

RESEARCH ARTICLE

REVISITING THE STATUS OF AGRICULTURAL PRODUCTIVITY IN ODISHA

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ABSTRACT

The present study analyses the productivity growth performance of major crop categories grown across the state of Odisha from 1970-71 to 2019-20. For analysing growth performance and comparing yield of important crops in Odisha, the research applies statistical methods such as annual growth rate (AGR), compound annual growth rate (CAGR), and ordinary least square method (OLS) of regression. On the other hand, the coefficient of variation (CV) and the instability index (Cuddy & Valle, 1978) have been used to investigate the state's crop productivity instability. The study reveals the fact that the selected categories of crops which include cereals, oilseeds, pulses, food grains, fibres and small millets have not been experienced with steady annual growth rate from 1970-71 to 2019-20 rather they have been featured with high volatility. Moreover, the high degree of instability is evident in productivity of specified crop categories in Odisha. To boost agricultural production rates, it is vital to emphasise agricultural research and development and ensure that research discoveries are easily accessible to farmers, particularly small and marginal farmers.

JEL Code: Q10, Q19

KEYWORDS

Growth Performance, Productivity Instability, Major Crops, Odisha

1. INTRODUCTION

Agriculture is one of the important economic activities of the human society. Despite the rapid industrialization and urbanization in the world, agriculture still employs about half of the working population. Agriculture has been a major source of employment and contribution to the national economy in emerging countries. However, it contributes to economic development in a variety of ways, including providing food for the nation, expanding exports, transferring labour to non-agricultural industries, contributing to capital formation, and securing markets for industrialization (Thitte, 2012). In context of Indian economy agriculture is considered as backbone and its development may substantially contribute to the country's overall prosperity. The proportion of agricultural output in national income is also considered as a barometer of economic progress. Agriculture sector provides the highest employment to the growing labour force in India.

This sector contributes 18.8 per cent to Gross Value Added (GVA) during 2021-22 where as it records 3.6 per cent growth rate in 2020-21 and 3.9 per cent in 2021-22 in India (Economic Survey, 2021-22). Odisha is the ninth-largest state in the country by area and the eleventh-largest by population. According to the IMF World Economic Outlook GDP estimate for 2021, its nominal GDP will be around USD 85.7 billion in 2021-22, higher than at least 121 nations in the world. However, Odisha's economy is predominantly agrarian in which agriculture sector provides employment to 55 per cent of labour force in rural areas and 5 per cent in urban areas. On the other hand it accounts 22 per cent of gross state value added (GSVA) in 2019-20 and 20.6 per cent in 2021-22 AE (advance estimation) in current prices (Odisha Economic Survey, 2020-21). Therefore, the importance of agricultural growth is recognised in terms of the state's overall development through job creation, income generation,

raw material supply to the industrial sector, and ensuring food security for the poor.

However, agricultural growth in the state of Odisha is uneven, rain-fed, traditional, and vulnerable to natural disasters including as droughts, floods, and cyclones (Nayak, 2016). Though agriculture is treated as a vital sector in Odisha economy, the need of equitable agricultural growth still remains far away (Patra, 2014). In fact agricultural scenario is featured with high variation in growth and productivity and this major concern is to be revisited. This article is organised into five sections: the first deals with the introduction and statement of problems, the second with the previous literature, the third with data sources and methodology, the fourth with results and discussion, and the final with the conclusion of study.

2. LITERATURE REVIEW

(Jena, 2014) has examined the disparities of agricultural development among districts of Odisha using principal component analysis (PCA). Accordingly, there are 7 backward and 8 districts come under underdeveloped category and large regional inequalities is experienced in the state. Therefore, the study opines that appropriate steps by the Government can be useful to reduce this disparity level. However, a similar study carried out by Majhi which looks at regional inequalities in the status of key agricultural indicators at the district level in (Majhi, 2019). The study indicates that, in contrast to neighboring districts, agricultural development inequality is increasing in Odisha's western and southern districts. Furthermore, compare the pre- and post-liberalization processes of regional agricultural growth in Odisha to investigate if regional disparities have widened in the post-reform period (Swain et al., 2009). As an outcome of the study, four coastal districts, including Balasore, Cuttack,

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Puri, and Ganjam, as well as two central table land districts, Sambalpur and Bolangir, are more progressive in agricultural performance than other districts over three decades (1980-81 to 1998-99).

As a result, the inadequate irrigation is identified as the most important cause of low agricultural output, the need for irrigation facility expansion through public investment and irrigation water management decentralization should be encouraged. Between 1971 and 2010, the national and regional average agricultural productivity grew over the last four decades, but the national level productivity growth rate has been steadily declining due to regional variance (Murtaza and Masood, 2020). Patra investigated Odisha's agricultural status, including paddy and total food grain productivity across districts, as well as inter- district variances in agricultural performance (Patra, 2014). The study states that there is a critical need to improve innovation in order to embrace appropriate and effective technologies, as well as more financial inclusion by the RBI and NABARD and crop-specification methods. In this connection, Nayak has viewed the use of fertilizer is the most important factor of agricultural productivity, so the government should take appropriate measures to address existing institutional flaws (Nayak, 2016).

In addition, examines agricultural development trends as well as inter-district and regional variations in Odisha's agricultural sector during the pre and post-liberation period (Reddy, 2012). Dynamic changes in cropping patterns are detected during the pre-liberalization period, but these changes are not sustained during the post-liberalization period. The study also finds that in both the pre and post-liberalization periods, Odisha's productivity of all key crops was lower than the rest of India. Therefore, efforts should be made to improve literacy rates, marketing facilities, and the transformation of low-input agriculture to high-input-high-value agriculture, all of which can aid in the reduction of regional differences. Some researchers looked at the growth and instability of principal crops as well as their sensitivity to climatic factors during different stages of technological development in the state of Odisha (Senapati and Goyari, 2019).

According to the study, the yield growth rate of the state's major selected crops is poor, but rice, potato, maize, groundnut, and sugarcane growth and instability are all declining in all districts. To improve agricultural growth in the state, the study recommends that the government should allocate more funding to agricultural research in one hand and the farmers should avail of irrigation facilities for dry land, power supply, transportation, and chemical fertilisers as needed on the other hand to improve agricultural growth in the state. Mallick and Pattanayak examine the inter-state disparities in production and productivity of five major crops among thirteen selected states in India (Mallick and Pattanayak, 2016). The result of the study reveals that the inter-state disparities in agricultural production and productivity have declined as a whole, more particularly in the case of cereals and sugarcane. On the other hand, while the disparity is realised in the production of pulses and fibres, the situation has worsened in the case of oilseeds. The study recommends that initiatives should be undertaken to create profitable occupation by establishing agro-based enterprises and providing enough storage and marketing facilities. However, a study undertaken by Dash and Behera reveals that considerable variation in composite indices of agricultural development is found among different districts of Odisha (Dash and Behera, 2015).

2.2 Objectives

- To examine the growth performance of productivity of major crop categories in Odisha.
- To investigate the extent of instability in agricultural productivity for specified crop categories of the state.

2.3 Hypothesis

Ho1: There is no instability in yield or productivity of selected categories of crops in Odisha

Ha1: Existence of instability in yield or productivity of specified crop categories in Odisha

2.4 Limitations

The present study is not free from certain shortcoming which are; The research does not look at individual crop data; rather, it looks at crop statistics by category. Furthermore, the state of Odisha has geographical and climatic complexity, which contributes to variation in agricultural productivity across the state. However, the study solely evaluates agricultural productivity in aggregate terms across the state.

3. DATA SOURCES AND METHODOLOGY

3.1 Data Sources

This study is based on secondary data from 1970-71 to 2019-20 which have been collected from 5 Decades of Odisha Agriculture Statistics, 2020, Directorate of Agriculture and Food Production, Government of Odisha. We have taken total yield of selected major crop categories like cereals, food grains, oil seeds, pulses, fibres (Kharif), vegetables, spices and condiments and small millets in Odisha.

3.2 Statistical Tools

We have used following mentioned statistical techniques to analyse the secondary data.

3.2.1 Annual Growth Rate (AGR)

The percentage of Annual Growth Rate (AGR) of certain economic variable (X) between two time periods is calculated by the following equation stated as;

$$Annual\ Growth\ rate(AGR) = \frac{X(t) - X(t-1)}{X(t-1)} \times 100 \tag{1}$$

Here 't' is the current time period and 't - 1' is the preceding time period.

3.2.2 Compound Annual Growth Rate (CAGR)

$$Compound\ Annual\ Growth\ Rate(CAGR) = \left(\frac{EV}{BV}\right)^{\frac{1}{n}} - 1 \times 100 \tag{2}$$

Where, EV=Ending value, BV =Beginning value and n =Number of years

3.2.3 Coefficient of Variation (CV)

$$CV = \frac{Standard\ Deviation\ of\ Variable(\sigma)}{A.\ Mean\ (AM)\ of\ Variable(\mu)} \times 100 \tag{3}$$

$$Standard\ Deviation\ (SD) = \sigma = \sqrt{\frac{\sum(x_i - \mu)^2}{N}}$$

SD(σ) = Population standard deviation, 'N'= Size of the population and x_i = Each value of variables from the population

3.2.4 Instability Index

The divergence from the trend is defined as instability. Researchers have used the coefficient of variation (CV) as a measure of instability in the literature. The level of instability in agricultural productivity or yield for the state Odisha has been investigated through the instability index developed by Cuddy & Valle (1978). The instability in agricultural yield is estimated by using the Cuddy- Della Valle index (CDVI) which is stated in the following equation 4.

$$CDVI = Instability\ Index = CV \times \sqrt{(1 - R^2)} \tag{4}$$

Where;

$$CV = \frac{Standard\ Deviation\ of\ Variable}{A.Mean\ of\ Variable} \times 100$$

R² is coefficient of determination estimated from a time trend regression adjusted for the number of degrees of freedom.

3.2.5 Ordinary Least Squares (OLS) Regression

Ordinary least squares (OLS) regression is a statistical technique for estimating the relationship between one or more independent variables (Xi) and a dependent variable (Y). This method estimates the relationship by minimizing the sum of the squares in the difference between the observed and predicted values of the dependent variable constructed as a straight line. Ordinary least squares (OLS) regression can be defined in following equation.

$$Y = \alpha + \beta X + \epsilon \tag{5}$$

Where 'α' is the intercept and indicates where the straight line intersects the Y-axis (the vertical axis); 'β' is the slope and indicates the degree of steepness of the straight line; and 'ε' represents the error term. The slope coefficient, or 'β', indicates the average change in 'Y' associated with a one-unit change in 'X'.

3.2.6 Research Design

In order to examine mentioned objectives concerning to growth performance of agricultural productivity in Odisha, we have taken yield of selected major crop categories like cereals, food grains, oil seeds, pulses, fibres (Kharif), vegetables, spices as well as condiments and small millets in Odisha. Total Cereals include Rice & Paddy, Wheat, Jowar, Bajra, Maize, Ragi, Small Millets, and total Pulses comprise Arhar, Mung, Biri, Kulthi, Gram, Fieldpea, Lentil, Cowpea, and Other Pulses. Both Cereals and Pulses are taken as Food grain production category in Odisha. On the other total Oilseeds include Groundnut, Til, Castor, Mustard, Sunflower, Safflower, Linseed, Niger and total Fibres production comprise Cotton, Jute, Mesta,

Sunhemp. However crops like Sweet Potato, Potato, Onion, and Other Vegetable are regarded as the overall vegetable production categories. While Chilly, Coriander, Garlic, Turmeric, Ginger, Betel Vine and Other Spices are taken as total Spices categories. The thirty districts of Odisha are categorised in ten zones as per agro-climatic criteria such as North-Western Plateau, North Central Plateau, North Eastern Coastal Plain, East and South Eastern Coastal Plain, North Eastern Ghat, Eastern Ghat High Land, South Eastern Ghat, Western Undulating Zone, Western Central Table Land and Mid Central Table Land. But we have taken aggregate productivity of each crop categories irrespective of different climatic zones in Odisha.

4. RESULT AND DISCUSSION

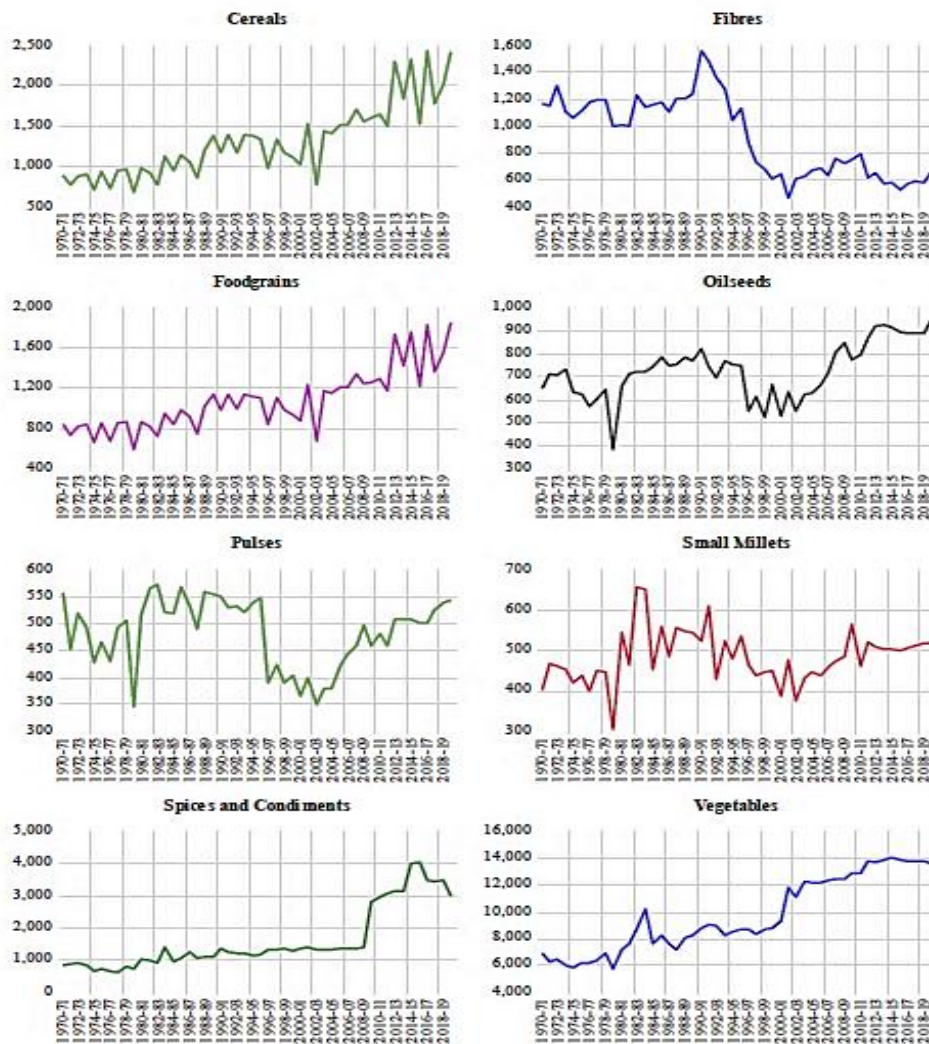


Figure 1: Total Yield of selected major Crop categories in Odisha (1970-71 to 2019-20).

In Odisha, total yield of key crop categories is expressed in kilograms per hectare (Kg./Ha) as shown in figure 1. The productivity of cereals grew from 898 (Kg./Ha) in 1970-71 to 2424 (Kg./Ha) in 2019-20. For fibres the total productivity shows a declined trend from 1165 (Kg./Ha) in 1970-71 to 662 (Kg./Ha) in 2019-20. For food grains production, it realized a rising trend from 848 (Kg./Ha) in 1970-71 to 1847 (Kg./Ha) in 2019-20. However, the yield of oilseeds was 652 (Kg./Ha) in 1970-71 which has increased to 945 Kg./Ha in 2019-20. But for pulses, there is no remarkable changes rather the yield rate declines 556 (Kg./Ha) in 1970-71 to 544 (Kg./Ha) in 2019-20. On the other hand yield rate of small millets, spices and condiments, vegetable are 402kg, 822kg, 6886kg per hectare in 1970-71 which are increased to 517kg, 3010kg, 13628kg per hectare 2019-20 respectively. The changes in the yield of cereals, fibres, food grains, oilseeds, pulses, small millets, spices & condiments and vegetables in five decades are 1526, -503, 999, 293, -12, 115, 2188, 6742 respectively. In addition, it is clear that the yield rate of fibres and pulses has decreased during the last fifty years. Furthermore, vegetable production achieves the biggest increase in total yield, followed by spices and condiments. We calculate the annual growth rate of yield in each year to assess the minute state of total yield of each crop category (table 1).

Table 1 shows the annual growth rate (AGR) of yield in Odisha from 1970-71 to 2019-20 for cereals, pulses, food grains, oilseeds, fibres (Kharif), vegetables, spices & condiments, and tiny millets. It is clear that the productivity growth rate of each crop categories has been declining for the majority of the years. Furthermore, the annual increase rate of yield for certain crop types is particularly uncertain.

The average yield of specific crop categories is 1304.28kg/ha (Cereals), 482.84kg/ha (Pulses), and 1075.42kg/ha (Food grains), 725.34kg/ha (Oilseeds), 928.76kg/ha. (Fibres), 9738.16kg/ha (Vegetables), 1600.12kg/ha (Spices and Condiments) and 483.76kg/ha. (Small Millets) in Odisha (Table 2). The coefficient of variation (CV) of yield of these crops, on the other hand, is 34.67 (cereals), 13.13 (pulses), 28.29 (food grains), 16.69 (Oilseeds), 31.44 (Fibres, Kharif), 28.80 (Vegetables), 60.79 (Spices and Condiments), and 13.53 (Small Millets). During the study period, CAGR of specified crop categories is also recorded uneven features. Cereals, pulses, food grains, oilseeds, fibres (Kharif), vegetables, spices and condiments, and small millets had CAGRs of 2.01, -0.04, 1.57, 0.75, - 1.13, 1.37, 2.63, and 0.50, respectively.

Table 1: AGR of Yield of Major Crop Categories in Odisha from 1970-71 to 2019-20

Year	AGR of Cereals	AGR of Pulses	AGR of Food Grains	AGR of Oilseeds	AGR of Fibres	AGR of Veg.	AGR of Spices & Condiments	AGR of Small Millets
1971-72	-13.25	-18.53	-13.68	9.51	-1.29	-9.15	6.33	15.92
1972-73	12.84	14.79	12.30	-0.98	13.22	2.73	6.52	-0.86
1973-74	3.87	-5.38	3.16	3.82	-15.21	-6.81	-7.95	-1.73
1974-75	-22.23	-13.21	-21.82	-13.49	-3.89	-2.91	-25.32	-7.71
1975-76	32.68	8.90	29.41	-1.57	5.18	5.86	15.00	4.53
1976-77	-23.25	-7.74	-21.21	-8.64	5.29	1.20	-9.51	-8.90
1977-78	31.12	14.92	26.18	5.60	2.13	1.81	-4.95	13.03
1978-79	2.64	2.43	1.17	6.63	-0.17	9.48	25.12	-1.11
1979-80	-29.29	-31.49	-30.36	-39.97	-16.69	-17.76	-8.21	-31.61
1980-81	42.73	49.42	44.09	70.47	1.30	25.56	39.06	78.69
1981-82	-5.91	9.48	-4.85	8.05	-1.48	6.97	-2.87	-15.05
1982-83	-15.48	1.24	-11.53	1.41	23.29	13.61	-8.66	41.68
1983-84	43.92	-9.08	31.14	0.14	-6.92	17.68	57.53	-0.61
1984-85	-15.21	-0.58	-11.72	2.77	1.49	-25.48	-33.12	-30.52
1985-86	20.46	9.46	17.18	5.53	1.47	7.47	14.29	23.62
1986-87	-7.84	-6.17	-7.99	-4.09	-6.12	-6.96	15.28	-13.21
1987-88	-18.15	-8.08	-17.58	0.27	9.32	-6.22	-15.66	14.61
1988-89	39.49	14.52	36.13	4.38	-0.50	13.28	3.71	-1.80
1989-90	14.49	-0.89	12.05	-2.29	2.91	1.55	0.28	-0.73
1990-91	-14.61	-0.72	-13.29	6.90	26.19	6.09	23.35	-3.68
1991-92	18.37	-3.99	15.02	-9.38	-5.12	3.17	-8.46	16.44
1992-93	-15.81	0.57	-12.97	-6.32	-7.90	-0.96	-3.00	-29.56
1993-94	18.86	-1.88	14.80	10.33	-6.38	-7.45	1.17	21.91
1994-95	-1.72	3.07	-1.58	-2.21	-18.17	2.74	-5.87	-8.22
1995-96	-2.40	1.86	-1.87	-0.80	8.52	2.04	2.19	11.88
1996-97	-27.35	-28.83	-23.61	-25.74	-22.57	0.47	14.95	-13.41
1997-98	37.03	8.72	31.39	10.47	-16.74	-3.72	-0.30	-6.02
1998-99	-11.68	-7.78	-10.50	-14.05	-7.52	4.11	1.65	2.06
1999-00	-6.10	3.07	-5.26	27.00	-9.32	0.19	-5.24	0.67
2000-01	-6.86	-9.43	-5.66	-20.51	5.55	7.07	7.24	-14.03
2001-02	47.87	9.59	39.37	19.59	-27.51	26.53	1.52	23.06
2002-03	-49.74	-12.75	-45.21	-13.39	29.64	-5.98	-4.79	-20.84
2003-04	88.27	8.60	74.52	13.82	2.96	9.91	0.45	15.16
2004-05	-2.08	-0.26	-2.04	0.16	7.67	-0.31	-0.30	3.00
2005-06	7.00	11.64	4.94	6.54	1.63	-0.02	1.05	-1.79
2006-07	0.46	5.21	0.17	7.63	-7.30	1.14	1.26	4.57
2007-08	11.97	3.15	10.80	11.82	19.37	0.66	0.73	3.28
2008-09	-8.58	8.52	-7.07	5.47	-4.88	0.37	0.80	2.54
2009-10	3.08	-7.44	0.72	-8.37	4.30	3.47	103.32	16.70
2010-11	2.99	4.57	2.78	2.32	5.45	0.09	4.93	-18.37
2011-12	-9.50	-4.37	-9.13	9.06	-22.32	6.71	4.19	12.55
2012-13	53.38	10.43	47.83	6.00	6.66	-0.26	2.76	-1.92
2013-14	-19.89	-0.20	-17.90	0.87	-12.33	1.18	-0.54	-1.57
2014-15	26.51	0.20	23.49	-1.08	0.35	1.09	27.31	0.20
2015-16	-34.04	-1.18	-30.44	-2.40	-7.79	-0.98	0.70	-0.40
2016-17	58.71	0.00	49.55	-0.67	8.07	-1.06	-13.52	0.80
2017-18	-26.96	4.78	-25.49	-0.22	2.60	-0.01	-1.20	1.39
2018-19	13.51	2.66	13.85	0.00	-1.02	0.16	1.48	1.17
2019-20	20.18	0.74	18.85	6.54	13.16	-1.26	-14.00	-0.19

Source: Authors' estimation as per data in 5 Decades of Odisha Agriculture Statistics, 2020, Directorate of Agriculture and Food Production, Government of Odisha (GoO)

The average yield of total vegetables is the highest (9738.16 kg/ha), while total pulses yield is the lowest (482.84 kg/ha). Total spices and condiments have the highest compound annual growth rate (2.63), while total fibres have the lowest (-1.13). The yield of spices and condiments, on the other hand, has the maximum CV of 60.79, while pulse production has the lowest CV (13.13). Pulses production in Odisha is more consistent or

less unstable, but spices and condiments output is less consistent or more unstable. The matter of concern is that from 1970-71 to 2019-20, all production categories witnessed negative yearly growth rates on several occasions. As a result, the overall performance of yield for selected crop categories in Odisha is not as consistent as projected.

Table 2: Variability in Productivity of Major Categories of Crops in Odisha (1970-71 to 2019- 20			
	Yield of Cereals	Yield of Pulses	Yield of Food Grains
SD	452.17	63.38	304.22
Mean	1304.28	482.84	1075.42
CV	34.67	13.13	28.29
CAGR	2.01	-0.044	1.57
	Yield of Oilseeds	Yield of Fibres	Yield of Vegetables
SD	121.06	291.98	2804.72
Mean	725.34	928.76	9738.16
CV	16.69	31.44	28.80
CAGR	0.75	-1.13	1.37
	Yield Spices and Condiments	Yield Small Millets	
SD	972.73	65.43	
Mean	1600.12	483.76	
CV	60.79	13.53	
CAGR	2.63	0.51	

Source: Authors' estimation

4.1 Results of OLS (Ordinary Least Square) Regression for Productivity of Major Crop Categories

Table 3: Results of OLS Estimation for Yield of Major Crop Categories in Odisha				
Method: Least Square				
Dependent Variables	Variables	Coefficient	t-Statistics	Prob.
Cereals	C	632.67	9.13	0.000
	Time(T)	26.34	11.14	0.000*
	R-squared	0.72		
	Adjusted R- squared	0.72		
	F-statistics	124.01		
Pulses	Prob.(F-statistics)	0.000		
	C	496.06	27.17	0.000
	Time(T)	-0.52	-0.83	0.409
	R-squared	0.014		
	Adjusted R- squared	-0.0063		
Food grains	F-statistics	0.69		
	Prob.(F-statistics)	0.409		
	C	635.34	12.81	0.000
	Time(T)	17.26	10.19	0.000*
	R-squared	0.68		
Oilseeds	Adjusted R- squared	0.67		
	F-statistics	103.83		
	Prob.(F-statistics)	0.000		
	C	609.59	20.73	0.000
	Time(T)	4.54	4.52	0.000*
Fibres	R-squared	0.29		
	Adjusted R- squared	0.28		
	F-statistics	20.45		
	Prob. (F-statistics)	0.000040		
	C	1326.43	24.95	0.000
Vegetables	Time(T)	-15.59	-8.59	0.000*
	R-squared	0.61		
	Adjusted R- squared	0.59		
	F-statistics	73.89		
	Prob. (F-statistics)	0.000		
Spices & Condiments	C	5097.21	19.31	0.000
	Time(T)	181.99	20.21	0.000*
	R-squared	0.89		
	Adjusted R- squared	0.89		
	F-statistics	408.19		
Small Millets	Prob. (F-statistics)	0.000		
	C	190.54	1.21	0.24
	Time(T)	55.27	10.25	0.000*
	R-squared	0.68		
	Adjusted R- squared	0.68		
	F-statistics	104.98		
	Prob. (F-statistics)	0.000		
	C	467.68	24.88	0.000
	Time(T)	0.63	0.982	0.3307
	R-squared	0.019		
	Adjusted R- squared	-0.0007		
	F-statistics	0.965		
	Prob. (F-statistics)	0.33068		

Note: *, ** and *** represent the significance at 1%, 5% and 10%, respectively. Source: Author's estimations

The result of OLS presented in the table 3 can be presented in functional form in the following equations for different crops.

$$Y = \alpha + \beta t + e$$

Here 'Y' refers to dependent variables such as yield of Cereals, Pulses, Food Grains, Oil Seeds, Fibres, Vegetables, Spices and Small Millets, whereas α is value of intercept, ' β ' is coefficient of independent variable 'Time' (t) and 'e' is error term. After putting the estimated values as presented in equation 5, we can formulate the following equation as:

$$Cereals = 632.67 + 26.34 t + e \tag{5a}$$

$$Pulses = 496.06 - 0.518 t + e \tag{5b}$$

$$Food\ Grains = 635.34 + 17.26 t + e \tag{5c}$$

$$Oil\ Seeds = 609.59 + 4.54 t + e \tag{5d}$$

$$Fibres = 1326.43 - 15.59 t + e \tag{5e}$$

$$Vegetables = 5097.21 + 181.99 t + e \tag{5f}$$

$$Spices = 190.54 + 55.27 t + e \tag{5g}$$

$$Millets = 467.68 + 0.63 t + e \tag{5h}$$

Table 3 depicts the OLS (Ordinary Least Square) regression results for yield of different selected categorized crops from the 1970-71 to 2019-20. In the case of cereals, the yield grows at a rate of 26.33758 per unit change in time. As Prob. value 0.0000 is less than 0.05 (5 per cent level of significance), this result is positive and significant. So the null hypothesis that changes in time have no effect on yield is rejected. However, at the 5 per cent level of significance, Prob. Value 0.4093 is more than 0.05 for the growth rate of yield for pulses - 0.52 per one-year change in time is negative and negligible. We fail to accept the alternative hypothesis that a change in time has a large impact on yield. But for food grains, yield growth rate is 17.26 per year and it is significant and positive.

In case of oilseeds yield growth, it is 4.54 and it is significant where we accept the alternative hypothesis that change of one year time period leads to rise in yield rate. But in case of fibres production growth rate of yield shows a negative value -15.59, where Prob. Value 0.0000 is less than 0.05. So this result is negative and significant. On the other hand vegetable production experiences a positive and substantial 181.99 yield growth rate per year. Similarly the growth rate of yield of spices and small millets are 55.27 and 0.63 for change of time period one year which are significantly positive and insignificantly positive respectively. It may be observed that the yield growth rates for specified crop types are not uniform and have a broad range of variation.

4.2 Results of Cuddy- Della Valle Index (CDVI)

The value of CDV Index has a range of 0-15 is categorized as low instability, 15-30 as moderate instability and above 30 as high instability. Accordingly low instability is experienced in productivity of pulses, oilseeds, vegetables and small millets whereas moderate range of instability is recorded with productivity of cereals, food grains and fibres in Odisha. So far as productivity of spices and condiments is concerned it is characterised with high range of instability in productivity.

Crop Categories	CDVI Estimated Equation	Values	Range
Cereal	$CDVI = 34.67 \times \sqrt{(1 - 0.72)}$	18.35	Medium
Pulses	$CDVI = 13.13 \times \sqrt{(1 - 0.014)}$	13.04	Low
Food grains	$CDVI = 28.29 \times \sqrt{(1 - 0.68)}$	16.01	Medium
Oilseeds	$CDVI = 16.69 \times \sqrt{(1 - 0.29)}$	14.06	Low
Fibres	$CDVI = 31.49 \times \sqrt{(1 - 0.61)}$	19.66	Medium
Vegetables	$CDVI = 28.89 \times \sqrt{(1 - 0.89)}$	9.58	Low
Spices & Condiments	$CDVI = 60.79 \times \sqrt{(1 - 0.68)}$	34.388	High
Small Millets	$CDVI = 13.53 \times \sqrt{(1 - 0.019)}$	13.40	Low

Source: Authors' estimation

5. CONCLUSIONS

In this study, we look into the concerns of growth performance, as well as the severity of productivity instability among major crop categories in Odisha. In terms of agricultural output, the yield or productivity of various crops is the most important factor. Furthermore, farmers' revenue from agricultural production is largely determined by crop productivity. As a result, greater crop yield rates result in increased output volume and profit for farmers. However, in Odisha, the growth of yield per hectare for

selected crops is highly volatile and sluggish. Furthermore, within and across different crop categories, there is a lot of variability in growth performance of productivity from year to year. The results indicate that low instability is shown in the production of pulses, oilseeds, vegetables, and small millets in Odisha, but moderate instability is observed in the productivity of cereals, food grains and fibers. In terms of spices and condiment productivity, it is characterized by a wide range of instability. On the other hand, productivity growth rate of pulses and fibres is adversely affected within the study period although it is not significant in case of pulses.

Growth in crop yields is inevitable not just for the country as a whole, but also for individual states, particularly Odisha. For agricultural output to be sustainable, a steady and low- instability growth rate in yield is required. As a result, in order to improve yield rates, it is necessary to solve the difficulties that the agricultural sector faces. The government should prioritize agricultural research and development and ensure that research findings are accessible to farmers, particularly small and marginal farmers. Furthermore, the government should direct resources to rural infrastructure development, including irrigation facilities for all cultivable land, marketing and storage facilities and adequate cheap bank credit. On the other hand, the government should take the necessary steps and provide required support to encourage the use of modern technologies and crop diversity in order to enhance agricultural productivity.

FUTURE IMPLICATION

The current study investigates the level of slow and sluggish growth performance, as well as the extent of instability in agricultural output in Odisha. This information will assist policymakers in developing appropriate measures to improve and maintain sustainability in the state's agricultural growth performance. Furthermore, it will promote future studies to compare Odisha's agriculture performance with that of other agriculturally developed regions in order to discover a more suitable solution to the state's agricultural backwardness.

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