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Examining The Emerging Nature and Performance of Agriculture in The State of Odisha: An Inter-Regional Analysis

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Abstracts

The present study is an attempt to understand the performance of agriculture in Odisha. It estimates the five decades of agriculture from the year 1970-71 to year 2019-20 taking into consideration the long period with 34 major crops produced in Odisha. The cropping pattern of Odisha has changed significantly overtime. The cropping pattern of Odisha shows a shift from predominantly food crops. The growth rate of area during the preceding reform period were remarkable for most of the crops except fibers as compared to the post reform period. The growth rate of yield per hectare during the post reform period were much better for only few crops An important finding of the study is that the growth rate of area, yield and production was extremely low and volatile in Odisha. Thus, the future agricultural strategy for accelerating the growth rate of agricultural development of Odisha should include the expansion through the gross cropped area as well as net shown area, better irrigation facility and capital formation.

Key Words: Growth, Cropping pattern, Area, Yield, Production

Introduction

Odisha, located on India's eastern seacoast, spans over 15.6 million hectares of land and approximately 3.2 percent of the country's population which is 44.7 million people. The state is one of the poorest in the country, with over 36 percent of the rural population living in poverty, compared to the national average of 26 percent. In addition to this, Odisha has a predominantly rural economy, with 83 percent of the people residing in rural areas, as compared to the 69 percent across India (Hoda, Rajkhowa, & Gulati, 2017). Odisha, like the rest of the county, has undergone the structural transformation. Overtime the share of agriculture to the of gross state domestic product declined significantly. Whereas the share of industry and service sector to the total gross state domestic product is increasing overtime. The share of agriculture to

the total gross state domestic product during the year 1980-81 at constant prices (2004-05 base year) was 42.17 percent, which decreased to 13.99 per cent during the year 2011-12. Whereas the share of industry and service sector was 21.4 percent and 26.85 percent respectively, which is increased to 34.21 and 48.59 during the same period. The contribution of agriculture, forestry and fishing during the year 2020-21 was 14.65 to the gross state valued added (GSVA) at constant prices (Base year 2011-12). Despite the sector's declining share of overall gross state domestic products, it remains one of the state's primary source of livelihoods. In comparison to the national average of 55 percent, agriculture employs approximately 62 percent of the total labour force directly or indirectly (Census, 2011).

In Odisha, majority of the people are highly dependent on the agriculture sector. Therefore, for the overall development of the state, the development of the agriculture sector plays a crucial role. To reduce poverty the gross domestic product of growth rate of agriculture is at least two times more effective as compared to the gross state domestic product of growth rate of non agriculture as per the World Development Report (2008). Moreover, the growth rate of agriculture in Odisha is low and extremely volatile. This, may be because Odisha faced frequent natural calamities during the last five decades from year 1970-71 to 2019-20[1]. Keeping in view the importance of agriculture, the current study attempts to examine the nature and trend of agriculture in Odisha. Therefore, an attempt has been made to examine the growth rate of agriculture taking the long period (1970-71 to 2019-20) of 34 crops. Also, inter districts productivity growth rates are also examined.

Research Questions

The key research questions for the current studies are:

1. Is cropping pattern in Odisha diversified or dominant?
2. Is productivity of crops different for different agroclimatic zones of Odisha?
3. What is the performance of area under agriculture, yield, and production in Odisha?
4. What are the others indicators that contribute to the growth of agriculture in Odisha?

Objectives of the Study

The specific objectives of the study are:

1. To analyse the cropping pattern and diversification of agriculture in Odisha
2. To estimate the productivity of major crops of the different agroclimatic zones of Odisha.
3. To estimate the growth rate of area, yield and production of different major crops in Odisha.
4. To assess the relative contribution of major indicators of growth rate of agriculture in Odisha.

[1] Five Decades of Agricultural Statistics of Odisha, 2020

Review of Literature

Agriculture plays an important role for the economic development. Because it provides food for the nation, releases surplus labour, expands the home market for industrial output, boosts the domestic saving rate, and generates foreign exchange by exporting agricultural items (Johnston and Mellor, 1961). Indian agriculture is still in need of a comprehensive reform package in order to achieve high performance. Although, in a business-as-usual setting, it is clear that gradual and uneven transformation will no longer work. Agricultural Reforms should not be limited to agriculture alone. Other aspects of the agri-system, such as Logistics, processing, and marketing are all aspects of the input supply chain. This will necessitate altering existing incentive structures, reducing institutional barriers to encourage investment crucial in the development of new ideas. These are the innovations that have the potential to change the world. Increase the rate of expansion of agriculture, millions of people who work in agriculture lived a better standard of living (Chand et al., n.d.). Another study also focused on the importance of growth rate in the developing country like India. Since 1980-81, there is substantial evidence that regional differences in agricultural output and income have increased, and the gap between underdeveloped and developed, as well as poor and rich nations, has widened. Despite specific attempts to reduce inter-state conflict, this has occurred. By increasing agricultural development in undeveloped countries, inequities can be narrowed. There is a requirement must step up efforts on the technological, institutional, and infrastructure fronts to boost standards productivity and increase the rate of growth not just in the crop sector but also in the livestock and other subsectors. Agriculture is one of the most important sectors in developing countries. Eastern Europe need quick attention. Bihar, Orissa, and Assam, as well as hill regions and eastern Uttar Pradesh, are among the states. These states need quick attention for the development of the country as well states (Chand & Chauhan, 1999) . Although, another study highlights the importance of agriculture and industry sector. Focusing the industry sector and neglecting the agricultural sector results in the low growth rate in the agricultural sector. This leads to the fall in the income per capital income of the country. Therefore, to increase the per capita income of the country both the sector to be developed (Gollin et al., 2002). Also, the study (Bhalla & Singh, 2009), they try to examine the performance of agriculture in India's states during the post-reform period (1990-93 to 2003-06) and the immediate pre-reform period. The post-reform period (1980-83 to 1990-93) demonstrates that has been characterised by a slowing of growth Crop yields, as well as total agricultural output, have been increasing at a rapid pace in recent years. The majority of states by putting a stop to the prejudice against marketable goods. Economic reforms in agriculture were projected to improve the terms of trade in agriculture's favour, and encourage it to expand the growth. So, the dramatic slowdown in agricultural growth, which is occurring against the backdrop of strong expansion in the larger economy, is widening the gap between non-agricultural and agricultural employees' earnings. It also has a negative impact on the majority of the people is reliant on agriculture for survival (Chand et al., 2007). Also, some studies focused on the trends of agricultural growth rate across the states in India. The study found that there was mixed trend in the growth rate of major crops. Except few crops like Wheat, Bajra and Jowar during overall period of study record a growth rate in area in all others crops. During the second period there is a remarkable growth rate in the production of all these crops and whereas during the third period the

growth rate of commercial crop was remarkable. In addition, the growth rate of inputs such as chemical fertiliser, irrigation, HYV seeds etc was also visible during this period. Therefore, productivity growth and a shift in cropping pattern were important factors in the state's crop output growth (Kalamkar, n.d.). Moreover, the interdependence between the food and labour sectors is very much essential for development. For labour-intensive growth in rural areas, a plan combining agricultural growth promotion, productive non-farm employment, and high levels of social development would be required. A significant investment in human resource development should also be made in order to improve people's earning capacity (Radhakrishna, 2002).

Data Source and Methodology

Secondary data of various published sources used to justify the current study. Data on area, yield, and production were collected from the various reports of Odisha agricultural Statistics. Data were collected from 34 major crop produced in Odisha from the year 1970-71 to year 2019-20. We analyzed the five decades of agriculture or 50 years (1970-71 to 2019-20) long period with 34 major crops produced in Odisha. However, looking at the changing scenario of area, yield and production, these 50 years long period was divided into two sub period such as preceding the reform period (1970-71 to 1990-91) and following the reform period (1990-91 to 2019-20). In addition to this, these long period of preceding reform and following the reform period was divided into four sub period such as 1970-71 to 1980-81, 1981-82 to 1990-91, 1991-92 to 2009-10 and 2010-11 to 2019-20. Also, an overall period of all the five decades are also examined to look into the changes in the growth rate of area, yield and production. Compound annual growth rate were calculated to see the performance of agriculture. Apart from this, the productivity status of different agroclimatic zone of different districts of different crop was also examined. Taking into consideration of yield of the major crops from the year 2006-07 to year 2019-20, last 13 years of productivity status was also examined. So, from the year 2006-07 to year 2018-19 based on the last 13 years agroclimatic zone wise productivity status of major crops three category has been made; they are High, Medium and Low. The productivity is in the terms of yield quintal per hectare. This category made based on the state average productivity of the different crops. However, for all the major crops the category of low, medium and high productivity zone of different agro climatic zone has made based on the state average, below state average and above state average. The low productivity agroclimatic zone are those which is below the state average, the medium productivity agroclimatic zone are those which is state average only and the high productivity agroclimatic zone are those which is above the state average. This selection of productivity category for the of different agroclimatic zone is same for all the major crops.

Performance of Agriculture in Odisha

The proportion of area under different crops at a certain period/point in time is known as cropping pattern. A shift in cropping patterns involves a shift in the proportion of land planted to various crops. Moreover, the most important strategy for cropping pattern after the post green revolution period depends on irrigation facilities, soil, intensive cultivation, accessibility and availability of better planting, harvesting and plant protection techniques, high yielding of plant varieties, institutional factors, geographical condition etc.

(Vaidyanathan, 1987). However, for better understanding of total crop production in Odisha divided Two sub group such as (i) Food crops and (ii) Non-Food crops. This classification has been done by Directorate of Economic and Statistics, Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India. So, Food crops include Total cereals and millets, and pulses, sugar, condiment and spices, Fruits, and Vegetables. Whereas Non-Food crops include oilseeds and fibers.

However, based on the agricultural statistics of Odisha various issue the following are the details of crops produced in Odisha. Total rice includes, (Autumn) rice, (Winter) rice, Kharif rice, and summer rice. Wheat (Rabi), total maize includes, Kharif maize, (Rabi) maize, total ragi includes, Kharif ragi and (Rabi) ragi, jowar bajra, small millets, kharif cereals, (Rabi) cereals and total cereals. The total cereals include the total rice, wheat (Rabi), total maize, total ragi, jowar, bajra and small millets. The total pulses include Kharif green gram (Mung), (Rabi) green gram (Mung) and total green gram (Mung), Kharif black gram (Biri), (Rabi) black gram (Biri), total black gram (Biri), Kharif red gram (Arhar), (Rabi) horse gram (Kulthi), kharif cowpea, (Rabi) cowpea, total cowpea, bengal gram (Rabi), field pea (Rabi), lentil (Rabi), Kharif other pulses, (Rabi) other pulses, and total other pulses, Kharif total pulses and (Rabi) total pules. Total food grains include the total cereals and total pulses. The total oilseeds includes, Kharif groundnut, (Rabi) groundnut, total groundnut, Kharif sesamum (Til) , (Rabi) sesamum (Til) , total sesamum (Til), Kharif castor, (Rabi) castor, total castor, Kharif niger, (Rabi) niger, total niger, Kharif sunflower, (Rabi) sunflower, total sunflower, safflower (Rabi), linseed (Rabi), and mustard (Rabi). Kharif oilseed and (Rabi) oilseed include the total oilseed. Total fibres Kharif include jute Kharif, mesta Kharif and cotton Kharif, and Sunhemp Kharif. Total Vegetables includes Potato (Rabi), Onion (Rabi), Kharif sweet potato, (Rabi) sweet potato, Total sweeet potato. Total spices and condiments include Kharif spices and condiments, (Rabi) spices and condiments. sugarcane (Rabi), and tobaco (Rabi)

Diversification of Cropping Patten in Odisha

At the macro level the concepts of diversification are well-known. Macro level diversification means moving from agriculture to industry and service sector. However, when it comes to the agricultural diversification, there is lack of clarity. So, shifts from one crop to another crop is known as the diversification with in agriculture. In other words, shifting from rice crop to wheat crop is known as the diversification of agriculture. Most of the studies in the developing country witnessing that the market is the most important factor for determining the cropping pattern. In addition to this inputs and credit delivery systems, the availability of technology and agronomic condition of certain region for various crops forced for diversification, soils, irrigation facilities, low and high temperature, humidity and the intensity of sunlight etc. are important factors for determine the cropping pattern (Ghosh, 2011, Nayyar & Sen, 1994,). Table- 1 represents the Cropping Pattern or Share of various crops in Total Cropped Area. Among Cereals, the followings crops are occupying major share to the total cropped area in descending order, rice, ragi, small millets, maize, wheat, jowar and bajra. In the same way among pulses, green gram, black gram, horse gram, other pulses, red gram, bengal gram, field pea, cowpea and lentil. In addition to this, among the food grains the major crops over the last five decades the major crops which occupying major share

were rice, green gram, black gram, horse gram, ragi and small millets. So, among all the crops of total food grains major share occupy cereals and less share occupy pulses. So, the government has to give special attention to increase the share of pulses. Similarly, among Oilseeds, the major crops over the five decades in ascending orders are sesamum, groundnut, niger, mustard, castor, linseed, safflower and sunflower, among fibers jute, mesta, sunhemp and cotton. Moreover, among the total cropped area major share are from crops like vegetables, spices and condiments, sugarcane and tobacco.

The cropping pattern of Odisha is diversifying in nature. Although few crops occupy major share among the total cropped area, but over the last few decades the share of these crops is fluctuating in nature. Interestingly, the share of most of the crops were decreasing in nature but at the same time most of the crops' share were increasing significantly. The following crops were increasing rapidly over the last few decades they were, maize, green gram, black gram, red gram, groundnut, sesamum, mustard, cotton, fibers, vegetables and spices and condiments. The share of pulses increased from 15.75 percent to 24.68 percent during 1970-71 to 1980-81 to 2010-11 to 2019-20 over the last five decades. In addition to this, share of Oilseeds increased from 6.63 percent to 11.32 percent from 1970-71 to 1980-81 to 1981-82 to 1990-91, then the share decreased to 8.30 percent during the 2010-11 to 2019-20. The share of vegetables increased from 5.49 percent to 8.13 percent during the last five decades. Meanwhile, the share of Spices and Condiments increases slowly from 1.18 percent to 1.92 percent during the last five decades. Therefore, for the last five decades analysis of cropping pattern of Odisha, the cropping pattern showa a switch to maize, green gram, black gram, red gram, groundnut, sesamum, mustard, cotton, fibers, vegetables and spices and condiments.

Productivity of major crops under different agro climatic zone in Odisha

The productivity status of major crops under the different agro climatic zone of Odisha was considered to see the productivity performance of different districts among crops. As there was regional diversification of cropping pattern, districts were performed accordingly. Moreover, to improve the productivity status of different crops across the different districts suitable policy would be suggests.

There are 10 different agroclimatic zone and 30 districts in Odisha, agroclimatic zone in Odisha. They are shown in the following table:

Table 1. Distribution of districts of Odisha by agroclimatic zone

Region	District
North –Western Plateau,	Sundargarh and Deogarh
North Eastern Coastal Plain,	
North Eastern Ghat	Ganjam, Gajapati, Rayagada, and Phulbani
South Eastern Ghat	Malkangiri
Western Central Table Land	Kalahandi and Nuapada
North Central Plateau,	Balasore, Bhadrak and Jajpur
East and South Eastern Coastal Plain	Cuttack, Jagatsinghpur, Kendrapara, Puri, Khurda and Nayagarh
Eastern Ghat High Land	Koraput, and Nabarangapur
Western Undulating Zone	Bolangir, Sonepur, Boudh, Sambalpur, Bargarh, and Jharsuguda
Mid Central Table land.	Dhenkanal and Anugul

Also, these different agroclimatic zones have different climate and soil groups. The different climates of different agroclimatic zone are of basically concentrated on hot and moist sub humid, moist sub humid, hot humid, warm humid. Whereas the different broad soil groups of different agroclimatic zone are basically concentrated on red, brown forest, red and yellow, mixed red and black, lateric, deltaic alluvial, coastal alluvial and saline, red and yellow, red and black. The details of agroclimatic zone and their features presents in the appendix 1. There is diversity in terms of production, climate and soil group in Odisha.

Table 2: Cropping Pattern or Share of various crops in Total Cropped Area (Percent)

Crops	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
Rice	60.49	48.32	51.86	52.46	49.17
Wheat	0.67	0.59	0.23	0.21	0.09
Maize	1.48	1.88	1.96	2.35	3.20
Ragi	3.03	3.17	2.44	2.23	1.78
Jowar	0.35	0.36	0.21	0.12	0.08
Bajra	0.08	0.10	0.06	0.04	0.03
Small Millets	2.84	1.52	0.63	0.29	0.31
Cereals	68.94	55.94	57.39	57.70	54.66
Green Gram	6.14	7.44	7.25	8.30	10.33
Black Gram	3.63	5.80	6.02	6.73	6.64
Red Gram	0.79	1.54	1.75	1.56	1.71
Horse Gram	3.31	4.24	3.90	2.99	2.71
Cowpea	0.25	0.15	0.32	0.68	0.69
Bengal Gram	0.42	0.53	0.37	0.41	0.47
Field Pea	0.31	0.14	0.22	0.29	0.40
Lentil	0.00	0.00	0.08	0.12	0.13
Other Pulses	0.90	1.89	0.91	0.58	1.60
Pulses	15.75	21.72	20.82	21.66	24.68
Foodgrains	84.69	77.66	78.21	79.35	79.34
Groundnut	1.52	3.65	3.36	2.76	2.83

Sesamum	1.65	3.24	3.53	3.35	2.65
Castor	0.40	0.44	0.28	0.20	0.12
Niger	1.41	2.04	2.04	1.37	0.81
Sunflower	0.02	0.03	0.06	0.14	0.24
Safflower	0.04	0.04	0.03	0.02	0.01
Linseed	0.32	0.39	0.34	0.34	0.21
Mustard	1.28	1.50	1.56	1.31	1.43
Oilseeds	6.63	11.32	11.20	9.50	8.30
Jute	0.63	0.46	0.24	0.13	0.08
Mesta	0.47	0.45	0.35	0.27	0.11
Cotton	0.04	0.05	0.21	0.62	1.66
Sunhemp	0.10	0.14	0.14	0.11	0.07
Fibres	1.24	1.10	0.95	1.13	1.92
Vegetables	5.49	7.42	7.19	7.83	8.13
Spices and Condiments	1.18	1.77	1.86	1.72	1.92
Sugarcane	0.55	0.54	0.49	0.41	0.37
Tobacco	0.22	0.19	0.11	0.05	0.01
TCA	100	100	100	100	100

Source: Authors Calculation from the Agricultural Statistics of Odisha, Various Years

Table -2 represents the agroclimatic zone wise productivity status of major crops in Odisha during the year 2006-07 to year 2018-19. Across the different agroclimatic zone of Odisha there are high variations across the major crops. So, from year 2006-07 to year 2018-19 based on the last 13 years agroclimatic zone wise productivity status of major crops three category has been made; they are High, Medium and Low. The productivity is in the terms of yield quintal per hectare. This category made based on the state average productivity of the different crops. However, for all the major crops the category of low, medium and high productivity zone of different agro climatic zone has made based on the state average, below state average and above state average. The low productivity agroclimatic zone are those which is below the state average, the medium productivity agroclimatic zone are those which is state average only and the high productivity agroclimatic zone are those which is above the state average. This selection of productivity category for the of different agroclimatic zone is same for all the major crops.

Table- 2 represents the agroclimatic zone wise productivity status of major crops in Odisha during the 2006-07 to 2018-19. The Rice production is the significant part of the Odisha economy. Although, for the majority of the population Rice is the staple food in Odisha. In addition to this also, overtime, majority of the area under rice production as compared to the other crops production. Although, for Rice the state average productivity 18 quintal per hectare in which 14 quintal per hectare is minimum and maximum is 27 quintal per hectare. So, the state average low productivity agroclimatic zone are those which coming under below state average which is 18 quintal per hectare, medium productivity agroclimatic zone are those which coming under state average only which is 18 quintals per hectare and high productivity agroclimatic zone are those which coming under above state average which is more than 18 quintal per hectare.

Table- 2 represents the agroclimatic zone wise productivity status of major crops in Odisha during the 2006-07 to 2018-19. For Cereals the state average productivity 18 quintal per hectare in which 14 quintal per hectare is minimum and maximum is 27 quintal per hectare. So, the state average low productivity agroclimatic zone are those which coming under below state average which is 18 quintal per hectare, medium productivity agroclimatic zone are those which coming under state average only which is 18 quintals per hectare and high productivity agroclimatic zone are those which coming under above state average which is more than 18 quintal per hectare.

Table- 2 represents the agroclimatic zone wise productivity status of major crops in Odisha during the 2006-07 to 2018-19**.** For Pulses the state average productivity 5 quintal per hectare in which 4 quintal per hectare is minimum and maximum is 6 quintal per hectare. So, the state average low productivity agroclimatic zone are those which coming under below state average which is 5 quintal per hectare, medium productivity agroclimatic zone are those which coming under state average only which is 5 quintals per hectare and high productivity agroclimatic zone are those which coming under above state average which is more than 5 quintal per hectare. Table 2 represents the agroclimatic zone wise productivity status of major crops in Odisha during the 2006-07 to 2018-19**.** For Food grains the state average productivity 14 quintal per hectare in which 10 quintal per hectare is minimum and maximum is

21 quintal per hectare. So, the state average low productivity agroclimatic zone are those which are below state average which is 14 quintal per hectare, medium productivity agroclimatic zone are those which coming under state average only which is 14 quintals per hectare and high productivity agroclimatic zone are those which coming under above state average which is more than 14 quintal per hectare. Table 2 represents the agroclimatic zone wise productivity status of major crops in Odisha during the 2006-07 to 2018-19**.** For Oilseeds the state average productivity 9 quintal per hectare in which 4 quintal per hectare is minimum and maximum is 17 quintal per hectare. So, the state average low productivity agroclimatic zone are those which coming under below state average which is 9 quintal per hectare, medium productivity agroclimatic zone are those which coming under state average only which is 9 quintals per hectare and high productivity agroclimatic zone are those which coming under above state average which is more than 9 quintal per hectare. Table 2 represents the agroclimatic zone wise productivity status of major crops in Odisha during the 2006-07 to 2018-19. For Fibres the state average productivity 6 quintal per hectare in which 4 quintal per hectare is minimum and maximum is 23 quintal per hectare. So, the state average low productivity agroclimatic zone are those which coming under below state average which is 6 quintal per hectare, medium productivity agroclimatic zone are those which coming under state average only which is 6 quintals per hectare and high productivity agroclimatic zone are those which coming under above state average which is more than 6 quintal per hectare. Table 2 represents the agroclimatic zone wise productivity status of major crops in Odisha during the 2006-07 to 2018-19. For Sugarcane the state average productivity 715 quintal per hectare in which 297 quintal per hectare is minimum and maximum is 793 quintal per hectare. So, the state average low productivity agroclimatic zone are those which coming under below state average which is 715 quintal per hectare, medium productivity agroclimatic zone are those which coming under state average only which is 715 quintals per hectare and high productivity agroclimatic zone are those which coming under above state average which is more than 715 quintal per hectare.

From the analysis of five decades of agroclimatic zone of Odisha, it is found that Subarnapur, Bargarh and Sambalpur perform better in rice and other crops also. Subarnapur districts are under the high productivity zone in terms of rice production accounting more than state average that is 27 quintal per hectare following by Jagatsingpur and Bargarh districts 22 quintal per hectare. Bargarh district falls under high productivity zone in terms of rice production and Sambalpur district falls under medium productivity zone. So, the figure-1 represents the Rice productivity status of different districts in Odisha. Also, the productivity across the major crops in terms of high, medium, and low and across the different districts of Odisha is given below in the table-3.

Therefore, from the above table it is clear that there has been high variation of rice productivity across the different districts of Odisha. So, wide range of productivity variations were found across districts within the same zone. Interestingly, the study area of Hirakud command area such as Subarnapur, Bargarh and Sambalpur perform well in terms of the productivity of rice production as compared to the different

districts of Odisha. The districts like Subarnapur and Bargarh fall under high productivity zone, whereas Sambalpur falls under medium productivity zone.

Growth Performance of Major crops in Odisha

The growth performance of area yield and production of 34 crops in Odisha agriculture is shown in table-4. 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. Compound annual growth taken into consideration to see the growth performance of 24 crops in Odisha. Its estimates the five decades or 50 years of different crops produced in Odisha. This long period was divided into preceding reform period (1970-71 to 1990-91), reform and post reform period (1991-92 to 2019-20). These are further sub divided into five sub period 1970-71 to 1980-81 (Period I), 1981-82 to 1990-91(Period II),, 1991-92 to 2000-01(Period III),, 2000-01 to 2009-10(Period IV),, and 2010-11 to 2019-20 (Period V).

The compound annual growth rate of area under 34 crops is represented in the table 4. During the first period 1970-71 to 1980-81, the growth rate of area of all the crops is positive except rice and cereals.

Table 2: Agroclimatic zone wise productivity status of major crops in Odisha during the 2006-07 to 2018-19 (Yield Quintals/Hectare)

Climate Zone	Districts	Rice		Cereals		Pulses		Foodgrains		Oilseeds		Fibers		Sugarcane	
North – Western Plateau	Sundargarh	15	L	15	L	5	M	13	L	5	L	10	H	678	L
	Deogarh	17	L	17	L	4	L	12	L	5	L	8	H	588	L
North Central Plateau	Mayurbhanj	17	L	17	L	6	H	15	H	8	L	8	H	297	L
	Keonjhar	17	L	17	L	5	M	14	M	4	L	14	H	659	L
North Eastern Coastal Plain	Balasore	19	H	19	H	5	M	18	H	13	H	16	H	654	L
	Bhadrak	19	H	19	H	5	M	18	H	11	H	22	H	729	H
	Jajpur	16	L	16	L	4	L	12	L	17	H	18	H	659	L
East and South Eastern Coastal Plain	Cuttack	21	H	21	H	5	M	14	M	14	H	21	H	661	L
	Jagatsingpur	22	H	22	H	5	M	15	H	16	H	23	H	706	L
	Kendrapara	16	L	15	L	4	L	11	L	16	H	21	H	705	L
	Puri	18	M	18	M	4	L	14	M	17	H	13	H	669	L
	Khurda	18	H	18	M	5	M	13	L	12	M	6	M	632	L
	Nayagarh	16	M	16	M	4	L	11	L	5	L	6	M	696	L
North Eastern Gha	Ganjam	18	M	17	M	5	M	12	L	9	M	7	H	740	H
	Gajapati	16	L	15	L	6	H	12	L	8	L	5	L	626	L
	Rayagada	20	H	19	H	6	H	15	H	5	L	6	M	666	L
	Phulbani	15	L	16	L	5	M	12	L	4	L	4	L	306	L
Eastern Ghat High Land	Koraput	20	H	17	H	5	M	15	H	4	L	9	H	793	H
	Nawaragpur	18	M	23	M	5	M	21	H	7	L	8	H	623	L
South Eastern Ghat	Malkangiri	16	L	16	L	5	M	14	M	9	M	9	H	505	L
Western Undulating Zone	Kalahandi	18	M	19	M	6	H	13	L	9	M	4	L	725	H
	Nuapada	15	L	14	L	4	L	10	L	9	M	5	L	607	L
Western Central Table Land	Bolangir	18	M	18	M	5	M	13	L	11	H	5	L	744	H
	Sonepur	27	H	27	H	5	M	21	H	10	H	5	L	684	L
	Boudh	19	H	19	H	5	M	14	M	6	L	8	H	761	H
	Sambalpur	18	M	18	M	5	M	15	H	5	L	7	H	632	L
	Bargarh	22	H	22	H	4	L	18	H	12	H	6	M	735	H
	Jharsuguda	14	L	14	L	5	M	12	L	5	L	7	H	632	L
Mid Central Table Land	Dhenkanal	21	H	21	H	4	L	14	M	8	L	9	H	705	L
	Angul	15	L	15	L	5	M	10	L	6	L	9	H	634	L
State Average		18		18		5		14		9		6		715	

Source: Authors Calculation from the five decades of Agricultural Statistics of Odisha, 2020

Figure 1: Productivity of Rice across the different districts of agroclimatic zone of Odisha during 2006-07 to 2018-19 (Yield Quintal Per Hectare)

Source: Authors Calculation from five decades of agricultural statistics of Odisha, 2020

Table 3: Performance of different crops across the different districts during 2006-07 to 2018-19 (Yield Quintals per Hectare)

Crops	High Productivity Zone	Medium Productivity Zone	Low Productivity Zone
Rice	Sundargarh, Deogarh, Mayurbhanj, Keonjhar, Jajpur, Kendrapara, Gajapati, Phulbani, Nuapara, Jharsuguda, Anugul	Puri, Nayagarh, Ganjam, Nabarangpur, Kalahandi, Balangir, Sambalpur	Balasore, Bhadrak, Cuttack, Jagatsinghapur, Khordha, Rayagada, Koraput, Subarnapur, Boudh, Bargarh, Dhenkanal
Cereals	Sundargarh, Deogarh, Mayurbhanj, Keonjhar, Jajpur, Kendrapara, Gajapati, Phulbani, Nuapara, Jharsuguda, Anugul	Puri, Nayagarh, Ganjam, Nabarangpur, Kalahandi, Balangir, Sambalpur	Balasore, Bhadrak, Cuttack, Jagatsinghapur, Khordha, Rayagada, Koraput, Subarnapur, Boudh, Bargarh, Dhenkanal
Pulses	Deogarh, Jajpur, Kendrapara, Puri, Nayagarh, Nuapara, Dhenkanal, Bargarh	Sundargarh, Keonjhar, Balasore, Bhadrak, Cuttack, Jagatsinghpur, Khordha, Ganjam, Phulbani, Koraput, Nayagarh, Malkangiri, Bolangir, Sonepur, Boudh, Sambalpur, Jharsuguda, Anugul	Mayurbhanj, Gajapati, Rayagada, Kalahandi
Foodgrains	Sundargarh, Deogarh, Jajpur, Kendrapara, Khordha, Nayagarh, Ganjam, Gajapati, Phulbani, Kalahandi, Nuapada, Bolangir, Jharsuguda, Anugul	Keonjhar, Cuttack, Puri, Malkangiri, Baudh, Dhenkanal	Mayurbhanj, Balasore, Bhadrak, Jagatsinghpur, Rayagada, Koraput, Nabarangapur, Sonepur, Sambalpur, Bargarh
Oilseeds	Sundargarh, Deogarh, Mayurbhanj, Keonjhar, Nayagarh, Gajapati, Rayagada, Phulbani, Koraput, Nabarangapur, Baudh, Sambalpur, Jharsuguda, Dhenkanal, Anugul	Khordha, Ganjam, Malkangiri, Kalahandi, Nuapada	Balasore, Bhadrak, Jajpur, Cuttack, Jagatsinghpur, Kendrapara, Puri, Bolangir, Sonepur, Bargarh

Fibres	Gajapati, Phulbani, Kalahandi, Nuapada, Bolangir, Sonepur	Khordha, Nayagarh, Rayagada, Bargarh	Sundargarh, Deogarh, Mayurbhanj, Keonjhar, Balasore, Bhadrak, Jajpur, Cuttack, Jagatsinghpur, Kendrapara, Puri, Ganjam, Koraput, Nabarangpur, Malkangiri, Baudh, Sambalpur, Jharsuguda, Dhenkanal, Anugul
Sugarcane	Sundargarh, Deogarh, Mayurbhanj, Keonjhar, Balasore, Jajpur, Cuttack, Jagatsinghpur, Kendrapara, Puri, Khorda, Nayagarh, Gajapati, Rayagada, Phulbani, Nabarangapur, Malkangiri, Nuapara, Sonepur, Sambalpur, Jharsuguda, Dhenkanal, Anugul		Bhadrak, Ganjam, Koraput, Kalahandi, Boalangir, Boudh, Bargarh

Whereas during the second periods 1981-82 to 1990-91, there were mixed growth rate which is positive for few crops and negative for most of the crops. The positive growth rate during the second period were, rice (0.52), black gram (3.26), red gram (8.01), pulses (1.73), food grains (0.10), groundnut (8.90), sesamum (8.84) , niger (2.24), oilseed (4.72), vegetables(3.20), and spices and condiments (1.87) . Whereas during the second period, the negative growth rate was wheat (-6.20), maize (-0.73), ragi (-3.44), jowar (-2.86), small millets (-15.56), cereals, (-0.49), green gram (-0.26), cowpea (-4.69), castor (-3.29), mustard (-1.53), fibres (-1.75), sugarcane (-0.34) and tobacco (-3.67). 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 (0.49), maize (0.41), fibres (0.44) and spices and condiments (1.46). Moreover, during the fourth period 2000-01 to 2009-10, interestingly improvement in the growth rate of area on most of the crops as compared to the third period. Those crops were such as wheat (2.76), maize (2.91), green gram (6.57), black gram (4.53), cowpea (4.91), pulses (4.65), food grains (1.12), groundnut (1.35), sesamum (4.20), mustard (2.70), oilseed (1.39), vegetables (7.70), spices and condiments (1.49), sugarcane (1.79) and tobacco (1.06). 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 all major aggregate crops such as cereals, pulses, food grains, oilseeds, vegetables, sugarcane and tobacco were negative except fibers.

The growth rate of production per hectare for 34 crops is represented in the table- 4. During the first period the growth rate of production per hectare all the major crops were positive excepts cereals (-3.12), food grains (-2.49), and tobacco (-3.99). The positive growth rate of production per hectare were during the first period were such as pulses (2.27), oilseeds (2.90), fibres (0.62), vegetables (0.64), spices and condiments (6.57), and sugarcane (6.31). Whereas during the second period the growth rate of production per hectare of cereals, pulses, food grains, oilseeds, and vegetables were much better as compared to the first period. was less as compared to the first period. The growth rate of production per hectare during the second period were cereals (3.36), pulses (2.53) , food grains (3.24) , oilseeds (6.53), fibres (0.48),

vegetables (4.81), spices and condiments (2.74), sugarcane (0.93) and tobacco (-2.48). Moreover, the worrying factor is that during the third period the growth rate of production per hectare all the aggregate crops were negative. During the third period the growth rate of production per hectare of all the individual crops as well as the aggregate crops were negative excepts maize and spices and condiments. The growth rate per hectare of all the major crops during the fourth period were remarkable. The growth rate of production per hectare during the fourth period were cereals (4.92), pulses (7.39), food grains (5.16), oilseeds (5.77), fibres (1.64), vegetables (11.60), spices and condiments (9.89), sugarcane (2.44) and tobacco (6.64). Whereas the growth rate of production per hectare for all crops during the fifth period was much less as compared to the Fourth period. The growth rate of production per hectare of all major aggregate crops were negative excepts cereals, pulses, food grains, and vegetables.

The compound annual growth rate of yield per hectare for 34 crops is represented in the table 4. During the first period the growth rate of yield per hectare of all aggregate crops were negative such as cereals, pulses, food grains, oilseeds, and vegetables. Whereas the growth rate of yield of two individuals' crops were positive only such as wheat and sugarcane. During the second period the growth rate of yield per hectare of all the major aggregate crops were positive such as cereals (3.88), pulses (0.79), food grains (3.14), oilseeds (1.73), fibers (2.27), vegetables (1.56), spices and condiments (5.4), sugarcane (1.28) and tobacco (1.24). During the third period the growth rate of yield per hectare of all major aggregate crops were negative excepts vegetables. The negative yield all the major aggregate crops were such as rice (-0.71), pulses (-3.42), food grains (-0.63), oilseeds (-2.27), fibres (-9.86), spices and condiments (-0.52), sugarcane (-2.25), tobacco (-0.27). However, during the fourth period the growth rate of yield per hectare of all major aggregate crops as well as the individual crops were positive such as cereals (5.02), pulses (2.60), food grains (4.00), oilseeds (4.32), fibres(1.69), vegetables(3.63), spices and condiments (8.27), sugarcane(0.63) and tobacco(5.56). Whereas during the fifth period the growth rate of yield per hectare of all major crops were low as compared to the fourth period.

Table 4: Compound 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	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
Rice	-0.91	-3.71	-2.82	0.52	4.30	3.77	0.49	-0.19	-0.68	-0.17	4.78	4.96	-0.81	3.73	4.58
Wheat	16.37	18.05	1.45	-6.20	-6.81	-0.65	-6.61	-8.56	-2.09	2.76	5.23	2.40	-19.83	-18.87	1.20
Maize	6.70	3.22	-3.26	-0.73	1.40	2.16	0.41	0.50	0.09	2.91	9.68	6.58	0.07	1.36	1.30
Ragi	6.12	0.43	-5.36	-3.44	-1.02	2.50	-1.88	-5.41	-3.61	-0.24	1.51	1.75	-4.66	-1.49	3.32
Jowar	2.98	1.34	-1.59	-2.86	-2.15	0.74	-7.12	-10.25	-3.36	-3.97	-2.82	1.20	-4.63	-4.07	0.58
Small Millets	2.81	-0.29	-3.02	-15.56	-15.60	-0.04	-5.61	-7.19	-1.68	-8.75	-4.78	4.34	8.52	9.87	1.26
Cereals	-0.21	-3.12	-2.92	-0.49	3.36	3.88	0.23	-0.47	-0.71	-0.10	4.92	5.02	-0.88	3.43	4.35
Green Gram	8.07	1.82	-5.79	-0.26	-1.52	-1.26	-2.42	-5.45	-3.12	6.57	9.27	2.54	-0.14	1.32	1.47
Black Gram	7.73	2.52	-4.82	3.26	3.99	0.71	-1.87	-6.75	-4.96	4.53	7.14	2.50	-3.82	-2.58	1.30
Red Gram	4.50	-0.58	-4.86	8.01	14.10	5.63	-2.10	-4.57	-2.53	-1.27	1.57	2.87	-0.57	1.72	2.30
Cowpea	8.88	5.01	-3.55	-4.69	-3.27	1.50	13.70	11.20	-2.20	4.91	7.76	2.70	3.23	3.94	0.68
Pulses	7.82	2.27	-5.13	1.73	2.53	0.79	-2.97	-6.30	-3.42	4.65	7.39	2.60	-0.87	0.49	1.38
Foodgrains	1.32	-2.49	-3.75	0.10	3.24	3.14	-0.65	-1.27	-0.63	1.12	5.16	4.00	-0.88	3.13	4.04
Groundnut	10.63	3.85	-6.13	8.90	7.99	-0.84	-4.97	-4.75	0.22	1.35	6.39	4.98	-2.09	-0.78	1.34
Sesamum	7.97	0.78	-6.64	8.84	11.28	2.24	-2.32	-7.84	-5.64	4.20	6.90	2.59	-2.88	-2.19	0.73
Castor	6.91	-0.68	-7.09	-3.29	-1.11	2.25	-3.51	-5.24	-1.81	-1.59	1.13	2.76	-8.11	-7.72	0.45
Niger	6.93	0.64	-5.91	2.24	3.97	1.70	-3.09	-6.79	-3.82	-5.29	-2.37	3.10	-6.09	-7.16	-1.15
Mustard	11.32	4.84	-5.81	-1.53	-0.18	1.39	-2.84	-6.88	-4.14	2.70	5.53	2.75	-0.25	1.54	1.79
Oilseeds	9.08	2.90	-5.66	4.72	6.53	1.73	-3.34	-5.53	-2.27	1.39	5.77	4.32	-3.58	-1.71	1.94
Fibers	2.36	0.62	-1.70	-1.75	0.48	2.27	0.44	-9.47	-9.86	-0.03	1.64	1.69	6.04	3.94	-1.99
Vegetables	2.75	0.64	-2.06	3.20	4.81	1.56	-6.64	-6.64	0.00	7.70	11.60	3.63	-1.68	-1.10	0.59
Spices and Condiments	8.04	6.57	-1.36	1.87	2.74	0.86	1.46	0.93	-0.52	1.49	9.89	8.27	-2.33	-2.14	0.20
Sugarcane	4.92	6.31	1.33	-0.34	0.93	1.28	-4.97	-7.11	-2.25	1.79	2.44	0.63	-8.28	-8.05	0.25
Tobacco	2.83	-3.99	-6.64	-3.67	-2.48	1.24	-8.12	-8.36	-0.27	1.06	6.64	5.56	-26.82	-28.57	-2.40

Table 5: Compound 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 1970-71 to -1990-91			Following Reform Period 1991-92 to 2019-20			Overall Period 1970-71 to 2019-20		
	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
Rice	-0.08	1.27	1.35	-0.52	1.33	1.86	-0.26	1.76	2.03
Wheat	4.97	5.66	0.65	-8.78	-8.81	-0.03	-3.39	-2.95	0.46
Maize	4.29	6.45	2.07	1.28	5.47	4.14	2.60	5.27	2.60
Ragi	2.33	2.98	0.64	-2.63	-1.38	1.29	-0.59	-0.18	0.41
Jowar	2.18	3.62	1.42	-5.36	-5.70	-0.36	-2.21	-2.17	0.05
Small Millets	-4.09	-2.82	1.32	-2.64	-3.21	-0.58	-3.21	-2.71	0.51
Cereals	0.06	1.44	1.38	-0.58	1.40	1.99	-0.24	1.80	2.05
Green Gram	4.21	3.40	-0.77	0.45	0.75	0.29	1.94	1.55	-0.38
Black Gram	5.53	6.15	0.60	-1.11	-1.72	-0.61	1.64	1.51	-0.13
Red Gram	6.02	7.24	1.16	-0.96	0.40	1.37	1.90	3.11	1.20
Cowpea	1.10	1.36	0.25	5.65	6.34	0.66	3.53	4.02	0.48
Pulses	4.77	4.72	-0.05	-0.39	-0.29	0.10	1.71	1.66	-0.04
Food grains	1.07	1.86	0.79	-0.52	1.21	1.74	0.18	1.78	1.60
Groundnut	9.03	9.72	0.64	-1.96	-0.88	1.10	2.21	3.09	0.86
Sesamum	6.86	7.55	0.65	-1.92	-1.45	0.48	1.63	1.27	-0.35
Castor	1.53	0.42	-1.09	-5.01	-4.37	0.68	-2.43	-2.69	-0.27
Niger	4.33	4.41	0.06	-4.74	-5.66	-0.97	-0.78	-1.22	-0.45
Mustard	5.55	5.71	0.15	-1.64	-2.53	-0.91	1.42	1.30	-0.12
Oilseeds	6.47	7.70	1.16	-2.29	-1.45	0.86	1.23	2.00	0.76
Fibers	0.69	2.18	1.47	2.53	-0.38	-2.83	1.74	0.57	-1.15
Vegetables	3.48	4.72	1.20	-1.17	0.29	1.48	0.85	2.26	1.40
Spices and Condiments	5.33	7.96	2.50	-1.09	2.11	3.24	1.59	4.32	2.68
Sugarcane	2.45	3.98	1.49	-3.48	-3.41	0.08	-0.97	-0.36	0.62
Tobacco	0.35	-1.23	-1.58	-15.60	-15.76	-0.19	-9.11	-9.53	-0.47

Table 6: Overall Performance of compound Annual Growth rate of Area, Yield and Production of different crops in Odisha during 1970-71 to 2019-20

High (> 4 %)	Medium (2.00-3.9 %)	Low (0-1.9 %)	Negative
Area			
Cotton	maize, cowpea, groundnut,	green gram, black gram, red gram, horse gram, bengal gram, field pea, pulses, food grains, sesamum, mustard, oilseeds, fibres, vegetables, spices and condiments	rice, wheat, ragi, jowar, bajra, small millets, cereals, castor, niger, linseed, jute, mesta, sun hemp, sugarcane, tobacco
Production			
maize, cowpea, cotton, spices and condiments	red gram, groundnut, vegetables,	rice, cereals, green gram, black gram, horse gram, benga gram, field pea, pulses, food grains, sesamum, linseed, mustard, fibres	wheat, ragi, jowar, bajra, small millets, castor, niger, jute, mesta, sunhemp, sugarcane, tobacco
Yield			
	rice, maize, cereals, spices and condiments	wheat, ragi, jowar, bajra, small millets, red gram, cowpea, bengal gram, foodgrains, groundnut, linseed, oilseed, jute, cotton, sunhemp, vegetables, sugarcane	green gram, black gram, horse gram, field pea, pulses, sesamum, castor, niger, mustard, mesta, fibres, tobacco

Table 7: Compound Annual Growth Rate of Major Indicator of Odisha Agriculture during 1990-91 to 2017-18

Gross Cropped Area	-2.76
Net Shown Area	-1.80
Gross Irrigated Area	-2.55
Net Irrigated Area	-2.52
N	3.55
P2O5	4.66
K2O	3.97
Total Fertiliser	3.87
Consumption of Fertiliser Kg/Per Ha.	4.66
Annual Rainfall	-1.28
Power Consumption in Agriculture	2.29
Agricultural Credit	13.98

Source: Authors Calculation from agricultural Statistics of Odisha, 2020 and Handbook of Statistics on Indian States, Reserve Bank of India various issue.

From the above analysis, it is clear that the growth rate of area of all the major aggregate crops has been declining significantly, still the production growth and yield growth is increasing. The growth rate area of cereals was declining significantly overtime. The growth rate area of pulses was declining significantly up to the third period than a rise in the fourth period, afterwards further growth rate falls negatively. The growth rate area of food grains, oilseeds, spices and condiments, sugarcane and tobacco. During all the periods, the growth rate of production per hectare for all the major aggregate crops such as cereals, pulses, food grains, oilseeds, fibres, vegetables, spices and condiments, sugarcane and tobacco has been remarkable during the fourth periods.

The growth performances of area, yield and production of 34 crops in Odisha agriculture during the period from (1970-71 to 2019-20 is shown in table- 5. The crops included are 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. The growth rate of area under cultivation during the pre-reform period was remarkable as compared to the post reform period. It is interesting to understand that the growth rate of yield per hectare during the post reform period was much better as compared to the pre-reform for crops like cereals (1.99), pulses (0.10), food grains (1.74), vegetables (1.48), and spices and condiments (3.24) .

Table 6 estimates the long term annual average growth rate of 34 major crops in Odisha from 1970-71 to 2019-20. During the period, agriculture was adversely affected due to the climate change. During the last five decades from the year 1970 to year 2019 Odisha faced frequent natural calamities. There were severe deviations in the rain fall as well that also adversely affected agricultural growth. 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 state faced natural calamities. Further from 1996 the state faced frequent natural calamities ever year.

To understand the overall performance of area, yield and production of different crops in during year 1970-71 to year 2019-20, the growth has been divided into four categories based on the annual average growth rate such as high, medium, low and negative. The high growth rate crops coming under more than >4%, medium growth rate crops with 2.00- 3.9 % annual average growth rate, low growth rate crops under 0-1.19 % annual average growth rate and negative growth rate. The crops under low growth rate were, all varieties of gram, field pea, pulses, food grains, sesamum, mustard, oilseeds, fibres, vegetables, and spices and condiments. Where as in terms of growth rate of production the crops coming under low growth crops were, rice, cereals, green gram, black gram, horse gram, bengal gram, field pea, pulses, food grains, sesamum, linseed, mustard, and fibres. Where as in terms of yield per hectare the crops coming under low growth crops were, wheat, ragi, jowar, bajra, small millets, red gram, cowpea, bengal gram, food grains, groundnut, linseed, oilseed, jute, cotton, sunhemp, vegetables, and sugarcane. The details performance of growth on the basis of area, yield and production are represented in the table -6.

However, the per hectare productivity during the pre-reform period was higher for few crops compared to the post reform period being even negative for some of the crops. The growth rate of yield per hectare during the pre-reform period improved for the crops like cereals, food grains, and spices and condiments.

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 low and extremely volatile for all the crops excepts maize, ragi, jowar, small millets, castor, niger, sugarcane and tobacco.

3.5.4 Major Key Indicator of Agriculture in Odisha

Apart from the growth rate of area, yield, and production of agriculture, the other key major indicator is also examined. The major key indicator is gross cropped area, net shown area, cropping intensity, gross irrigated are, net irrigated are, total fertilizer, annual rainfall, power consumption of agriculture, and agricultural credits. The agricultural credits include only the commercial bank credit on agriculture and not includes others bank credit on agriculture. The table- 7 represents the major key indicator of agricultural development in Odisha. In any regions agricultural development, cropping intensity play an important role. Increased cropping intensity indicates that intensive use of more land used for cultivation. The ratio of gross cropped area is used to calculated cropping intensity. To increase the agricultural production increasing in cropping intensity and the productivity would be essential for the economy or both the cropping intensity and the productivity. The cropping intensity of Odisha more or less fluctuating in nature overtime. Moreover, if we see the cropping intensity in Odisha over the year it was decreasing in nature. This was because of the growth rate of gross cropped area and the net shown area was declining overtime (Appendix 2). The table- 7 represents the key indicator of annual average growth rate of Odisha agriculture during year 1990-91 to year 2017-18. Although, the worrying results is that the compound annual average growth rate of gross cropped area was negative which is -2.76. Also, the compound annual growth rate of net shown area was negative which is -1.80. To increase the growth rate of production assured source of irrigation is the important determinant. But overtime the growth rate of gross irrigated area and the net irrigated area were negative. In addition to this for the better plant growth without any disease prone plant the role of fertilisers much more important. In Odisha the use of fertiliser increases significantly overtime. During year 1990 to year 2018-19, the growth rate of total fertiliser was 3.87. Whereas the growth rate of consumption of fertiliser kg per hectare was 4.66. Overtime the growth rate of annual rainfall was negative in Odisha. Interestingly, the consumption of power in the agriculture sector also increased significantly. In addition to this, the role of credit is also equally important in the agriculture. During year 1990-91 to year 2018-18, the growth rate of credit in the agriculture sector was 13.98.

Thus, from the analysis of major indicator the study found that for accelerating the growth of the agricultural sector the expansion of these indicators needs special care and attention. The gross cropped and the net shown area declining overtime in Odisha. This was may be because of the rapid urbanization,

construction, population growth and many more. Also, if these situations will continue the economy going to face extreme challenges. Because population was growing in a faster rate while the gross cropped area was decreasing consistently. Although, the food grain and nonfood grain increasing in nature but after a saturation point or steady state growth food grain and nonfood grains production was also not mitigating the economy's demand of food grains production. Therefore, now the question arises in such situation how the faster population growth cope of with the food productions.

The Rainfall Pattern of Odisha during the last five decades (1970 to 2019)

Commonly between June 1st to September 30th is the monsoon season of India. The rainfall between the months of June to September is known as the South-West Monsoon Rains and October -December is North-East monsoon season in India. In other words, meteorological season are winter season (January-February), pre monsoon season (March- May), south west monsoon season (June- September) and post monsoon season (October- December). The south west monsoon rains or the June-September rains accounts for nearly 80 percent of the annual precipitation and majority of the area under cultivation is dependent on these rains in Odisha. However, to increase the agricultural production and productivity rainfall plays a vital role. The normal rainfall or long period average rainfall in Odisha falling overtime. Between 1992 to 2000 the long period average rainfall in Odisha was 1502.6, which was fall to 1482.2 (2001 to 2004) and further fall to 1451.2 (2005 to 2019). During 2018 as well as 2019 the state has received a surplus rainfall of 1643.33 mm and 1627.79 mm which was above the normal rainfall (see figure 2).

It investigates the monthly distribution pattern of rainfall trends from 1992 to 2019 in Odisha. It was found that the South-West Monsoon Rains get more rainfall as compared to the other monsoon season (see figure 3). The average rainfall pattern was increasing rapidly from march to July and decreasing speedily from July to November. The average rainfall pattern was peaked in the month of July. The rainfall pattern of Odisha among the different months looks like a normal bell-shaped curve.

From 1970 to 2000, long period average rainfall was 1502.2 mm in Odisha. During these 31 years the state had received surplus rainfall for seven year such as 1970,1971, 1985,1986,1990, 1994, and 1995. whereas for rest of the year the state had received deficit rainfall. The state got the deficit rainfall continuously from 1972 to 1984. Moreover, from 2001 to 2004, long period average rainfall was 1482.2 mm in Odisha and from 2005 to 2019, long period average rainfall was 1451.2 mm in Odisha. So, overtime the normal rainfall in Odisha was declining. During 2005 to 2009 even if the state has received the deficit rainfall but the deficit was low as compared to the 1970 to 2000.

From table-8 it found that form the last fifty years the state has faced frequently natural calamities overtime. Out of the fifty years the state has faced 42 years natural calamities and only for 8 years the state has faced no natural calamities. The state has faced 13 years of floods during these 50 years. Interestingly, the worrying factor is that the state has faced frequent natural calamities after 1995.

Figure 2: Trends in Indian monsoon rains 1970 to 2019

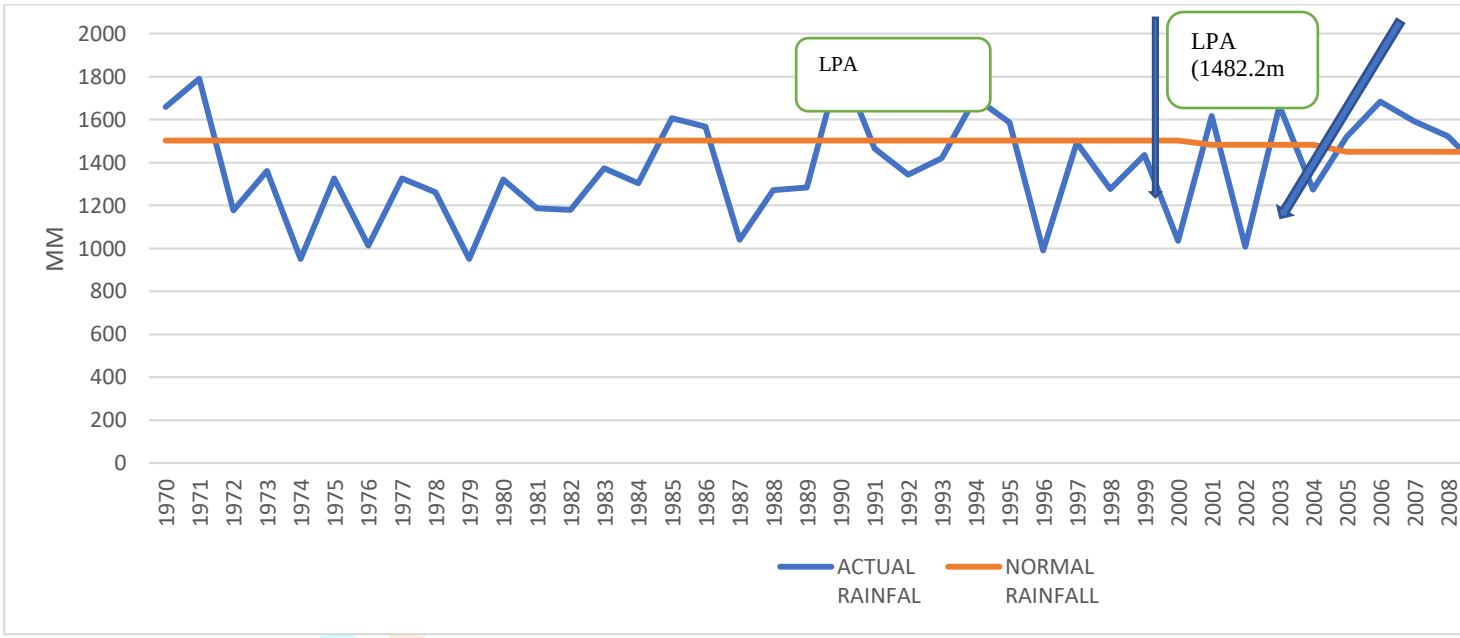

Figure 3: Average Monthly Distribution of patten of monsoon rain from 1992 to 2019 in Odisha (in Percent)

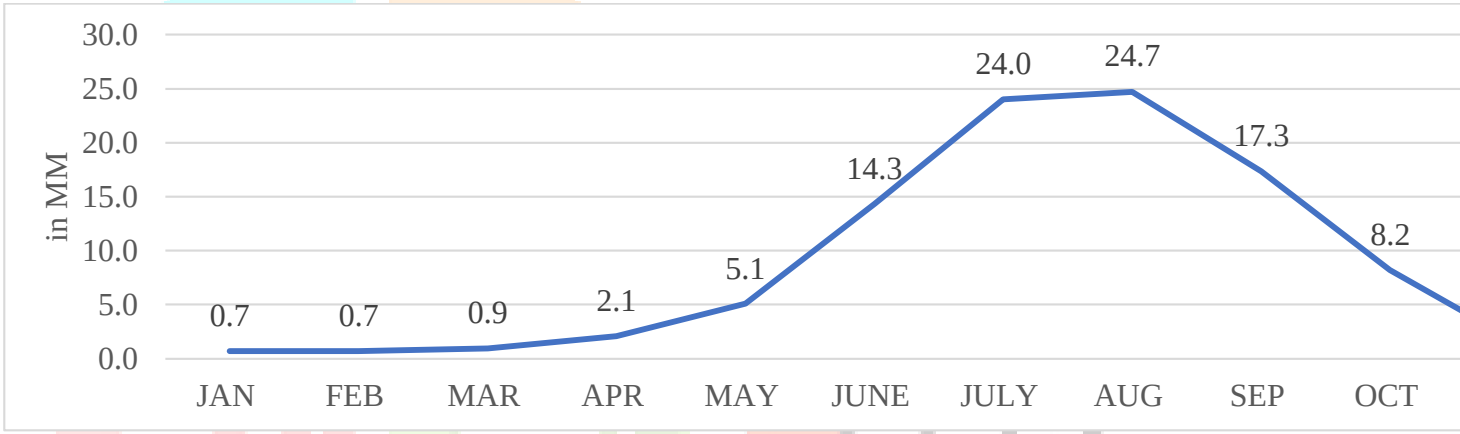

Table-8: Study of Natural Calamities from 1970 to 2019

Natural Calamities	Frequency of Natural Calamities	Year
cyclonic storm	4	**2013, 2014, 2018, 2019**
Drought	4	1984,1997,2000,2002,
Drought & Flood	2	2011,2012,
Drought & Heat Wave	1	1998
Drought, Flood & Heavy Rain	2	2015,2016,
Flood	13	1970,1973,1975, 1977,1985,1990,2001,2003,2004,2005,2006
Flood & Drought	1	1992
Flood, Drought	2	1972, 1980
Flood, Heavy Rain, Drought & Pest attack	3	2009, 2010, 2017
Hailstorm, Whirlwind, Tornado	1	1978
Severe Cyclone, Flood	1	1971
Severe Drought	4	1996
Severe Drought, Flood	1	1974
Severe Flood, Drought, Cyclone	1	1982
Super Cyclone	1	1999

Whirlwind, Tornado, Flood, Drought	1	1981
No Calamities	0	1983,1986,1988,1989, 1991,1993,1994,199
Total	42	

Source: Authors Calculation from the five decades of agricultural statistics, 2019-20

**For 1970 to 2000, the LPA value is 1502.2, For 2001-2004 the LPA value is 1482.2 and for all other year the LPA value is 1482.2

Conclusions and Policy Suggestions

The cropping pattern of Odisha shifting from dominant crop rice to maize, green gram, black gram, red gram, groundnut, sesamum, mustard, cotton, fibers, vegetables and spices and condiments. Whereas, in terms of the productivity under the different agroclimatic zone Subarnapur districts performing well in rice crop as compared to the other high productivity districts. Similarly, for pulses and oilseeds few districts performing better and few districts performing worse. Similarly, the performance of fibers productivity was better for majority of the districts. But the productivity of Sugarcane worse for majority of the districts only few districts were performing well. The growth rate of area, yield, and productions of Odisha were extremely low and volatile. During the first period 1970-71 to 1980-81, the of area of all the crops were low positive except rice and cereals. Also, during the first period remarkable growth rate in the area of crops like green gram, cowpea, groundnut, mustard, oilseeds and spices and condiments.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. During the second period remarkable growth rate of area of crops like red gram, groundnut, and sesamum.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, maize, cowpea, fibres, and spices and condiments. During the third period the growth rate of area of cowpea was impassive as compared to the other individual crop in the same period. Moreover, during the fourth period 2000-01 to 2009-10, interestingly growth rate of area on most of the crops were improved as compared to the third period. However, during the fifth period (2010-11 to 2019-20) the growth rate of most of the crops were negative excepts maize, cowpea, and fibres. During the fifth period the growth rate of area of fibres was impressive. Interestingly, even if the growth rate of area of the most crops declining but still production of the most of the crops performing better. During the first period the growth rate of production per hectare of most of the crop was positive except few crops like rice, small millets, cereals, red gram, food grains, castor, and tobacco. During the first period the growth rate of production per hectare was impressive for wheat crops. During the second period the growth rate of production per hectare was much better as compared to the first period. The growth rate of production per hectare of all the aggregate crops such as cereals, pulses, oilseeds, foodgrains, fibres, vegeables, and spices and condiments were remarkable during the second period as compared to the first period. During the third period the growth rate of production per hectare of all the major aggregate crops much lower than the second period. Even the growth rate of production per hectare of most of the crops were negative. During the fourth period, remarkable positive growth rate of production per hectare of all the major aggregate crops such as cereals, pulses, food grains, oilseeds, fibres, vegetables, and spices and condiments. However, during the fifth period the growth rate of production per hectare of all the major

aggregate crops such as cereals, pulses, food grains, oilseeds, fibres, vegetables and spices and condiments were much low as compared to the fourth period. Moreover, if we look into the overall period of growth rate of area were low with negative. This means that overtime the area under different crops decreasing which was most serious concerned for the state. Also, the growth rate of overall period of production was also low and extremely volatile.

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. So, there is unstable growth rate of area, yield and production of different crops in Odisha. Thus, the future agricultural strategy for the accelerating the growth rate of agricultural development of Odisha expand through the gross cropped area as well as net shown area, better irrigation facility, agricultural extension services, better improved inputs and capital formation. As there is significantly decreases the gross cropped area and net shown area of the state over time. Through, the institutional intervention its reduces the of culturable waste land, fallow lands, fallow land other than current fallow and expands the gross cropped area and net shown area.