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A Comparative Analysis of Agricultural and Horticultural Crop Production in Odisha: Trend and Growth Dynamics

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Abstract : The present study is focused on investigating the growth and trends in food grain production and vegetable production in Odisha during 1990-91 to 2019-20. CAGR and trend analysis have been carried out to emphasize the growth patterns of both the types of crops in the region. ANOVA has been used to identify the variability between different time periods in case of both crops. The findings suggest significant variability wherein the food grain production has been moderate whereas the vegetables have had high fluctuations in their production patterns during different time periods. These observations can be attributed to climatic variation and other issues.

***KEYWORDS*- Agricultural production, Horticultural production, Trend, CAGR, ANOVA, Odisha**

I. INTRODUCTION

Agriculture is the backbone of Odisha's economy as a majority of the population directly depends upon agriculture and its allied activities. Foodgrain output in the state has increased significantly, by 24.2% in 2022-23. (Odisha Economic Survey, 2022-23). The state is distinguished by its extensive agricultural diversity with both food grains, pulses, oilseeds, fruits and vegetables playing important roles in its agricultural landscape. This transition is critical for enhancing food security, raising farmer incomes and fostering rural sustainability (Nayak et al., 2018). The cropping pattern has changed significantly as several national studies highlight a significant shift from foodgrain cultivation to commercial crops driven by market demand, policy reforms & consumer preferences (Kannan, 2009). Coarse cereals, traditionally grown in arid areas have seen a decline in area under cultivation due to lower profitability (Kannan, 2009; Panwar & Dimri, 2018). Diversifying agricultural production towards high value commodities (HVCs) is widely recognized as a promising strategy to counteract the downward trend in Indian agriculture's growth. This strategy has been supported by various studies (Rosegrant and Hazell 2000; World Bank 2002). As cereal production has increased significantly but pulses and oilseeds production has been a bit sluggish. As a result, there is a chronic shortage of edible oils and pulses in the country (Chand and Pal 2003). Consequently, a perceptible change in consumer preferences away from cereals towards high value non- cereal nutrient-rich diets including fruits and vegetables is visible (Joshi et al., 2007; Birthal et al., 2013). However, crops like oilseeds showed a negative growth trend due to high production costs and unremunerative prices. To increase productivity and farmer income, the state government has prioritised agricultural modernisation via reforms, farm mechanisation and agri-entrepreneurship assistance (Odisha Economic Survey, 2023-24). Climate change, technological adoption, government regulations and market demand have all contributed to Odisha's dynamic fluctuations in agricultural productivity over the years. Understanding the trends and growth patterns of these crop categories is critical for developing future agricultural strategies and ensuring long term food security. The adoption of hybrid seeds, modern farming techniques and better irrigation systems has been pivotal in boosting productivity across states (Kumar & Joshi, 2020). During the Green Revolution, there was a constant push to diversify agriculture in terms of crops, mostly for economic reasons (Joshi et al., 2006; Paltasingh and Goyari, 2013). However, the changes in the cropping pattern are the result of the interactive effect of many factors, including resource-related factors, technology-related factors and institutional and infrastructure-related factors (Paltasingh et al., 2012). Over time, the relative significance of these elements has changed in Odisha's agriculture. In light of this situation, it is essential to examine the performance of agriculture in Odisha throughout the years, especially during the time after the reforms. Agricultural crops, especially rice and wheat continue to dominate Odisha's agricultural production making significant contributions to the state's food security. However, horticultural crops are gaining popularity due to their increased profitability and nutritional value and they have the potential to change the agricultural landscape. Because despite the expanding

relevance of both crop kinds a very few research has been done to compare their production trends and growth rates. This study seeks to close this gap by examining the trends and growth patterns of agricultural and horticultural crops in Odisha between 1990 and 2020.

II. RESEARCH METHODOLOGY

The present study has used secondary time series data of agricultural crop production i.e total food grains production & horticultural crop production i.e total vegetable production spanning from 1990-91 to 2019-20, sourced from Odisha Agricultural Statistics, To have a clear picture about the trends and growth patterns between these two crop groups, the study divided the time period into six periods: Group 1: 1990-91 to 1994-95 Group 2: 1995-96 to 1999-00 Group 3: 2000-01 to 2004-05 Group 4: 2005-06 to 2009-10 Group 5: 2010-11 to 2014-15 Group 6: 2015-16 to 2019-20. The study used trend analysis which will be interpreted through line graph to identify production patterns over time. The Compound Annual Growth Rate (CAGR) is calculated to measure growth trajectories for both crop categories. To statistically compare the mean production levels, a one-way ANOVA test is conducted.
Compound Annual Growth Rate Calculation

$$\text{CAGR} = \left(\frac{final\ value}{initial\ value}\right)^{1/n} - 1$$

Where,
Final Value = Value at the end of the period.
Initial Value = Value at the start of the period.
n= The total number of years in the period

ANOVA Calculation

Null Hypothesis (H0): There is no significant difference in production levels across the six time periods.
Alternative Hypothesis (Ha): There is a significant difference in production levels across the six time periods.

The model to compare the mean production level is

$$Y_{it} = \mu + \phi_t + \epsilon_{it}$$

Where,
Yit = production level for the i-th observation at time period t.
μ = overall mean production level.
ϕt = effect of the t-th time period.
ϵit = error term.

III. RESULTS AND DISCUSSION

This section deals with the empirical results and their analysis.

Trend Analysis

The present study employs trend analysis to visualize and interpret the production patterns of agricultural and horticultural crops over the defined time periods including total food grains production and total vegetable production over the defined periods (1990-91 to 2019-20)

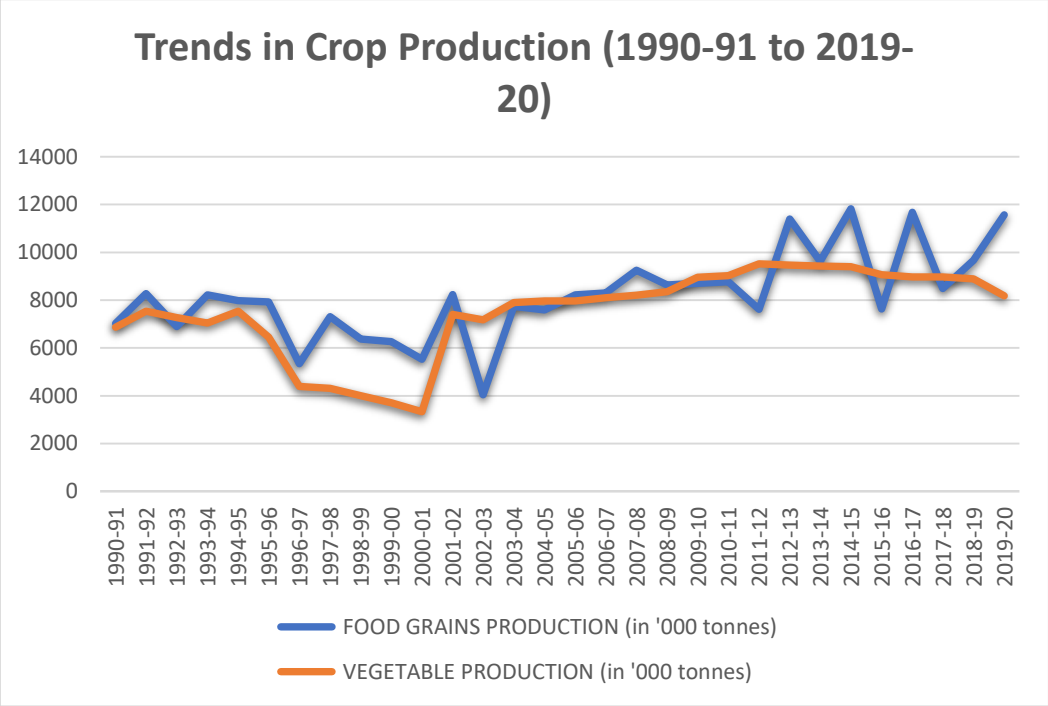

Fig-1
Source- Odisha Agricultural Statistics (1990-91 to 2019-20)

The production of agricultural crops shows significant fluctuations over the years, with notable dips in 1996 and 2002. A strong recovery and upward trend are evident in later years, particularly after 2009, peaking around 2014. Between 1990-91 and 1994-95, agricultural crops maintained steady production around 8,000 metric tons, while horticultural crops experienced a gradual decline from about 6,000 metric tons. From 1995-96 to 1999-00, agricultural crop production fell sharply below 6,000 metric tons and horticultural crops continued to decrease, hitting a low of approximately 4,000 metric tons. The period from 2000-01 to 2004-05 saw a strong recovery in agricultural crops, reaching 10,000 metric tons, while horticultural crops began stabilizing with slight improvement. During 2005-06 to 2009-10, agricultural crops remained steady at around 10,000 metric tons, and horticultural crops showed modest growth, reaching nearly 8,000 metric tons. From 2010-11 to 2014-15, agricultural crops maintained consistent production near 10,000 metric tons, while horticultural crops stabilized without notable growth. In the final period, 2015-16 to 2019-20, agricultural crops peaked at nearly 12,000 metric tons, whereas horticultural crops showed variability and a slight downward trend by the end. This is because of frequent cyclones and floods which affect agricultural crops due to their dependency on weather conditions. Thus, these crops seem to experience higher volatility majorly influenced by climatic factors or input usage. While the production of horticultural crops shows a relatively steady trend with fewer drastic fluctuations compared to agricultural crops. Because these crops often grown in protected environments or with advanced irrigation methods, are less vulnerable to climate variations.

Growth Rate Analysis

To determine the growth paths for the production of food grains as well as vegetable products, the research will use the CAGR formula, which clearly gives an idea about the annual average growth rate during the specified periods. The following table provides the required production figures for calculating the annual growth rate.

	CAGR (%)	
Time Period	**Food Grains Production**	**Vegetable Production**
1990-2019	1.67	0.58
1990-94	2.58	1.89
1995-99	-4.58	-10.53
2000-04	6.51	18.99
2005-09	1.16	2.39
2010-14	6.16	0.82
2015-19	8.68	-2.05

Table-1
Source- Author's own calculation

Analysis of Compound Annual Growth Rate (CAGR) from 1990-91 to 2019-20 reveals a number of vital things in the context of growth rate of food grains and vegetables in Odisha. While there has been moderate growth in food grains at 1.67% per annum,

vegetables have registered very slow growth rate at 0.58%. The figures suggest huge variations in terms of stability and performance of the two kinds of crops. Food grains are comparatively more resilient and stable crops with regard to production owing to regular policy support, adoption of HYVs (high yielding varieties), better irrigation systems and other technological developments. On the other hand, slow growth rate in vegetables points towards existence of certain problems, including market instability, poor storage facility and sensitivity to climatic change. In the case of growth rate during different periods of five years, certain variations become evident. While there has been moderate growth in food grains at 2.58% in the initial period (1990-94). Nevertheless, there was a remarkable decrease (-4.58%) in the period 1995-99 due to unfavourable climatic conditions like cyclones and floods along with minimal utilization of advanced agricultural methods. There was an impressive increase in food grains production during the period 2000-04 with a growth rate of 6.51% due to the efforts by the government after the super cyclone, development of irrigation facilities and use of HYVs. Growth rate dropped down during the period 2005-09 with a value of 1.16% possibly because of stagnancy in yield or soil degradation but increased again during 2010-14 (6.16%) and reached its highest point during 2015-19 (8.68%). Recent growth rates have been made possible because of subsidies, mechanization and proper utilization of advanced farming techniques. Vegetable production, however, witnessed a great deal of fluctuation in comparison to food grains. During the initial period (1990-94), growth rate was moderate at 1.89% possibly due to the increasing number of horticultural activities. Nevertheless, the period 1995-99 witnessed an unusual decrease (-10.53%) in vegetable production which could be because of various reasons like the super cyclone, lack of post-harvest facilities etc. There was an exceptional increase during 2000-04 with a growth rate of 18.99%. This positive change was facilitated through an increased emphasis on horticulture development projects like the National Horticulture Mission along with the increase in the demand for vegetables. Nevertheless, the growth rate declined in the periods 2005-09 (2.39%) and 2010-14 (0.82%), and a negative growth was registered in 2015-19 (-2.05%). The negative growth rate is due to reasons like climate-related problems, perishable nature, lack of proper storage facilities and fluctuations in market prices. This demonstrates that some specific interventions are necessary to ensure a stable growth in vegetable production.

ANOVA Analysis

The following table shows a one-way ANOVA test result to statistically compare the mean production levels between the two crop groups across the six periods.

Dependent Variable		Sum of Squares	df	Mean Square	F-Statistics	Sig. (p-value)
AGRT	Between Groups	0.842	5	0.168	5.268	0.002
	Within Groups	0.767	24	0.032		
	Total	1.608	29			
HRT	Between Groups	1.837	5	0.367	11.613	0.000
	Within Groups	0.759	24	0.032		
	Total	2.596	29			

Table: 2.1
Notes: - significance at 1%, 5% level respectively.
Source: Author's calculation using SPSS 20

The results of the ANOVA analysis provide critical insights into the variability in food grains and vegetable production across different time periods. For food grains production, the F-statistic is 5.268 with a p-value of 0.002, which is less than the standard significance level of 0.05. This indicates that there are significant differences in food grains production across the time periods analyzed. The between-group sum of squares (0.842) is slightly higher than the within-group sum of squares (0.767), suggesting that the variation in food grains production can be attributed more to changes over time rather than random fluctuations within each group. This trend might be due to the consistent support food grains receive through agricultural policies, subsidies and technological advancements, which have contributed to stable but significant growth patterns over the years. However, fluctuations could be linked to factors such as changes in monsoon patterns, fertilizer availability or market dynamics which tend to affect staple crops less drastically compared to horticultural crops. In the case of vegetable production, the F-statistic is significantly higher at 11.613, with a p-value of 0.000, confirming strong evidence of significant differences in production across the time periods. The between-group sum of squares (1.837) is much larger than the within-group sum of squares (0.759), indicating that variations in vegetable production are driven predominantly by differences between time periods rather than within individual groups. This

higher variability could be attributed to several factors including the perishability of vegetables, their greater dependence on market demand and higher sensitivity to climatic changes. In contrast to the cultivation of food grains, growing vegetables tends to be more input-intensive involving factors like irrigation, fertilizers and control of pests which may vary regionally and over time owing to changing resource availability and government involvement. Furthermore, adoption of new technologies and changes in cropping patterns may have added to the large disparities in vegetable production. In comparison to the two types of crops, the F-statistics value for vegetables (11.613) is much higher compared to that for food grains (5.268). Hence, we can see that the fluctuations in vegetable production are relatively high compared to food grains production. This is likely due to the inherent instability associated with horticulture crop production being subject to shocks in the form of severe weather conditions, emergence of pest outbreaks or market price fluctuations. On the contrary, food grains production is rather stable because it is a staple crop whose cultivation enjoys consistency owing to government policy, minimum support prices and subsidies. Overall, the results reveal significant temporal differences in the production trends of both crop types with vegetable production showing more variability compared to food grains.

CONCLUSION AND POLICY IMPLICATIONS

This study highlights that there exist separate trends and growth patterns for agricultural crops and horticultural crops during the period 1990-91 to 2019-20 in Odisha. Growth of food grains was moderate but stable with support from constant policy measures and technology. Vegetable growth was highly variable depending upon the effect of climatic stress and market fluctuations. The ANOVA results further highlight significant temporal differences, with vegetable production showing greater fluctuations than food grains. Based on the above findings, it is crucial to prioritize strategies that enhance the stability and growth of both agricultural and horticultural crops in Odisha. The focus should be on promoting high-yielding, climate-resilient varieties for food grains accompanied by balanced fertilization and increased irrigation access. For horticultural crops, it is vital to tackle issues such as post-harvest losses, market fluctuations and insufficient cold storage facilities. Improving market connections, encouraging value addition and promoting diversification into high-value crops can greatly enhance profitability. Implementing capacity-building programs such as training in precision farming, integrated pest management and efficient resource use should be prioritized to empower farmers. Additionally, targeted financing options, digital resources and collaborations between public and private sectors can stimulate agricultural innovation and investment. Ultimately developing climate action plans tailored to specific regions and investigating resilient crop varieties will be crucial for promoting sustainable agricultural development, ensuring food security and enhancing rural livelihoods in the state.

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