

Examining the Agricultural Diversification in Odisha

¹Prabhati Behera

²Dr. Ravindra Sharma

1,2Guru Ghasidas Vishwavidyalaya, Bilaspur, Chhattisgarh

Abstract:- Odisha's agricultural sector has seen significant changes in terms of policy intervention and land utilisation status, area, yield, production, cropping pattern, and so on. An attempt has been made in this context to analyse the performance of agricultural crops in Odisha. The development of a wider range of agricultural crops over time and space is referred to as agricultural diversification. In this study, the variation in agricultural performance in the state of Odisha from 1970–1971 to 2019–20 is analysed. The state of Odisha is expected to experience growth in terms of area, yield, and production on an annual average basis. It has been noted that, at the state level, agricultural diversification has grown, but not significantly. When looking at the diversification of the area under cultivation across the states, some diversified results have been seen. To become self-sufficient and highly diversified, Odisha agriculture still has a long way to go. Furthermore, over the last few decades, Odisha agriculture has been plagued by natural disasters such as drought, flood, cyclones, heatwaves, and so on. With this context in mind, this paper attempts to investigate agricultural diversification in Odisha.

Keywords:- *Cropping Intensity, Cropping Pattern, Annual Average Growth, Natural Calamities.*

I. INTRODUCTION

Agricultural transformation involves changes in production patterns and crop diversification for sustainable growth. Also, crop diversification is crucial for reducing inconsistent agricultural production and yield. So, agriculture dominates Odisha's economy, with 87 percent of the rural population living in rural areas. Therefore, agriculture remains Odisha's economic backbone, employing 60 percent of the labor force and providing primary income for citizens. However, in this paper we are going to examine crop diversification by using secondary Data and suitable method are used to portray the agricultural diversity especially in Odisha. The state predominantly known as an agrarian state. As approx. 70% of rural population depends on agriculture. There are two ways of increasing agricultural productivity, one is to increasing farming land and second is to increase fertility of land. As land is absolute and constant in nature so it's not possible to

increase the agricultural land. But multiple cropping or diversification of crop may increase the fertility of land. It is such a stress relieving factor to farmer community if he adopts agricultural crop diversification as well to the economy. Crop diversification refers to the addendum of new cropping system into the agricultural production. Every addition of new crops gives new opportunity to farmer as it creates new market demand. The reason behind adopting crop diversification is green revolution. The advent of high yielding seeds due to green revolution, new innovation of technologies gives rise of crop diversification in Agriculture.

II. REVIEW OF LITERATURE

(N. Ghosh)The study has considered the state of Andhra Pradesh as a part of investigation. And find out the possible facts that induce multiple cropping in the southern state. The analysis is done separately for the state as a holistic way and for state agro- climatic region in the state. So, the author has examined factors affecting cropping intensity at inter-state as well inter-regional level at four different points of time. To examine different cropping intensity in the region, pooled cross-section regressions are used and to examine temporal variations, the study included Time-series Data of selected districts. The factors examined are percentage of irrigation, intensity of land use with irrigation, tractorisation and rainfall. The study concludes that canal irrigation seems to be the most important factors promoting cropping intensity. So, policy implication arising from this study is that canal irrigation schemes need to be promoted in almost all the regions of the state.

(Dhindsa and Sharma, 1995)have analysed the growth rates of area, production and yield of various crops/crop groups in relation to the cropping pattern changes in Punjab State during 1965-67 to 1990-91. The study also includes the relative contribution of area yield, cropping pattern and their respective interactions to the growth of crop output in the state, and examine the aggregate changes in cropping pattern in terms of substitution and expansion effects. Also, the authors have studied the measure changes in agricultural output (in value terms) due to changes in cropping pattern. The present is based on secondary study. It is collected from Statistical Abstracts of Punjab. The studies showed that one of the reasons of changing cropping pattern in Punjab is policies of the Government regarding support prices and

¹Ph.D. Scholar, Department of Economics, School of Studies in Social Science, Guru Ghasidas Vishwavidyalaya, Bilaspur.

²Assistant Professor, Department of Economics, School of Studies in Social Science, Guru Ghasidas Vishwavidyalaya, Email:

procurement also assured demand for cotton textiles factories was the reason for not reducing acreages under cotton. More concentration on wheat and rice cultivation and research extension, Government policy also availability of inputs of the crops that is improved seeds, chemical fertilizers and pesticides etc. motivated changes in cropping pattern in favour of rice, wheat and cotton American. To maintain a balanced cropping pattern, more heed needs to be paid for advent of suitable production technologies in case of pulses and oilseeds, and repeated paddy-wheat production should be less emphasized to avoid the depletion of underground water and fertility of land. ate. Thus, the agricultural planning in the state should aim at a balanced and more booming cropping system.

(Karunakaran and Palanisami, 1998) have analysed the impact of irrigation especially different sources of irrigation on cropping intensity. So that evaluation of investment pattern can be assumed in major and minor irrigation projects and hence can maximise the benefits of the available resources. The different irrigation sources include Canal, Tank, dug well, Tube well and other sources. The study is based on secondary Data 1969-70 to 1993-94 in Tamil Nadu. The study includes the linear regression model to estimate relationship between irrigation development and cropping intensity at State Level. To confirm the results cross section regression analysis is used with different sources of irrigation. Relative share of different sources of irrigation to net irrigated area in Tamilnadu is taken in the study also irrigation expenditure and potential area for India and Tamilnadu And over first five year plan (1951-56) to seventh five year plan (1985-90) at 1990-91 prices, however compound growth rates (CGR) of selected variables Tamilnadu (1969-70 to 1993-94) is taken to show the disparity in growth rates of different sources of irrigation caused changes in the composition of the irrigation sources. To study the effect of irrigation development on cropping intensity analysis with irrigation ratio is analysed and a sub periodic analysis is done with different sources of irrigation ratio. The study concludes that canal and tank irrigation, dug well irrigation showed significantly positive impact on the cropping intensity up to the year 1979-80. But afterwards it is found that tube well and dug well have more impact on cropping intensity. Also, these minor irrigation catches more investment plan in the further periods. Because comparatively it is shown that it requires only minimum investment per hectare than major and medium irrigation projects.

(Basantaray and Nancharaiah, 2017) have examined the extent of crop diversification and its impact on farm income. In the study across all of the district of Odisha is taken into consideration. Here, Herfindal index is used in the study to identify the extent of crop diversification. The study is based on secondary data taken from National Sample Survey Office (NSSO) in its 70th round on 'Situation Assessment Survey of Agricultural Households. To study extent of Diversification and Farm Income across Districts in Odisha area under foodgrains and non-foodgrains, crop diversification, and net returns across districts of Odisha are taken. According to the index farmer are categorized into

three category that is highly diversified, moderately diversified, and least diversified. It is found that three districts are highly diversified that those districts were linked into the level of development of those districts proxied by per capita income and the low yield of paddy. The study concludes that Jharsuguda, Anugul, and Balangir to be highly diversified districts; Bargarh, Debagarh, Puri, Ganjam, Gajapati, Kandhamal, Kalahandi, Nabarangpur and Koraput to be moderately diversified districts; and Sambalpur, Sundargarh, Kendujhar, Mayurbhanj, Baleswar, Bhdak, Kendrapada, Jagatsinghapur, Cuttack, Jajapur, Dhenkanal, Nayagarh, Khordha, Baudh, Sonapur, Nuapada, Rayagada, and Malkanagiri to be least diversified districts. Different category of farmers is diversified in different districts. Not a particular kind of farmer is more diversified or least diversified.

(B. K. Ghosh, 2011) have focused to examine the cropping pattern of India during the year from 1970-71 to 2006-07. The study is based on secondary data taken from the various issues of Statistical Abstract of India, published by the Ministry of Statistics and Programme Implementation, Government of India, and Statistical Database of Reserve Bank of India. To examine the nature of crop diversification changes in land allocation according to the cultivation of different crops in different seasons is taken. Concentration of crop diversification is examined through using of Herfindal's index and substitution and expansion effects. It is found the study that in India especially rice and wheat are the dominant crop in the state. However, there is found to be a change trend in the cropping pattern in favour of non-foodgrain cash crops over time, though the foodgrain crops still dominate the cropping pattern of the state. Also crop yield is the major driving force in agricultural production for changing cropping pattern in India. Also, it is revealed that the increased production is not highly dependent on area of cultivation of different crops but the yield of crops it is dependent most.

III. DATA AND METHODOLOGY

The study is based on the secondary data. Attempt has been made to study the changes in the state agricultural diversification in different years under production for major crops groups in the Odisha. The data have been collected from the various issues of Agricultural Statistics of Odisha published by Directorate of Agriculture and Food Production Odisha. The annual average growth has been estimated from 1970-71 to 2019-20 to see the changes in the growth rate of area, yield and production of various crops grown in Odisha. However, to see the changes in the Gross Cropped Area and Net Shown Area, three decades has been analysed from 1999-91 to 2019-20. These three decades has been divided into six period from 1990-91 to 1994-95, 1995-96 to 1999-00, 2000-01 to 2004-05, 2005-06 to 2009-10, 2010-11 to 2014-15, and 2015-16 to 2019-20. Also, to measure extent or magnitude of crop diversification Herfindahl-Hirschman Index is used in our study. The Herfindahl index is sum of square of the proportion of individual crop groups in a portfolio. With an increase in diversification, a sum of the square of the proportion of crop

groups (HI) decreases. This is measure of concentration, alternatively, an inverse measure of diversification since the Herfindahl index decreases with an increase in diversification. The HI is bound by zero (Complete diversification) to one (complete Specialization) (K.M. Singh and et. All). The index was first used to measure the regional concentration of industries (Theil, 1967). With the increase in diversification, the Herfindahl Index would decrease. Since the index measures concentration; it is transformed by subtracting from one, i.e., 1 – HI. The transformed value of HI avoids confusion on comparing it with other indices.

➤ *Herfindahl Index (HI)* —

It is the sum of square of the proportion of acreage under each crop to the total cropped area and is given as follows

$$HI = \sum_{i=1}^N Pi^2$$

Where N = the total number of crops and Pi = area proportion of the ith crop in total cropped area.

IV. LAND UTILIZATION PATTERN IN ODISHA

Land is a crucial natural resource because it gives humans access to a variety of foods and serves as the foundation for all other life forms. In some way, aquatic, flora and fauna are present. In this context, the land utilization pattern plays a significant role. The table 1 indicate All Odisha gross cropped area and net shown area.

Table 1 All Odisha Gross Cropped Area and Net Shown Area (NSA, GCA in Thousand Hectares)

Period	NSA	GCA	NSA/TGA (%)	GCA/TGA (%)	GCA/NSA Cropping Intensity (%)
1990-91 to 1994-95	6310	9659	41	62	153
1995-96 to 1999-00	6085	8696	39	56	143
2000-01 to 2004-05	5778	8377	37	54	145
2005-06 to 2009-10	5467	8297	35	53	151
2010-11 to 2014-15	4486	5161	29	33	115
2015-16 to 2019-20	4054	4677	26	30	115
CAGR	-8.7	-13.8	-8.7	-13.8	-5.6

Source: Authors Calculation from Agricultural Statistics of Odisha various Issues

The above table intend to explain the cropping intensity from the year 1990-91 to 2019-20. So, two variables have been taken such that NSA which stands for Net Sown Area, GCA-Gross Cropped Area and a constant TGA-Total Gross Area. Cropping intensity is calculated by Dividing Gross Cropped Area and Net Sown Area*100. Average of quinquennial data of NSA and GCA is taken in the table. Then percentage of Net Sown Area per Total Gross Area and percentage of Gross Cropped Area is estimated. Compound Annual Growth Rate is estimated to compare the past performance of these parameters. We see there is negative compound growth rate of NSA and GCA that is -8.7 and -13.8 respectively as both have dwindled over Year on Year that is 6310 hectares to 4054 hectares for former and 9659 hectares to 4677 hectares for later. Year wise NSA are such 6085 hectares in the year 1995 to year 2000. Then net sown area decreased to 5778 hectares during the year 2000 to 2005. Further it is decreased to 5467 hectares and ahead declined to 4486 during the year 2005 to 2010 and 2010 to 2015 respectively. It is may be due to the increasing Population throughout the years and uneconomic size of holdings. As NSA and GCA is shrinking over years so that percentage of NSA/TGA has decreased from 41 percent to 26 percent and percentage of GCA/TGA from 62 percent to 30percent. Hence there CAGR is -8.7 and -13.8 respectively. Furthermore, the cropping intensity is an important growth indicator that has been diminished significantly from 153 percent to 115 percent due to climate aberrations and its CAGR is -5.6. Also, agriculture of Odisha is characterized by traditional method of farming, Scanty amount of capital, low investment, low saving, poor

irrigation facility etc. That is the reason we are attaining a negative growth rate throughout the years.

V. GROWTH RATE OF AREA, YIELD AND PRODUCTION IN ODISHA

The growth rate of area, yield and production is important for a state like Odisha. In this, context an attempt has been made to examine the growth rate of different crops in terms of area, yield and production. The table 2 indicate that Annual Average Growth Rate of Area, Yield and Production of different crops during 1970-71 to 2019-20. The table 2 is constructed to show Annual Average Growth Rate of Area, Yield and Production of different crops during 1970-71 to 2019-20. Annual Average Growth Rate of different crops have computed here to examine the state of crops in agriculture Odisha and we are going to link them with crop Diversification. As we can see in the table Annual Average Growth Rate of area, yield and production of different crops have been evaluated where the Annual Average growth rate Rice based on area, yield and production is -0.002, 0.061 and 0.065 respectively. While wheat has zero growth rate based on area any how regarding yield and production it is 0.007 and 0.012 respectively. Maize recurring 0.030 growth in terms of Area, while regarding Yield and Production it is 0.038 and 0.073 respectively. Ragi having Annual Average Growth Rate of Area is -0.001 and for Yield and production is 0.017 and 0.019 respectively. Jowar is having growth rate in terms of Area, Yield and Production are -0.001, 0.009 and 0.003 respectively. Annual Average Growth Rate of Area, Yield and production for Bajra is -0.001, 0.019 and 0.026

respectively. Small millets having growth rate of -0.012, 0.020 and 0.028 respectively in terms of Area, Yield and Production. Anyhow growth rate of Area, Yield and Production of Total cereals is -0.002, 0.054 and 0.059 respectively. Green gram (Mung) is having growth rate of 0.032, 0.06 and 0.045 regarding Area, Yield and Production respectively. Anyhow Black Gram having Annual Average growth rate of 0.022, 0.008 and 0.036 based on Area, Yield and Production respectively. Red gram attaining Annual Average growth rate of 0.025, 0.20 and 0.055 in terms of Area, Yield and Production. Annual Average growth rate Horse gram based on area, yield and production is 0.014, 0.008 and 0.028 respectively. Cowpea has 0.075 growth rate based on area any how regarding yield and production it is 0.014 and 0.079 respectively. Bengal gram recurring 0.024 growth in terms of Area, while regarding Yield and Production it is 0.010 and 0.042 respectively. Field gram having Annual Average Growth Rate of Area is 0.048 and for Yield and production is 0.016 and 0.065 respectively. Pulses is having growth rate in terms of Area, Yield and Production are 0.025, 0.007 and 0.038 respectively. So, in the above annual average growth rate of food grain are explained therefore in gross, Annual Average Growth Rate of Area, Yield and production for Total food grain is 0.003, 0.042 and 0.055 respectively. Here in the table Oilseeds include Ground nut, Sesamum, castor, Niger, linseed and mustard in which in terms of area castor is having negative growth rate i.e., -0.018 and other oil seeds like Ground nut, Sesamum, Niger, linseed and mustard are having growth of 0.028, 0.003, 0.064, 0.029 respectively. Considering Yield of Oilseeds then according to the estimates positive growth is

found out i.e., 0.026 is the annual average growth rate of groundnut, 0.011 for Sesamum, 0.004 for castor, 0.007 for Niger, 0.011 for linseed, 0.009 for mustard. Castor in terms of area and production having negative growth rate that is 0.012. Growth rate of other oilseeds somehow have seen positive growth rate and linseed is having highest production that is 0.074. And other oilseeds such as groundnut, sesamum, niger, mustard are having 0.054, 0.048, 0.011, 0.046 production rate respectively. Jute, Mesta, Sugarcane, Tobacco are having negative growth rate in terms of Area and production except sugarcane which has positive growth regarding production. So, their growth rate based on area is -0.030, -0.030, -0.003 and -0.060 respectively and based on production they are having growth rate of -0.016, -0.026, 0.006 and -0.039 respectively. And based on yield their growth rate is 0.030, 0.003, 0.008 and 0.010 respectively. Anyhow, Annual Average Growth Rate of Area, Yield and production for Total vegetables is 0.018, 0.018 and 0.040 respectively. Crop fibre having negative yield rate that is -0.004. Where Cotton is having highest annual average growth rate in terms of Area and production that is 0.205 and 0.242. Annual Average Growth Rate of Area, Yield and production for Total species and condiments is 0.027, 0.043 and 0.074 respectively. For sun hemp it is 0.013, 0.016 and 0.027. From the estimated table it can be inferred that most of the food grain having negative annual average growth rate in term of area. It is due to increased population and urbanisation also it may due to crop diversification. Farmer may shift crops such as subsistence crops to cash crops. Anyhow there are positive growth rate in term of yields is seen here besides fibre having a negative yield rate.

Table 2 Annual Average Growth Rate of Area, Yield and Production of Different Crops During 1970-71 to 2019-20

Crops	Area	Yield.	Production
Rice	-0.002	0.061	0.065
Wheat	0.000	0.007	0.012
Maize	0.030	0.038	0.073
Ragi	-0.001	0.017	0.019
Jowar	-0.010	0.009	0.003
Bajra	-0.001	0.019	0.026
Small Millets	-0.012	0.020	0.028
Total cereals	-0.002	0.054	0.059
Green Gram (Mung)	0.032	0.006	0.045
Black Gram (Biri)	0.022	0.008	0.036
Red Gram (Arhar)	0.025	0.020	0.055
Horse Gram (Kulthi)	0.014	0.008	0.028
Cowpea	0.075	0.014	0.079
Bengal Gram	0.024	0.010	0.042
Field Pea	0.048	0.016	0.065
Pulses	0.025	0.007	0.038
Total Foodgrains	0.003	0.042	0.055
Groundnut	0.028	0.026	0.054
Sesamum (Til)	0.033	0.011	0.048
Castor	-0.018	0.004	-0.012
Niger	0.003	0.007	0.011
Linseed	0.064	0.011	0.074
Mustard	0.029	0.009	0.046
Total Oilseeds	0.019	0.018	0.042
Jute	-0.030	0.020	-0.016
Mesta	-0.030	0.003	-0.026

Cotton	0.205	0.045	0.242
Sunhemp	0.013	0.016	0.027
Fibres	0.026	-0.004	0.015
Total Vegetables	0.018	0.018	0.040
Total Spices and Condiments	0.027	0.043	0.074
Sugarcane	-0.003	0.008	0.006
Tobacco	-0.060	0.010	-0.039

Source: Authors Calculation from Agricultural Statistics of Odisha various Issues

VI. CROPPING PATTERN IN ODISHA

The main goal of this study is to examine whether there is any kind of diversification of crops in Odisha. The study includes the following crop groups: foodgrains and non-foodgrains such as cereals, pulses, grains, oilseeds, fibre, vegetables, and condiments and spices. The table 3 indicate the cropping pattern of Odisha.

Table 3 Cropping Pattern in Total Cropped Area (In Percent)

Crops	1970-71 to 2019-20
Rice	52.7
Wheat	0.4
Maize	2.1
Ragi	2.6
Jowar	0.2
Bajra	0.1
Small Millets	1.2
Total cereals	59.2
Green Gram (Mung)	7.8
Black Gram (Biri)	5.7
Red Gram (Arhar)	1.5
Horse Gram (Kulthi)	3.4
Cowpea	0.4
Bengal Gram	0.4
Field Pea	0.3
Lentil	0.1
TOTAL Other Pulses	1.2
Total Pulses	20.7
TOTAL Foodgrains	80.0
Groundnut	2.8
Sesamum (Til)	2.9
Castor	0.3
Niger	1.5
Sunflower	0.1
Safflower	0.0
Linseed	0.3
Mustard	1.4
Total Oilseeds	9.4
Jute	0.3
Mesta	0.3
Cotton	0.5
Sunhemp	0.1
Total Fibres	1.3
Total Vegetables	7.2
Total Spices and Condiments	1.7
Sugarcane	0.5
Tobacco	0.1
Total Percent	100.0

Source: Authors Calculation from Agricultural Statistics of Odisha Various Issues

The table represents percentage share of food grain and non-foodgrain which basically the cropping pattern over the total cropped area which is taken from the year 1970-71 to 2019-20 in Odisha. Where total cereals occupy 59.2 percent of total cropped area. Total cereals include rice, wheat, maize, Ragi, Jowar, Bajra, small millets and they possessed 52 percent, 0.4percent, 2.1 percent, 2.6 percent, 0.2 percent, 0.1 percent and 1.2 percent respectively. We see that rice is occupying highest area and hence we see it as the most dominant crop in Odisha. However, among total pulses occupy 20.7 percent of share in which green gram occupying the highest share that is 7.8 percent and rest of the pulses such as black gram, red gram, horse gram, cowpea, Bengal gram, field pea, lentil and other pulses are having percentage share of 5.7, 1.5, 3.4, 0.4,0.4,0.3,0.1 and 1.2 respectively. So, in gross the total food grain is occupying 80 percent of total cropped area. Where measure proportion is possessed by cereals where rice plays significantly. Further Total oilseeds is covered by 9.4 percent. Among the oilseeds Sesamum and groundnut has taken up most of the share that is 2.9 and 2.8 percentage of share respectively. And rest oilseeds such as castor, niger, sunflower, safflower, linseed, mustard occupy 0.3, 1.5, 0.1, 0.0, 0.3 and 1.4 percentage share respectively. Anyhow Total fibre are engaged by 7.2 percent share over the total

cropped area in which Jute, mesta, cotton and Sunhemp have taken 0.3, 0.3, 0.1 and 1.3 percentage of share respectively. Moreover, Total spices and condiments covered less percentage of area that is 1.7 percent of total cropped area. Finally, sugarcane and Tobacco are engaged by 0.5 percent and 0.1 percent respectively.

The table 4 is the representation of calculated value of HI index of various crops in Odisha from 1970-71 to 2019-20. It is mentioned in the above section that HI is the inverse measure of crop diversification. The table is estimated by taking the decadal average and applying the formula to assess the HI value of different crops in Odisha. From the data it can be inferred that Rice is the more diversified crops and cultivated in many regions in Odisha. It has the lowest and stagnant value of HI that is 0.0100 that shows that it is less concentrated in one region only and cultivated in many regions in the state. HI of wheat is decreased from 0.0112 in the year 1970-80 to 0.0100 in the year 2000-10 which shows that the crop is getting more diversified bit and cultivated in many regions however in the year 2010-20 it became less diversified as the value increased to 0.0148. However, in case of maize it getting diversified more and more year on year, here HI value decreased from 0.0105 to 0.0100.

Table 4 Hi Index of Various Crop in Odisha from 1970-71 to 2019-20.

Crops	1970-80	1980-90	1990-00	2000-10	2010-20
Total rice	0.0100	0.0100	0.0100	0.0100	0.0100
Wheat (rabi)	0.0112	0.0105	0.0108	0.0101	0.0148
Total maize	0.0105	0.0100	0.0100	0.0101	0.0100
Total ragi	0.0105	0.0102	0.0101	0.0100	0.0103
Jowar	0.0106	0.0101	0.0106	0.0102	0.0103
Bajra	0.0110	0.0102	0.0108	0.0103	0.0105
Small millets	0.0102	0.0124	0.0103	0.0110	0.0107
Total cereals	0.0100	0.0100	0.0100	0.0100	0.0100
Total green gram(mung)	0.0107	0.0101	0.0102	0.0103	0.0100
Total black gram(biri)	0.0105	0.0101	0.0101	0.0102	0.0101
Red gram(ahar)kharif	0.0103	0.0104	0.0101	0.0100	0.0100
Total horse gram (kulthi)	0.0108	0.0101	0.0101	0.0101	0.0101
Total cowpea	0.0106	0.0117	0.0119	0.0115	0.0102
Bengal gram (rabi)	0.0107	0.0103	0.0102	0.0105	0.0103
Field pea (rabi)	0.0103	0.0113	0.0102	0.0104	0.0100
Lentil(rabi)	NA	NA	0.0166	0.0116	0.0103
Total other pulses	0.0117	0.0102	0.0167	0.0206	0.0102
Total pulses	0.0106	0.0101	0.0102	0.0102	0.0100
Total foodgrains	0.0100	0.0100	0.0100	0.0100	0.0100
Groundnut	NA	0.0105	0.0102	0.0101	0.0101
Seasamum	0.0106	0.0103	0.0102	0.0104	0.0101
Castor	0.0104	0.0102	0.0101	0.0101	0.0106
Niger	0.0105	0.0102	0.0102	0.0102	0.0103
Sunflower	0.0158	0.0155	0.0128	0.0123	0.0105
Safflower (rabi)	0.0174	0.0105	0.0114	0.0128	0.0113
Linseed (rabi)	0.0109	0.0103	0.0102	0.0102	0.0178
Mustard (rabi)	0.0113	0.0101	0.0103	0.0101	0.0101
Total oilseed	0.0107	0.0102	0.0102	0.0101	0.0101
Jute (kharif)	0.0101	0.0104	0.0113	0.0103	0.0115
Mesta (kharif)	0.0102	0.0101	0.0100	0.0101	0.0115
Cotton (kharif)	0.0163	0.0122	0.0161	0.0105	0.0104

Sunhemp (kharif)	0.0107	0.0102	0.0101	0.0101	0.0104
Total fibres (kharif)	0.0101	0.0101	0.0101	0.0101	0.0102
Potato (rabi)	0.0126	0.0101	0.0101	0.0104	0.0107
Onion (rabi)	0.0104	0.0100	0.0100	0.0101	0.0100
Total sweet potato	0.0105	0.0100	0.0101	NA	0.0101
Total vegetables	0.0103	0.0101	0.0107	0.0102	0.0100
Total spices & condiments	0.0107	0.0100	0.0102	0.0100	0.0100
Sugarcane (rabi)	0.0103	0.0101	0.0102	0.0102	0.0105
Tobacco (rabi)	0.0101	0.0102	0.0107	0.0104	0.0140

Source: Authors Calculation from Various Issues of Agricultural Statistics of Odisha.

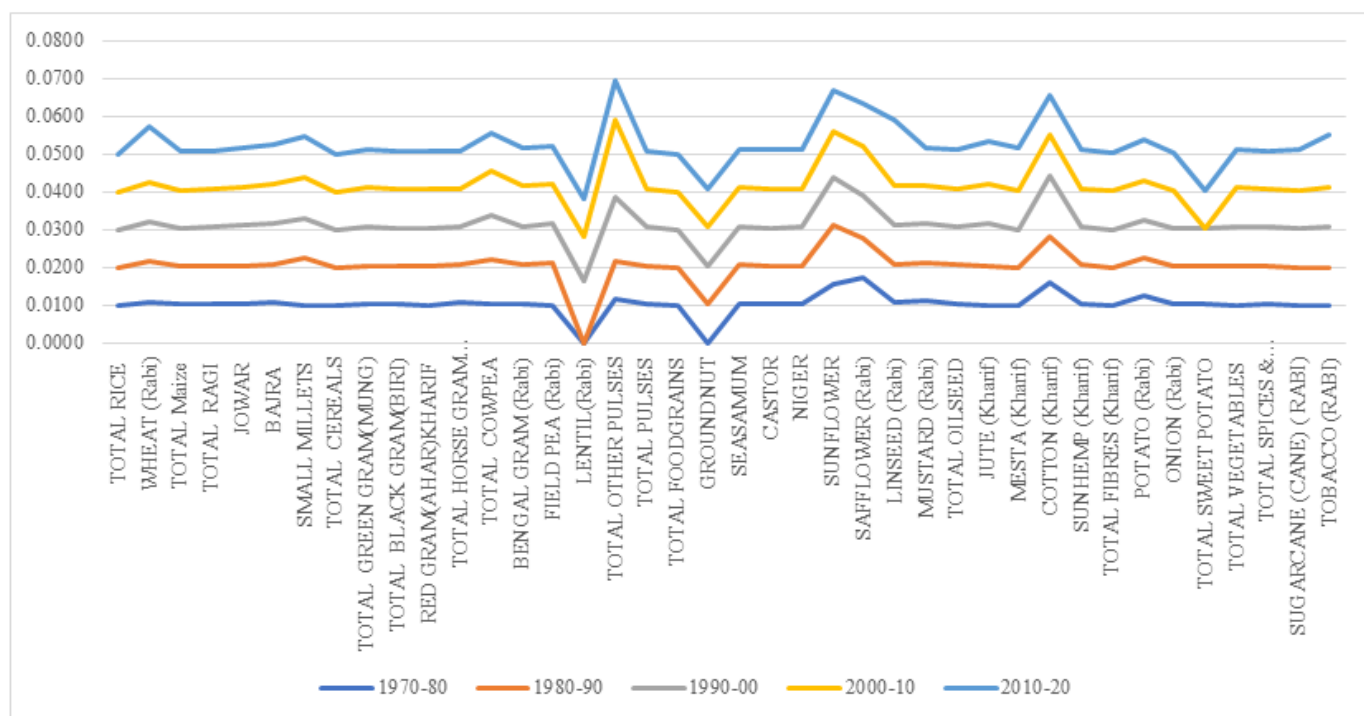


Fig 1 Hi Index of Various Crop in Odisha from 1970-71 to 2019-20.

Source: Authors Calculation from Various Issues of Agricultural Statistics of Odisha

In case ragi also same as Maize, the crop is getting more diversified year on year that its HI value is decreased from 0.0105 in the year the 1970-80 to 0.0103 in the year 2010-20 which refers more diversification. Also, Jowar and Bajra are cultivated more in various regions in the state which can be known from the data that the value of index is decreased in recent year from 0.0106 to 0.0103 and 0.0110 to 0.0105 respectively. Anyhow frequency of cultivation of small millets has declined hence less diversified comparison to other crops. So, in Gross Total cereals is diversified in Odisha and cultivated more in various regions of Odisha. It is seen that there is more diversification in case of Pulses as the table shows that year on year the value of index is dwindling for green gram, black gram, red gram, horse gram, Cow pea, Bengal gram, Field Pea, Lentil, total other pulses are getting more diversified in the state. The values are decreased as such that from 0.0107 to 0.0100, 0.0105 to 0.0101, 0.0103 to 0.0100, 0.0108 to 0.0101, 0.0106 to 0.0102, 0.0166 to 0.0103, 0.0117 to 0.0102, 0.0106 to 0.0100 respectively. As whole Food grains are happening to be diversified from the year 1970-71 to the year 2019-20. Further Groundnut, Sesamum, are the crops having

decreased value from 0.0105 to 0.0101, 0.016 to 0.0101 respectively. Same way Niger, Sunflower, Safflower and Mustard are also having decreased value of the index that is 0.0105 to 0.0103, 0.0158 to 0.0105, 0.0174 to 0.0113 and 0.0113 to 0.0101 respectively. Which shows that Total oilseeds are getting diversified more in years however Castor and linseed those are seemed to be less diversified crops those index value has increased from 0.0104 to 0.0106 and 0.0109 to 0.0178 respectively. Total fibres too have shown significant diversification however in fibres, Jute and Mesta are less diversified that is their index values increased from 0.0101 to 0.0115 and 0.0102 to 0.0115 respectively. But in case of Cotton and Sun hemp it is seen that they are more diversified. Further there is diversification among total vegetables which also includes potato, sweet potato and onion. Also spices and condiments are more diversified crops. Anyhow Sugarcane and Tobacco are less diversified crops that can be inferred from the table. Their index value has increased from 0.0103 to 0.0105 and 0.0101 to 1.0140 respectively. To sum up, almost all the crops are getting diverse year on year. Except some crops like castor, wheat, sugarcane and tobacco.

Table 5 Transformed Hi Index of Various Crop in Odisha from 1970-71 to 2019-20.

Crops	1970-80	1980-90	1990-00	2000-10	2010-20
Total rice	0.9900	0.9900	0.9900	0.9900	0.9900
Wheat (rabi)	0.9888	0.9895	0.9892	0.9899	0.9852
Total maize	0.9895	0.9900	0.9900	0.9899	0.9900
Total ragi	0.9895	0.9898	0.9899	0.9900	0.9897
Jowar	0.9894	0.9899	0.9894	0.9898	0.9897
Bajra	0.9890	0.9898	0.9892	0.9897	0.9895
Small millets	0.9898	0.9876	0.9897	0.9890	0.9893
Total cereals	0.9900	0.9900	0.9900	0.9900	0.9900
Total green gram(mung)	0.9893	0.9899	0.9898	0.9897	0.9900
Total black gram(biri)	0.9895	0.9899	0.9899	0.9898	0.9899
Red gram(ahar)kharif	0.9897	0.9896	0.9899	0.9900	0.9900
Total horse gram (kulthi)	0.9892	0.9899	0.9899	0.9899	0.9899
Total cowpea	0.9894	0.9883	0.9881	0.9885	0.9898
Bengal gram (rabi)	0.9893	0.9897	0.9898	0.9895	0.9897
Field pea (rabi)	0.9897	0.9887	0.9898	0.9896	0.9900
Lentil(rabi)	NA	NA	0.9834	0.9884	0.9897
Total other pulses	0.9883	0.9898	0.9833	0.9794	0.9898
Total pulses	0.9894	0.9899	0.9898	0.9898	0.9900
Total foodgrains	0.9900	0.9900	0.9900	0.9900	0.9900
Groundnut	NA	0.9895	0.9898	0.9899	0.9899
Seasamum	0.9894	0.9897	0.9898	0.9896	0.9899
Castor	0.9896	0.9898	0.9899	0.9899	0.9894
Niger	0.9895	0.9898	0.9898	0.9898	0.9897
Sunflower	0.9842	0.9845	0.9872	0.9877	0.9895
Safflower (rabi)	0.9826	0.9895	0.9886	0.9872	0.9887
Linseed (rabi)	0.9891	0.9897	0.9898	0.9898	0.9822
Mustard (rabi)	0.9887	0.9899	0.9897	0.9899	0.9899
Total oilseed	0.9893	0.9898	0.9898	0.9899	0.9899
Jute (kharif)	0.9899	0.9896	0.9887	0.9897	0.9885
Mesta (kharif)	0.9898	0.9899	0.9900	0.9899	0.9885
Cotton (kharif)	0.9837	0.9878	0.9839	0.9895	0.9896
Sunhemp (kharif)	0.9893	0.9898	0.9899	0.9899	0.9896
Total fibres (kharif)	0.9899	0.9899	0.9899	0.9899	0.9898
Potato (rabi)	0.9874	0.9899	0.9899	0.9896	0.9893
Onion (rabi)	0.9896	0.9900	0.9900	0.9899	0.9900
Total sweet potato	0.9895	0.9900	0.9899	NA	0.9899
Total vegetables	0.9897	0.9899	0.9893	0.9898	0.9900
Total spices & condiments	0.9893	0.9900	0.9898	0.9900	0.9900
Sugarcane (rabi)	0.9897	0.9899	0.9898	0.9898	0.9895
Tobacco (rabi)	0.9899	0.9898	0.9893	0.9896	0.9860

Source: Authors Calculation from Various Issues of Agricultural Statistics of Odisha.

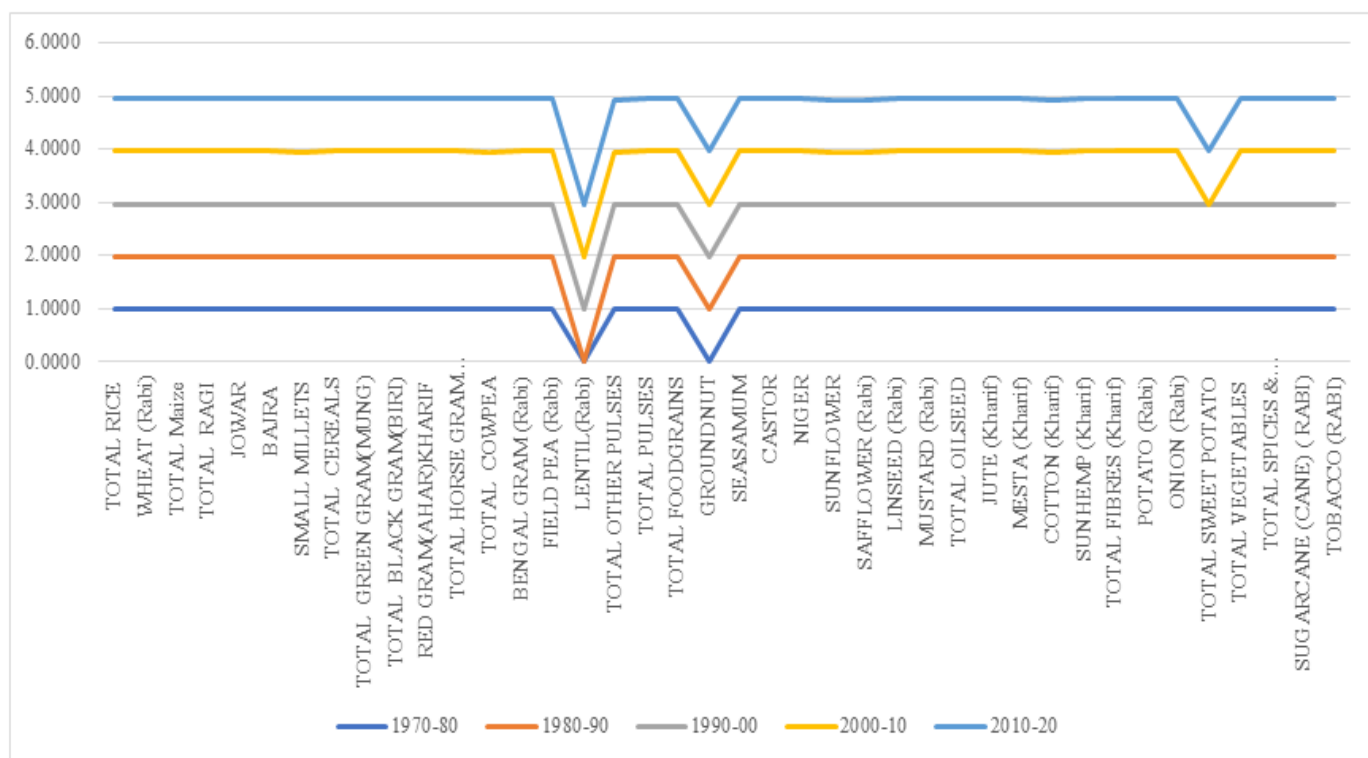


Fig 2 Transformed Hi index of Various Crop in Odisha from 1970-71 to 2019-20.
Source: Authors Calculation from Various Issues of Agricultural Statistics of Odisha

The table 5 shows Transformed Herfindahl Index (THI) of several crops. As HI is an inverse measure of crop diversification so that THI (1-HI) is taken to measure crop diversification to avoid confusion as it is positively correlated with diversification. Rice is the most diversified crop in Odisha cultivated in most of the region shows its dominance over crops. The value of THI for Rice is 0.9900. Higher is the THI value higher is the diversification. Wheat is bit of less diversified crop which shown in the table. The value of THI is reduced from 0.9888 in the year 1970-80 to 0.9852 in the year 2010-20. Overall total cereals are more diversified which includes Maize, Ragi, Jowar, Bajra, small millets their index values are increased such as 0.9895 to 0.9900, 0.9895 to 0.9897, 0.9894 to 0.9897, 0.9890 to 0.9895, 0.9898 to 0.9893 respectively. Also, total pulses occupying increasing index value that is 0.9894 to 0.9900. Total pulses include Total cereals, Total Green gram, Total black gram, red gram, Total horse gram, Total cowpea, Bengal gram, Field pea, Lentil, Total other pulses, their index values are increased from 0.9893 to 0.9900, 0.9885 to 0.9899, 0.9897 to 0.9900, 0.9892 to 0.9899, 0.9894 to 0.9898, 0.9893 to 0.9897, 0.9834 to 0.9897, 0.9883 to 0.9898 respectively. Aggregately total foodgrains are diversified in recent years occupying index value of 0.9900. In case of Total oilseed, castor is less diversified compare to other oilseed its index value decreased from 0.9896 to 0.9894. Another oilseed which includes groundnut, sesamum, Niger, sunflower, safflower and mustard their index value escalate from 0.9895 to 0.9899, 0.9894 to 0.9899, 0.9895 to 0.9897, 0.9842 to 0.9895, 0.9826 to 0.9887, 0.9891 to 0.9822, 0.9887 to 0.9899 respectively. Here, there is significant elevation of index value for sunflower and safflower indicate their lift in the diversification. Further total fibres

are diversified a bit as Jute and Mesta are bit of less diversified crops here as their index value dropped from 0.9899 to 0.9885 and 0.9898 to 0.9885 respectively. Anyhow Cotton and Sun hemp are inflating from 0.9837 to 0.9896 and 0.9893 to 0.9896 indicate their increased level of diversification in the state. Further total vegetables show improved diversification its index value raised from 0.9897 to 0.9900. That is Potato is significantly diversified and its index value is grown from 0.9874 to 0.9893. For onion it is increased from 0.9896 to 0.9900 and index for sweet potato is increased from 0.9895 to 0.9899. Also, total spices and condiments is diversified in recent years that is the value hiked from 0.9893 to 0.9900. Sugar cane and Tobacco are less diversified crop in Odisha as their values indicate in the table which reduced from 0.9897 to 0.9895 and 0.9899 to 0.9860. So, as the index is used to avoid confusion at comparison as it is a positive measure to crop diversification. It is easy to interpret the result.

VII. SUMMARY AND CONCLUSIONS

Crop diversification is crucial in Odisha's subsistence agriculture to meet diverse nutritional needs and adapt to changing circumstances. Study shows dwindling cropping intensity in Odisha due to natural calamities and catastrophic environments, resulting in reduced production area. In addition to this, crops in Odisha show declining annual growth rates in area and production, but yields show positive results. Rice dominates, but land allocation towards certain crop groups has increased diversification indices. So, cultivation of fiber and oilseeds declines, cereals, pulses, and vegetables grow. Therefore, Odisha's traditional farming methods, low capital, investment, and poor irrigation

facilities contribute to negative growth rates. Thus, the state's agriculture diversifies to include High Value Crops, but success requires adequate inputs like seeds, fertilizers, and infrastructure for increased cropped area and yield. So, diversification of crops requires electricity-powered irrigation, storage, marketing, and fertilizer availability, along with increased crop yield and agro-equipment expansion.

REFERENCES

- [1]. Basantaray, A. K., and G. Nancharaiah. "Relationship between Crop Diversification and Farm Income in Odisha — An Empirical Analysis." *Agricultural Economics Research Review*, vol. 30, no. Conference, 2017. *ideas.repec.org*, <https://ideas.repec.org/a/ags/aeraae/265243.html>.
- [2]. Dhindsa, K. S., and Anju Sharma. "Analysis of Cropping Pattern Changes in Punjab During 1965-66 to 1990-91." *Indian Economic Review*, vol. 30, no. 1, 1995, pp. 69–87.
- [3]. Ghosh, Bidyut Kumar. "Determinants of the Changes in Cropping Pattern in India: 1970-71 to 2006-07." *The Bangladesh Development Studies*, vol. 34, no. 2, 2011, pp. 109–20.
- [4]. Ghosh, Nilabja. "Role of Fertiliser and Irrigation in Determining Cropping Intensity: A Regionwise Study of Andhra Pradesh." *Indian Journal of Agricultural Economics*, vol. 45, no. 4, 1990. *RePEc - Econpapers*, <https://econpapers.repec.org/article/agsinijae/272459.htm>.
- [5]. Karunakaran, K. R., and K. Palanisami. "An Analysis of Impact of Irrigation on Cropping Intensity in Tamil Nadu." *Indian Economic Review*, vol. 33, no. 2, 1998, pp. 207–20.