inequities can be reduced by accelerating agricultural development in developing nations. In order to raise standards of productivity and accelerate growth in the crop sector as well as in the livestock industry and other subsectors, there is a need to step up efforts on the technological, institutional, and infrastructure fronts. In developing nations, one of the most significant industries is agriculture. Eastern Europe demands immediate attention. The states include eastern Uttar Pradesh, hilly areas, Bihar, Orissa, and Assam. For the development of both the nation and these states, immediate attention is required (Chand and Chauhan). Nevertheless, a different study emphasises the significance of the agricultural and industrial sectors. The low growth rate in the agricultural sector is a result of concentrating on the industrial sector while ignoring the agricultural sector. This causes the country's income per capital income to decline. Consequently, in order to raise the country's per capita income, both sectors must be developed (Gollin et al.) . Additionally, the study (Bhalla and Singh) aims to analyse the performance of agriculture in India's states over the immediate pre-reform period as well as the post-reform period (1990-93 to 2003-06). As evidenced by the post-reform period (1980–1983 to 1990–1993), growth slowed during this time period. In recent years, both crop yields and overall agricultural output have been rising

quickly. The majority of states have done this by ending the bias against marketable goods. It was anticipated that agricultural economic reforms would enhance the terms of trade in its favour and encourage it to increase growth. Therefore, the wage gap between agricultural and non-agricultural employees is growing as a result of the sharp slowdown in agricultural growth, which is taking place in the context of robust economic expansion. Additionally, it has a detrimental effect on the vast majority of people, who depend on agriculture to survive (Chand et al.) . Several studies also looked at trends in India's states' rates of agricultural growth. The study discovered that there were conflicting trends in the growth rates of important crops. With the exception of a few crops like wheat, bajra, and jowar, every other crop during the entire study period showed an increase in area. The production of all of these crops increased at an impressive rate during the second period, whereas the commercial crop experienced an impressive growth rate during the third.

Since the late 1960s, an important factor in driving up crop production in the nation has been an increase in crop yield. Higher growth in crop production was largely due to modern varieties, irrigation, and fertilisers. However, in some regions, crop area and output composition have undergone significant changes as a result of technology and institutional support for a few crops, including rice and wheat. The crop output growth model's findings show that improved capital formation, improved irrigation facilities, regular rainfall, and improved fertiliser consumption will all contribute to the country's increased crop output (Kannan).

III. Data Source and Methodology

To support the current study, secondary data from numerous published sources were used. Data on area, yield, and production were gathered from the various agricultural statistics reports for Odisha. Data were gathered from 34 major crops grown in Odisha between 1970–1971 and 2019–2020. We examined the 34 major crops grown in Odisha over a period of 50 years, from 1970–1971 to 2019–2020, or five agricultural decades. However, this 50-year period was split into two subperiods, such as the period prior to the reform period (1970–1971) and the period subsequent to the reform period (1991–1991), in light of the changing scenario of area, yield, and production (1990-91 to 2019-20). Additionally, the lengthy period prior to the reform and the subsequent period were divided into four subperiods, from 1970–1971 to 1980–1981, from 1981–1982 to 1990–1991, from 1991–1992 to 2009–2010, and from 2010–11 to 2019–20. In order to investigate changes in the growth rate of area, yield, and production, an overall period of all five decades is also looked at.

Annual growth rate and annual average growth rate were calculated to see the performance of agriculture. The formula for annual growth rate (AGR) are given below

Where $V_{\text{Present}} = \text{Present Value}$, $V_{\text{Past}} = \text{Past Value}$

$$\text{AGR} = \frac{V_{\text{present}} - V_{\text{past}}}{V_{\text{Past}}} \times 100$$

. Whereas the formula for annual average growth rate (AAGR) are given below Where GRA = Annual Growth Rate in Period A, GRB = Annual Growth Rate in Period B, GRC = Annual Growth Rate in Period C, GRn = Annual Growth Rate in Period n and N = Number of Periods

$$\text{AAGR} = \frac{\text{GRA} + \text{GRB} + \text{GRC} + \dots + \text{GRn}}{N}$$

IV. Performance of Major Crops' Growth in Odisha

The area yield and production growth performances for 34 crops in Odisha agriculture. rice, wheat, maize, ragi, jowar, small millets, cereals, green gramme, black gramme, red gramme, cowpea, pulses, food grains, groundnut, sesame, castor, niger, mustard, oilseeds, vegetables, spices and condiments, sugarcane, and tobacco are among the crops that are examined. To view the growth performance of 34 crops in Odisha, the Annual Average Growth is taken into account. It makes an estimate of the 50 years or five decades that different crops have been grown in Odisha. This lengthy period was divided into two parts: the period prior to the reform (1970–71–1990–91), the period following the reform (1991–92–2019–20), and five subperiods (1970–71–80–81, 1991–92–2000–01, 2000–01–2009–10, and 2010–11–2019–20).

Table 1 shows the average annual growth rate of area for 34 crops. All crops saw positive area growth during the first decade from 1970–1971 to 1980–1981, with the exception of rice. Whereas during the second periods 1981–82 to 1990–91, there were mixed growth rate which is positive for few crops and negative for few crops. The positive growth rate during the second period were, rice (0.6) , green gram (2.3), black gram (3.9), red gram (7.7), cowpea (10.1), pulses (2.9) , food grains (0.4), groundnut (9.2), sesamum (9.3) , niger (4.3) , mustard (0.6) , oilseed (4.9) , vegetables(3.6) , spices and condiments (2.2) , and sugar cane (0.4). Whereas during the second period, the negative growth rate was wheat (-5.5), maize (-0.3), ragi (-2.3), jowar (-2.5), small millets (-10.3), cereals (-0.3), castor (-2.9), fibres (-0.2), and tobacco (-2.9).

Table 1: Average Annual Growth Rate of Area, Yield and Production of different crops in Odisha during 1970-71 to 2019-20 (in Percent)

Crops	Sub Period Within the Preceding Reform Period and Following Reform Period														
	1970-71 to 1980-81			1981-82 to 1990-91			1990-91 to 2000-01			2001-02 to 2009-10			2010-11 to 2019-20		
	Area	Yield	Prod.	Area	Yield	Prod.	Area	Yield	Prod.	Area	Yield	Prod.	Area	Yield	Prod.
Rice	-0.5	4.3	4.5	0.6	4.9	6.5	0.1	0.4	0.7	-0.4	10.8	11.2	-0.8	10.4	10.2
Wheat	24.3	3.1	28.9	-5.5	-1.0	-6.4	-6.2	-2.2	-7.8	2.6	2.4	5.3	-16.7	1.3	-15.5
Maize	10.2	4.2	17.2	-0.3	3.6	2.7	0.7	0.9	1.2	3.8	8.4	12.9	0.2	1.5	1.7
Ragi	8.4	0.9	10.7	-2.3	3.5	0.3	-2.2	0.1	-0.8	-0.5	0.6	0.1	-4.5	3.6	-1.0
Jowar	10.3	2.7	14.8	-2.5	3.4	0.6	-5.8	-3.0	-8.2	-3.6	0.7	-2.9	-3.9	0.6	-3.3
Small Millets	10.1	6.0	22.4	-10.3	1.4	-5.5	-5.1	-1.8	-7.2	-8.6	2.7	-5.3	8.7	1.3	10.1
Cereals	0.7	3.8	5.5	-0.3	4.1	4.8	-0.1	0.2	0.3	-0.3	10.1	10.6	-0.8	9.1	8.8
Green Gram	8.7	1.7	11.3	2.3	-0.1	2.0	-2.9	-3.4	-4.3	7.5	3.1	11.5	0.1	1.6	1.8
Black Gram	8.1	3.0	11.4	3.9	1.5	5.3	-2.4	-4.9	-6.5	4.7	3.2	9.4	-3.7	1.4	-2.4
Red Gram	6.1	0.1	8.2	7.7	5.2	14.5	-0.3	-1.3	-0.8	-0.6	3.6	3.2	-0.5	2.6	2.0
Cowpea	6.1	-0.1	5.4	10.1	4.7	10.4	10.0	-1.0	8.1	7.5	2.7	10.9	3.5	0.7	4.3
Pulses	8.3	1.4	10.6	2.9	0.9	3.7	-3.3	-3.5	-5.5	5.0	3.1	9.1	-0.8	1.5	0.7
Foodgrains	2.0	2.9	6.0	0.4	3.0	4.2	-1.1	0.0	-0.5	0.9	7.9	10.3	-0.8	7.8	7.5
Groundnut	9.7	5.3	14.3	9.2	1.4	9.9	-5.7	-0.7	-6.2	2.1	5.6	9.0	-1.9	1.4	-0.5
Sesamum	6.2	3.6	8.9	9.3	1.9	11.4	-4.5	-4.0	-7.3	7.4	3.1	12.3	-2.7	0.8	-2.0
Castor	7.6	-1.6	6.5	-2.9	1.6	-1.5	-4.7	-1.2	-5.4	-1.6	2.5	1.4	-8.0	0.5	-7.6
Niger	8.1	1.1	9.2	4.3	1.6	5.0	-0.6	-5.0	-5.1	-4.9	6.8	2.5	-5.9	-1.1	-6.8
Mustard	13.9	2.4	18.5	0.6	1.1	1.5	-4.7	-4.0	-7.7	3.6	3.4	7.9	0.6	1.8	2.6
Oilseeds	9.0	3.1	12.1	4.9	2.3	7.3	-4.5	-3.1	-6.6	3.1	4.6	9.0	-3.4	2.0	-1.5
Fibers	3.3	-1.0	1.7	-0.2	5.0	4.6	0.3	-8.0	-8.0	3.5	3.1	4.8	6.3	-1.4	4.5
Vegetables	5.0	1.0	6.8	3.6	2.8	5.8	-6.8	0.8	-6.3	8.7	3.6	14.3	-1.7	0.6	-1.0
Spices and Condiments	9.7	3.6	14.8	2.2	5.4	8.6	1.4	0.4	0.8	1.8	10.9	12.7	-2.0	0.8	-0.7
Sugarcane	5.4	1.7	6.9	0.4	1.6	2.2	-3.2	-0.5	-3.4	3.2	0.7	4.2	-8.0	0.3	-7.8
Tobacco	4.6	-4.0	1.4	-2.9	5.0	3.4	-12.7	-1.7	-13.0	2.2	6.9	12.0	-23.0	-1.4	-25.7

Source: Authors calculation from five decades of agricultural statistics, government of Odisha, 2019-20

The worrying factor is that during the third period 1991-92 to 2000-0, the growth rate of area for most of the crop was negative except only few crops like rice (0.1), cowpea (10.0), fibres (0.3) and spices and condiments (1.4). Moreover, during the fourth period 2000-01 to 2009-10, interestingly impressive growth rate of area on most of the crops such as wheat (2.6), maize (3.8) , green gram (7.5) , black gram (4.7) , cowpea (7.5) , pulses (5.0), food grains (0.9) , groundnut (2.1) , sesamum (7.4) , mustard (3.6) , oilseed (3.1) , fibers (3.5), vegetables (8.7) , spices and condiments (1.8) , sugarcane (3.2) and tobacco (2.2). Whereas the only few crops were negative during the fourth period. However, during the fifth period (2010-11 to 2019-20) the growth rate of cereals, pulses, food grains, oilseeds, fibers, vegetables, sugarcane and tobacco all crops are negative.

Similarly, during the first period the growth rate of yield of most of the crop was positive except few crops like cowpea (- 0.1), fibers (-1.0) and tobacco (-4.0). Whereas the aggregate growth rate of yield of cereals, pulses, food grains, oilseeds, vegetables, spices and condiments and sugarcane were positive. During the second period the growth rate of yield of all the crops such as cereals (4.1), pulses (0.9), food grains (3.0), oilseeds (2.3), fibers (5.0), vegetables (2.8), spices and condiments (5.4), sugarcane (1.6) and tobacco (5.0) were positive. During the third period the growth rate of yield of majority of the crops were negative except the crops such as rice (0.4), maize (0.2), ragi (0.9), cereals (0.1), food grains (0.0), vegetables (0.8) and spices and condiments (0.4). Remarkable positive growth rate of yield of all the crops for the fourth period such as cereals (10.1), pulses (3.1), food grains (7.9), oilseeds (4.6), fibers (3.1), vegetables (3.6), spices and condiments (10.9) sugarcane (0.7) and tobacco (6.9). However, during the fifth period the growth rate of yield of all the crop were positive but less positive growth achieved as compared to the fourth periods (see table 1).

Correspondingly, during the first period the growth rate of production per hectare all the crops were Positive such as cereals (5.5), pulses (10.6), food grains (6.0), oilseeds (12.1), fibers (1.7), vegetables (6.8), spices and condiments (14.8), sugarcane (6.9) and tobacco (1.4). Whereas during the second period the growth rate of production per hectare was less as compared to the first period. The growth rate of production per hectare during the second period were cereals (4.8), pulses (3.7) , food grains (4.2) , oilseeds (7.3) , fibers (4.6) , vegetables (5.8), spices and condiments (8.6) , sugarcane (2.2) and tobacco (3.4) . Moreover, during the third period the growth rate of production per hectare is much less as compared to the second periods. Interestingly, during the fourth period remarkable growth rate of production per hectare of all the major crops were a rise as compared to the third period.

Table 2: Average Annual Growth Rate of Area, Yield and Production of different crops during the preceding reform period, following reform period and overall period in Odisha (in Percent)

Crops	Preceding Reform Period			Following Reform Period			Overall Period		
	1970-1990			1991-2019			1970-71 to 2019-20		
	Area	Yield	Prod.	Area	Yield	Prod.	Area	Yield	Prod.
Rice	0.02	4.59	5.47	-0.35	7.09	7.27	-0.2	6.1	6.5
Wheat	9.38	1.07	11.25	-6.40	0.48	-5.69	0.0	0.7	1.2
Maize	4.91	3.91	9.97	1.62	3.67	5.42	3.0	3.8	7.3
Ragi	3.04	2.23	5.52	-2.32	1.34	-0.54	-0.1	1.7	1.9
Jowar	3.92	3.05	7.72	-4.44	-0.63	-4.85	-1.0	0.9	0.3
Small Millets	-0.08	3.73	8.41	-2.03	0.73	-1.13	-1.2	2.0	2.8
Cereals	0.19	3.95	5.12	-0.42	6.40	6.49	-0.2	5.4	5.9
Green Gram	5.48	0.79	6.66	1.57	0.42	3.05	3.2	0.6	4.5
Black Gram	6.04	2.24	8.35	-0.39	-0.14	0.28	2.2	0.8	3.6
Red Gram	6.91	2.66	11.38	-0.47	1.58	1.45	2.5	2.0	5.5
Cowpea	8.10	2.28	7.90	7.12	0.82	7.89	7.5	1.4	7.9
Pulses	5.59	1.16	7.16	0.38	0.32	1.47	2.5	0.7	3.8
Foodgrains	1.22	2.94	5.12	-0.32	5.15	5.69	0.3	4.2	5.5
Groundnut	9.42	3.35	12.08	-1.85	2.12	0.84	2.8	2.6	5.4
Sesamum	7.79	2.77	10.13	0.18	-0.05	1.13	3.3	1.1	4.8
Castor	2.37	0.04	2.48	-4.64	0.60	-3.72	-1.8	0.4	-1.2
Niger	6.19	1.33	7.09	-3.73	0.27	-3.02	0.3	0.7	1.1
Mustard	7.25	1.73	9.99	-0.15	0.37	0.88	2.9	0.9	4.6
Oilseeds	6.92	2.72	9.71	-1.56	1.12	0.36	1.9	1.8	4.2
Fibers	1.57	1.98	3.19	3.27	-2.10	0.30	2.6	-0.4	1.5
Vegetables	4.29	1.90	6.31	0.13	1.69	2.44	1.8	1.8	4.0
Spices and Condiments	5.95	4.51	11.70	0.48	4.15	4.47	2.7	4.3	7.4
Sugarcane	2.91	1.63	4.55	-2.48	0.16	-2.12	-0.3	0.8	0.6
Tobacco	0.87	0.52	2.40	-10.79	1.34	-8.32	-6.0	1.0	-3.9

Source: Authors calculation from five decades of agricultural statistics, government of Odisha, 2019-20

The growth rate of production per hectare during the fourth period were cereals (10.6), pulses (9.1) , food grains (10.3) , oilseeds (9.0), fibers (4.8), vegetables (14.3), spices and condiments (12.7), sugarcane (4.2) and tobacco (12.0). Whereas the growth rate of production per hectare for all crops during the fifth period was much less as compared to the Fourth period (see table 1). From the above analysis of growth rate of area, yield and production of 34 crops during the 50 years, it's clear that, interestingly for most of the crops the area is declining with negative significantly, still increasing the production growth and yield growth. Thus, there is unstable growth rate of area, yield and production of different crops in Odisha.

The growth performances of area, yield and production of 34 crops in Odisha agriculture during the preceding reform period (1970-71 to 1990-91), following reform period (1991-92 to 2019-20) and overall period (1970-71 to 2019-20) was representing in the table 2. The analysis of following crops is rice, wheat, maize, ragi, jowar, small millets, cereals, green gram, black gram, red gram, cowpea, pulses, food grains, groundnut, sesamum, castor, niger, mustard, oilseeds, fibers, vegetables, spices and condiments, sugarcane and tobacco. Annual Average Growth taken into consideration to see the growth performance of 34 crops in Odisha.

The growth performances of area of 34 crops in Odisha agriculture during the preceding reform period (1970-71 to 1990-91), following the reform period (1991-92 to 2019-20) was represents in the table 2. The growth rate of area during the preceding reform period were remarkable as compared to the following reform period. The growth rate of area during the preceding reform period were cereals (0.19), pulses (5.59) , food grains (1.22) , oilseeds (6.92), fibers (1.57) , vegetables (4.29) , spices and condiments (5.95) , sugarcane (2.91) and tobacco (0.87). Whereas the growth rate of area during the following reform period were cereals (-0.42), pulses (0.38) , food grains (-0.32) , oilseeds (-1.56) , fibers (3.27) , vegetables (0.13) , spices and condiments (0.48) , sugarcane (-2.48) and tobacco (-10.79).

Similarly, the growth rate of yield per hectare during the preceding reform period were remarkable as compared to the following reform period. The growth rate of yield per hectare during the following reform period were much better as compared to the preceding reform period for few crops such as cereal, food grain and tobacco. The growth rate of yield per hectare during the preceding reform period was cereals (3.95), food grains (2.94), and tobacco (0.52). Whereas the growth rate of yield per hectare during the following reform period were cereals (6.40), food grains (5.15), and tobacco (1.34). But for others crops the yield per hectare

during the preceding reform period was better, whereas during the post reform period the growth rate of yield per hectare were declining even negative growth rate (see table 2).

Likewise, the growth rate of production per hectare during the preceding reform period were remarkable as compared to the following reform period. The growth rate of production per hectare during the following reform period were much better as compared to the preceding reform period for few crops such as cereals, and food grains. The growth rate of production per hectare during the preceding reform period was cereals (5.12) and food grains (5.12). Whereas the growth rate of production per hectare during the post reform period were cereals (6.49), and food grains (5.69). But for others crops the production per hectare during the preceding reform period was better, whereas during the post reform period the growth rate of production per hectare were declining even negative growth rate.

The growth performances of overall period of area, yield and production of 34 crops in Odisha agriculture during the year 1970-71 to year 2019-20 was represents in the table 2. Its estimates the long term annual average growth rate of 34 major crops in Odisha from 1970-71 to 2019-20. Because long term annual average growth rate will give the suitable crops to identify and helps to suggest appropriate policy for the government to accelerate the growth rate of area, yield and production of different crops in Odisha.

The annual average growth rate of area for 34 crops from the year 1970-71 to year 2019-20 are represented in the table- 2. its shows that the growth rate of few crops was negative and most of the crop was positive. The positive growth rate of area during these period were, pulses (2.5), food grains (0.3), oilseeds (1.9), fibers (2.6), vegetables (1.8), and spices and condiments (2.7). The negative growth rate of area during these period were cereals (-0.2), sugarcane (-0.3) and tobacco (-6.0). Interestingly, remarkable positive growth rate of yield per hectare for all the crops excepts one crop which is fibers during these periods. These growth rate of yield per hectare were cereals (5.4), pulses (0.7), food grains (4.2), oilseeds (1.8), vegetables (1.8), spices and condiments (4.3), sugarcane (0.8) and tobacco (1.0). Whereas the negative growth rate of yield per hectare during these periods were Fibers (-0.4). Interestingly, remarkable positive growth rate of production per hectare for all the crops excepts one crop which is Tobacco during these periods. These growth rate of production per hectare were cereals (5.9), pulses (3.8), food grains (5.5), oilseeds (4.2), fibers (1.5), vegetables (4.0), spices and condiments (7.4), and sugarcane (0.6). Whereas the negative growth rate of yield per hectare during these periods were Tobacco (-3.9).

Table 3: Overall Performance of Annual Average Growth rate of Area, Yield and Production of different crops in Odisha during 1970-71 to 2019-20

Area			
High (> 4 %)	Medium (2.00-3.9 %)	Low (0-1.19 %)	Negetive
Cowpea, Field Pea, Linseed, Cotton	Maize, Green Gram, Black Gram, Red Gram, Horse Gram, Bengal Gram, Total Pulses, Groundnut, Sesamum, Mustard, Fibres, Spices and Conditments	Wheat, Foodgrains, Niger, Total Oilseeds, Sunhemp, Total Vegetables	Rice, Ragi, Jowar, Bajra, Small Millets, Cereals, Castor, Jute, Mesta, Sugarcane, Tobacco
Yield			
Rice, Cereals, Foodgrains, Cotton, Spices and Condiments	Maize, Small Millets, Red Gram, Groundnut, Jute	Wheat, Ragi, Jowar, Bajra, Greengram, Black Gram, Horse gram, Cowpea, Bengal gram, Field pea, Total Pulses, Sesamum, Castor, Niger, Linseed, Mustard, Mesta, Sunhemp, Total Vegetables, Sugarcane, Tobacco	Fibres
Production			
Rice, Maize, Cereals, Green Gram, Red Gram, Cowpea, Bengal Gram, Field pea, Foodgrains, Groundnut, Sesamum, Linseed, Mustard, Total Oilseeds, Cotton, Total Vegetables, Spices and Conditments	Bajra, Small Millets, Black Gram, Horse Gram, Total Pulses, Sunhemp,	Wheat, Ragi, Jowar, Niger, Fibres, Sugarcane	Castor, Jute, Mesta and Tobacco

Source: Authors calculation from five decades of agricultural statistics, government of Odisha, 2019-20

However, the growth performances of agriculture adversely affected due to the climate change. During the last five decades from the year 1970 to year 2019 states of Odisha frequently faced natural calamities. In addition to this, it deviates from the rain fall also which adversely affects the agricultural growth rate. Overtime, its negatively deviates from the normal rainfall in Odisha. The worrying factor is that during year 1970 to year 1982 the states faced natural calamities every year. Then from 1983 to 1995, every alternative year the states faced natural calamities.

Further from 1996 the state faced frequent natural calamities ever year. The recent past natural calamities were “Titli” cyclone storm during year 2018 and “Fani” and “Bulbul” extremely severe cyclone storm. These natural calamities adversely affected the agricultural growth in Odisha. The details natural calamities during the last five decades present in the appendix 1.

Therefore, to see the overall performance of area, yield and production of different crops in during year 1970-71 to year 2019-20, four categories have been made in terms of their annual average growth rate such as high, medium, low and negative. The high growth rate crops coming under more than $>4\%$ annual average growth rate, the medium growth rate crops coming under 2.00- 3.9 % annual average growth rate, low growth rate crops coming under 0- 1.19 % annual average growth rate and negative growth rate. So, in term of area cowpea, Field pea, linseed and cotton are considered as the high growth rate crops. Similarly, in terms of yield rice, cereals, food grains, cotton, spices a condiment coming under the high growth rate crops. Whereas, in terms of production rice, maize, cereals, green gram, red gram, field pea, food grains, groundnut, sesamum, linseed, mustard, total oilseeds, cotton, total vegetables, spices and condiments are coming under the high growth rate crops. The details performance of growth on the basis of area, yield and production are represented in the table 3.

From the above analysis it is found that, from the preceding reform period the growth rate of all the crops was significantly better than the following reform periods. The growth rate of area during the preceding reform period positive with significant. Whereas the growth rate of area during the following reform period was declining significantly with most of the crops. The growth rate was negative such as cereals, pulses, food grain, oilseeds, vegetables, spices and condiments, sugarcane and tobacco. If we compared the growth rate of area during preceding reform period to the following reform period, only one crops the growth rate was significantly remarkable which is Fibers. Interestingly, even if the growth rate of area during the preceding

reform period to the following reform period was declining significantly still the growth rate of yield per hectare was remarkable. The growth rate of yield per hectare during the preceding reform period to the following reform period remarkable better for the crops like cereals, food grains, spices and condiments, and tobacco. Whereas the growth rate of yield per hectare was worse for the crops like pulses, oilseeds, fibers, vegetables and sugarcane. However, the growth rate of production per hectare during the following reform period was significantly better for few of the crops as compared to the preceding reform period. The growth rate of production per hectare was worse during the following the reform periods such as oilseeds, fibers, vegetables, spices and condiments, sugarcane and tobacco. In addition to this the growth rate of Sugarcane and Tobacco during the following reform period was negative.

Apart from the preceding reform period and following reform period if we see the growth rate of area of overall period for all the crops most of the crops remarkably better. The overall growth rate of area for few crops was negative like cereals, sugarcane and tobacco. Although, the low growth rate of area, still the growth rate of production per hectare was impressive for all the crops excepts tobacco.

V. Important Key Agricultural Indicator in Odisha

The other important major indicator is also looked at, in addition to the growth rate of agricultural area, yield, and production. The primary key indicators include the gross cropped area, net shown area, cropping intensity, gross irrigated area, net irrigated area, total fertilizer, annual rainfall, agricultural power consumption, and agricultural credits. The agricultural credits only include commercial bank credits for agriculture; other bank credits for agriculture are not included. The primary indicator of Odisha's agricultural development is shown in table 4. Cropping intensity is a key factor in the agricultural development of any region. Increased cropping intensity denotes more land being used for cultivation in an intensive manner. Cropping intensity is determined using the ratio of gross cropped area. Both an increase in cropping intensity and productivity, or both, would be necessary for the economy in order to increase agricultural production. that Odisha's cropping intensity has a tendency to change over time. Furthermore, over the course of the year, Odisha's cropping intensity decreased naturally. The key indicator of the average annual growth rate of Odisha's agricultural sector from 1990–1991 to 2017–18 (See table 4). Cropping intensity increased at a negative rate of -0.71. This occurred as a result of the net shown area's gradual decline and the growth rate of the gross cropped area.

Table 4: Annual Average Growth Rate of Major Indicator of Odisha Agriculture during 1990-91 to 2017-18

Gross Cropped Area	-2.24
Net Shown Area	-1.73
Cropping Intensity	-0.71
Gross Irrigated Area	-1.04
Net Irrigated Area	-1.29
N	3.84
P2O5	5.36
K2O	5.76
Total Fertiliser	4.21
Consumption of Fertiliser Kg/Per Ha.	5.42
Annual Rainfall	1.06
Power Consumption in Agriculture	5.35
Agricultural Credit	5.26

Source: Authors Calculation from agricultural Statistics of Odisha, 2020 and Handbook of Statistics on Indian States,

Reserve Bank of India various issue.

However, the results are concerning because the gross cropped area experienced a -2.4 annual average growth rate. Additionally, the net shown area's growth rate, which is -1.73, was negative. A reliable source of irrigation is a key factor in increasing production growth rates. However, over time, both the gross and net irrigated areas experienced negative growth rates. Additionally, fertilisers play a much more significant role in better plant growth without disease-prone plants. The use of fertiliser has increased significantly over time in Odisha. The growth rate of total fertiliser from 1990 to 2018–19 was 4.21, whereas the growth rate of fertiliser consumption per hectare was 5.42. It's interesting to note that Odisha's annual rainfall growth rate over time was generally good. It's interesting to note that the agriculture industry experienced a significant increase in power consumption. Additionally, credit plays an equally significant role in agriculture. The growth rate of credit in the agricultural sector from 1990–1991 to 2018–2018 was 5.26. Despite being positive, credit growth has been slow.

As a result, the study's analysis of the key indicators revealed that the expansion of these indicators requires particular care and attention if the agricultural sector is to grow more quickly. The net shown area and the gross cropped area in Odisha have decreased over time. This may have been a result of the quick urbanization, building boom, population increase, and many other factors. Additionally, if these circumstances persist, the economy will face formidable difficulties. because the gross cropped area was steadily declining while the population was growing more quickly. Even though both food grain and nonfood grain

production was rising naturally, it was not reducing the economy's need for food grain production after reaching a saturation point or steady state growth.

VI. Conclusions

Area, yield, and production growth rates in Odisha were incredibly slow and unstable. With the exception of rice, all crop areas were low positive from 1970–1971 to 1980–1981 period. The growth rates between the second time periods, from 1981–1982 to 1990–1991, were mixed, with some crops experiencing positive growth and others experiencing negative growth. The concerning fact is that, aside from a select few crops like rice, cowpea, fibres, spices, and condiments, the growth rate of area for the majority of crops from the third period of 1991–1992 to 2000–01 was negative. Additionally, during the fourth period from 2000–01 to 2009–10, most crops, including wheat, maize, green gramme, black gramme, cowpea, pulses, food grains, groundnut, sesame, mustard, oilseed, fibres, vegetables, spices and condiments, sugarcane, and tobacco, experienced an intriguingly impressive growth rate of area. Cereals, pulses, food grains, oilseeds, fibres, vegetables, sugarcane, and tobacco all have negative growth rates for the fifth period (2010–11 to 2019–20). The yield of the majority of crops is still performing better even though the growth rate of the area of the majority of crops is declining. With the exception of a few crops like cowpea, fibres, and tobacco, the growth rate of yield for the majority of the crops was positive during the first period. All crops, including cereals, pulses, food grains, oilseeds, fibres, vegetables, spices and condiments, sugarcane, and tobacco, experienced positive yield growth during the second period. With the exception of rice, maize, ragi, cereals, food grains, vegetables, spices, and condiments, most crops had negative growth rates of yield during the third period. All crops, including sugarcane, tobacco, cereals, pulses, food grains, oilseeds, fibres, and vegetables, have experienced an astonishingly positive growth rate for the fourth period. However, the fifth period saw a positive increase in crop yield across the board, albeit at a slower rate than the fourth period.

For a few crops, including cereal, food grains, and tobacco, the growth rate of yield per hectare during the subsequent reform period was also significantly better than during the prior reform period. However, for a few crops, such as cereals and food grains, the growth rate of production per hectare during the subsequent reform period was significantly better than during the prior reform period. It is evident from the aforementioned analysis of the growth rates of area, yield, and production of 34 crops over a 50-year period that, interestingly, for the majority of the crops, the area is declining significantly while the production growth and yield growth are still

rising. Therefore, the area, yield, and production of various crops in Odisha are growing at an unstable rate. The expansion of the gross cropped area as well as the net shown area, better irrigation facilities, agricultural extension services, better improved inputs, and capital formation are thus part of the future agricultural strategy for accelerating the growth rate of Odisha's agricultural development. The gross cropped area and net shown area of the state have been steadily declining over time. Through institutional intervention, the amount of cultivable waste land, fallow land, and fallow land other than current fallow is decreased, and the gross cropped area and net shown area are increased.

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Appendix 1: Natural Calamities and the Deviation of Rainfall during the last five decades 1970 to 2019 (Figure in MM)

Year	Normal Rainfall	Actual Rainfall	Deviation from normal rainfall		Natural Calamities	Year	Normal Rainfall	Actual Rainfall	Deviation from normal rainfall		Natural Calamities
			in MM	in Percent					in MM	in Percent	
1970	1502.5	1660.2	157.7	10.5	Flood	1995	1502.5	1588	85.5	5.7	
1971	1502.5	1791.5	289	19.2	Severe Cyclone, Flood	1996	1502.5	990.1	-512.4	-34.1	Severe Drought
1972	1502.5	1177.1	-325.4	-21.7	Flood, Drought	1997	1502.5	1493	-9.5	-0.6	Drought
1973	1502.5	1360.1	-142.4	-9.5	Flood	1998	1502.5	1277.5	-225	-15	Drought & Heat Wave
1974	1502.5	951.2	-551.3	-36.7	Severe Drought, Flood	1999	1502.5	1435.7	-66.8	-4.4	Super Cyclone
1975	1502.5	1325.6	-176.9	-11.8	Flood	2000	1502.5	1035.1	-467.4	-31.1	Drought
1976	1502.5	1012.5	-490	-32.6	Severe Drought	2001	1482.2	1616.2	134	9	Flood
1977	1502.5	1326.9	-175.6	-11.7	Flood	2002	1482.2	1007.8	-474.4	-32	Drought
1978	1502.5	1261.3	-241.2	-16.1	Hailstorm, Whirlwind, Tornado	2003	1482.2	1663.5	181.3	12.2	Flood
1979	1502.5	950.7	-551.8	-36.7	Severe Drought	2004	1482.2	1273.6	-208.6	-14	Flood
1980	1502.5	1321.7	-180.8	-12	Flood, Drought	2005	1451.2	1519.5	68.3	4.7	Flood
1981	1502.5	1187.4	-315.1	-21	Whirlwind, Tornado, Flood, Drought	2006	1451.2	1682.8	231.6	16	Flood
1982	1502.5	1179.9	-322.6	-21.5	Severe Flood, Drought, Cyclone	2007	1451.2	1591.5	140.3	9.7	Flood (July, August & September)
1983	1502.5	1374.1	-128.4	-8.5		2008	1451.2	1523.6	72.4	5	Flood (July & September)
1984	1502.5	1302.8	-199.7	-13.3	Drought	2009	1451.2	1362.6	-88.6	-6.1	Flood, Heavy Rain, Drought & Pest aΣack.
1985	1502.5	1606.8	104.3	6.9	Flood	2010	1451.2	1293	-158.2	-10.9	Flood, Heavy Rain, Drought & Unseasonal Cyclonic Rain
1986	1502.5	1566.1	63.6	4.2		2011	1451.2	1338.1	-113.1	-7.8	Drought & Flood
1987	1502.5	1040.8	-461.7	-30.7	Severe Drought	2012	1451.2	1384.1	-67.1	-4.6	Drought & Flood
1988	1502.5	1270.5	-232	-15.4		2013	1451.2	1653.1	201.9	13.9	Very Severe Cyclonic Storm "Phailin"/Flood
1989	1502.5	1283.9	-218.6	-14.5		2014	1451.2	1608.7	157.5	10.9	Very Severe Cyclonic Storm "Hudhud"/Flood
1990	1502.5	1865.8	363.3	24.2	Flood	2015	1451.2	1224.8	-226.4	-15.6	Drought, Flood & Heavy Rain
1991	1502.5	1465.7	-36.8	-2.4		2016	1451.2	1283.1	-168.1	-11.6	Drought, Flood & Heavy Rain
1992	1502.5	1344.1	-158.4	-10.5	Flood & Drought	2017	1451.2	1336.4	-114.8	-7.9	Flood, Heavy Rain, Drought & Pest AΣack, Unseasonal Rain
1993	1502.5	1421.6	-80.9	-5.4		2018	1451.2	1643.3	192.1	13.2	Cyclonic Storm "Titli"
1994	1502.5	1700.2	197.7	13.2		2019	1451.2	1627.8	176.6	12.2	Extremely Severe Cyclonic Storm "Fani" & "Bulbul"

Sources: Five Decades of Agricultural Statistics of Odisha, 2020