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Growth Performance of Major Crop Groups in Odisha Agriculture: A Spatiotemporal Analysis

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Abstract

This study has analysed the pattern in growth of area, production and productivity of major crop groups across the physiographic zones in the state of Odisha for the period 1993-94 to 2010-11. It has observed an unstable and unsustainable growth in area, production and productivity over the years in the state as well as in all physiographic zones. The relatively high growth rate of foodgrains production in Odisha has been achieved mainly through area effect. Although, contribution of technology towards sustainable output growth has been recognized, growth in the yield rate is slow. This sluggish growth in area, production and yield of all crop groups in the state is because of slow expansion of irrigation network, low level of fertilizer consumption, slow rate of technology adoption, and low level of infrastructural development. The slowdown in the process of cropping pattern change indicates the failure of most government efforts to diversify agriculture in the state. It is time to reform this sector and accord importance to food safety issues to meet the growing demand for quality food through stable and sustainable growth in agriculture and replacing subsidies with investments and infrastructural development.

Key words: Odisha agriculture, growth performance, production, productivity, regional disparity, crop groups

JEL Classification: Q10, Q16

Introduction

In recent years, the growing demand for agricultural production has forced the farmers to adopt intensification of agricultural practices along with the increasing use of high-yielding crop varieties for achieving higher levels of production (Weinberger and Lumpkin, 2007). Being dependent on weather conditions, technological and infrastructural growth in production of crops is liable to substantial variations across time and space. The nature and extent of variability in the growth of agricultural production, its sources and implications have, however, not received systematic attention till recently in Odisha. However,

increase in production of foodgrains and crop stability are the key challenges to Odisha agriculture which is subsistence oriented, open to the vagaries of monsoon and highly susceptible to natural calamities, and has experienced fluctuating growth rates over the years.

Agriculture occupies the centre-stage in the overall development of Odisha's economy. Nearly 84 per cent population of the state lives in rural areas. Agriculture remains the mainstay of state economy and a major source of livelihood for a vast majority of population (Mishra, 2009). Odisha agriculture continues to provide employment to more than 60 per cent of the total work force in the state. However, over the years, in line with the trends in rest of the economy, agriculture's share to the Gross State Domestic Product (GSDP) has recorded a substantial decline. In the 1950s, the share

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of agriculture to GSDP was about 70 per cent, which has come down to skimpily less than 20 per cent in 2009-10 (at constant prices 1999-2000) (GoO, 2011-12). Such a structural transformation may at times be considered desirable, provided that with fall in the share of agriculture to GSDP, agriculture's share in employment falls commensurately and matching employment is created in two other broad sectors. Ironically, the situation speaks otherwise (Pattanaik and Nayak, 2010).

In the early-1980s, effort was made to bring convergence between agricultural development programmes and poverty alleviation programmes (Chand, 2003). During this period, some new heads were added to the agricultural sector such as food storage, ware housing, agricultural research and education. In the name of New Economic Reforms (1991) a structural change took place at the national as well as at state levels. However, during the post-economic reform period (1991-onwards), the issues were to raise productivity, increase cultivable area of pulses and commercial crops, effective utilization of irrigation facility and development of rural market for the improvement of agriculture (Mishra and Chand, 1995; Chand, 2001). Other issues such as mechanization of agriculture, development of agro-based industries, promoting private enterprises in marketing of agricultural product were also emphasized. To realize the objectives, target was to intervene in the area of seed, fertilizer, farm mechanization, commercial crops, credit and reclamation of problematic soils. To strengthen the economic status of farmers, attempt was made to diversify the cropping pattern through introduction of commercial crops. In addition, it was also proposed to encourage contract farming, agri-business consortium of small and marginal farmers (Chand, 2003).

Due to diverse agro-climatic conditions in the state of Odisha, a varied number of crops are produced. The changes in the cropping pattern are generally viewed as a shift from traditionally-grown less-remunerative crops to more-remunerative crops (Mohanty *et al.*, 2013). During Green Revolution period, there was a continuous surge for diversifying agriculture in terms of crops, primarily on economic considerations (Joshi *et al.*, 2006; Paltasingh and Goyari, 2013). The cropping pattern changes, however, are the outcome

of the interactive effect of many factors such as: resource-related factors (Paltasingh *et al.*, 2012) (irrigation, rainfall and soil fertility); technology-related factors (seed, fertilizer, and storage and processing); and institutional and infrastructure-related factors (farm size, extension, marketing systems, investment, output and input prices, government regulatory policies, and research). Odisha agriculture has experienced the change in the relative importance of these factors over time. Furthermore, liberalization and globalization policies also determine crop composition at both micro and macro levels (Vyas, 2001).

The state has given emphasis on achieving the above objectives for the development of agriculture through formation of '*pani panchayats*' involving local bodies in the management of the irrigation system (Srivastava *et al.*, 2014; Ghosh *et al.*, 2012), organising '*krushak bazaar*' for the marketing of agricultural produce, establishing '*krishi vigyan kendras*' (KVKs) at the district level to provide effective extension services, including supply of improved seeds, chemical fertilizer, pesticides (Pattanaik and Nayak, 2014). Given this state scenario, it is imperative to see how Odisha agriculture has performed over the years particularly during the post-reforms period.

Given this backdrop, the objective of this study is to analyse the historical pattern in the growth of agricultural production and productivity in Odisha and suggest a perspective for its development. A look into the growth pattern of area, production and productivity of major crop groups is indeed an essential prerequisite. It may be pertinent to note that although some such studies have been carried out in other agrarian states of the country (Bhalla and Singh, 2009; Bhattacharya and Bhattacharya, 2007; Vakulabharanam, 2004; Subrahmanyam and Satya Sekhar, 2003), a comprehensive study considering major crop groups and across the physiographic zones in the context of Odisha is seldom found. The crop groups included in the study are: cereals, pulses, foodgrains, oilseeds, fibres, vegetables and condiments and spices. The information built upon these statistics is expected to be immensely helpful in formulating plans and policies for the development of agricultural sector in the state a more objective way.

Table 1. Grouping of districts according to the physiographic conditions in Odisha

Physiographic condition	Northern Plateau (NP)	Central Table Land (CTL)	Eastern Ghat (EG)	Coastal Plains (CP)
Climate	Mostly hot & moist and sub-humid	Mostly hot & moist and sub-humid	Hot and moist, sub-humid, warm and humid	Includes moist & sub-humid, hot & moist, hot & humid
Soil types	Lateritic, red & yellow, red & brown, mixed red & black	Red & yellow, red & black, black, brown forest and lateritic	Red, mixed red & black, black, lateritic, alluvial	Red, deltaic, lateritic, deltaic alluvial, coastal alluvial, saline
Districts	Keonjhar, Mayurbhanj, Jharsuguda, Sundargarh	Bolangir, Sonepur, Dhenkanal, Angul, Sambalpur, Bargarh, Deogarh	Kalahandi, Nuapara, Koraput, Malkangiri, Nawarangpur, Rayagada, Kandhamal, Boudh	Balasore, Bhadrak, Cuttack, Jagatsinghpur, Jajpur, Kendrapara, Ganjam, Gajapati, Puri, Khurda, Nayagarh

Source: GoO (2012)

Database and Methodology

The study is based on the secondary data collected from various issues of *Odisha Agriculture Statistics*, published by the Directorate of Agriculture and Food Production, Odisha. For examining growth performance of major crop groups across regions of the state, compound annual growth rates have been calculated for two time periods, viz. Period-I (1993-94 to 2003-04) and Period-II (2003-04 to 2010-11). Analysis has been done crop group-wise with respect to area, yield and production. The state has been divided into four physiographic zones as there are vast variations in the agro-climatic conditions. A zone-wise analysis has been undertaken on the basis of 30 districts (Table 1). The focus is to compare the zone-wise growth rates recorded during the period under study.

Growth Trends in Area, Production and Yield under Major Crop Groups at State Level

Table 2 presents the growth trends in area, production and yield of major crop groups in Odisha for the period 1993-2011. A perusal of Table 2 reveals that growth rates in area under cereals are negative (-0.20%) not only for the entire study period (1993-94 to 2010-11), but also for Period-I (1993-94 to 2003-04) and Period-II (2003-04 to 2010-11). Across pulses, though spacious gap has been recorded in their growth rates between early and late reform periods, this group has registered a positive growth rate of 2.09 per cent in the state for the period 1993-2011. For foodgrains

an average growth rate of less than 0.5 per cent has been recorded. Impressive growth rate in area for pulses is indicative of the attempts made to bring more area under pulses crops through adoption of mixed cropping, crop rotation, paddy bund plantation and introduction of suitable varieties.

Under non-foodgrains category, area under oilseeds has grown by 0.51 per cent over the period 1993-2011. However, during Period-II, a significant growth (1.56%) in area under oilseeds has been observed. For fibres, a negative and inconsequential growth in area has been cataloged with -0.25 per cent growth over the entire study period. The area under vegetables has increased significantly by 2.2 per cent over the entire study period, whereas area under condiments and spices has shown very low growth. Overall, the arable land in the state has declined because of natural calamities, population pressure and diversion of agricultural land to non-agricultural uses, leading to sub-division of landholdings. The net sown area (NSA) in the state has declined with time.

A look at the growth in production of major crop groups reveals that the overall growth of foodgrains remained at 2.04 per cent. The production of both cereals and pulses has grown at a decent rate of 2.85 per cent and 2.10 per cent, respectively during the study period. Under non-foodgrains, the production of oilseeds and fibre crops has depicted a negative growth of -0.11 per cent and -0.05 per cent, respectively, whereas, vegetables and condiments and spices have

Table 2. Growth trends in area, production and yield of major crop groups in Odisha: 1993-2011

(in per cent)

Period	Cereals	Pulses	Foodgrains	Oilseeds	Fibres	Vegetables	Condiments & spices
Area							
1993-2004	-0.32	1.00	0.09	-0.54	-0.17	1.51	-1.98
2004-2011	-0.07	3.18	0.76	1.56	-0.33	2.93	1.06
1993-2011	-0.20	2.09	0.43	0.51	-0.25	2.22	-0.46
Production							
1993-2004	2.92	0.68	2.78	-1.91	-0.91	0.41	0.21
2004-2011	2.78	3.51	1.29	1.69	0.80	3.95	1.04
1993-2011	2.85	2.10	2.04	-0.11	-0.05	2.18	0.62
Yield							
1993-2004	2.83	-0.32	2.96	-1.29	-1.81	3.82	0.91
2004-2011	2.15	1.55	1.45	1.82	1.59	1.14	3.82
1993-2011	2.49	0.62	2.20	0.26	-0.11	2.48	2.37

Source: Authors' calculations based on data collected from *Odisha Agriculture Statistics*, Directorate of Agriculture and Food Production, Odisha

revealed a positive growth of 2.18 per cent and 0.62 per cent, respectively during the period 1993-94 to 2010-11. In the second period, an impressive growth in production of vegetables and pulses has been recorded. The analysis of growth rate of production has shown that all crop groups experienced acceleration in the post-reforms period (Period-II) compared to pre-reforms period (Period-I).

The growth in productivity of major crop groups in Odisha has been quite impressive during the study period 1993-2011. However, the growth in yield rate of the major crop groups has been positive during Period-II and negative for pulses, oilseeds and fibre crops in Period-I. Under non-foodgrains category, vegetables have recorded the highest growth in yield at 2.48 per cent, followed by condiments and spices during the overall study period. A significant improvement in the yield of oilseeds and fibres has been observed in Period-II. It is remarkable to note that Odisha agriculture being dominated by cereals cultivation, growth of area under cereals cultivation has declined by 0.20 per cent, whereas production and productivity of cereals has been quite impressive, which could be because of more use of HYVs (high-yielding varieties) of seeds and fertilizers. Whereas for pulses, even though area and production have increased, the productivity has not increased considerably. Under non-foodgrains, only vegetables

have shown a remarkable growth in these aspects. Reducing instability and regional disparities, increasing the pace of diversification as the growth augmenting strategies for sustained agricultural growth in the state must get due attention.

Growth Trends in Area of Major Crops across Physiographic Zones of Odisha

Odisha agriculture is known for its diversity which is mainly the result of variations in resource endowments, climate, soil type, land fertility, rainfall, temperature, water resources, topography, technology adoption, infrastructure, natural calamities, availability of inputs, marketing, irrigation facilities, farm mechanization, cropping intensity, size of landholdings, locations, crop diversification and commercialization of agriculture, farmer's indebtedness, migration, and historical institutional and socio-economic factors. As a result, agricultural sector has followed an uneven path and huge gaps have been there in production and productivity across different regions and districts across the state. Analysing growth trends with respect to area, production and yield across the physiographic zones of major crop groups will help to look into the trends at the disaggregate level and to develop decentralized development strategies to ensure inclusive growth in the state in the long-run.

The growth pattern of area under cultivation for major crop groups across the four physiographic zones of Odisha has been presented in Table 3. The overall growth of area under foodgrains remained positive in all the zones during the overall period. A significant growth in area under foodgrains has been observed in EG zone (1.12%) for the overall period. The area under cereals has declined in all the zones, except EG. However, area under pulses has increased in all the zones during 1993-94 to 2010-11 and the increase has been significant during Period-II. A look at area growth under oilseeds reveals that it is the NP zone where a significant improvement has been observed in the overall study period as well as during the sub-periods, whereas the performance of other zones has been very poor. The increase in area of fibres has been significant for the EG zone, whereas CP zone has performed very desolately as compared to other zones. Area under vegetables has grown significantly in all the zones during the overall study period, especially in Period-II. A positive growth in area under condiments & spices has been observed only in the CTL zone during the overall study period, especially in Period-II, the area

under condiments & spices has increased in all the physiographic zones in the state.

Since most of the small and marginal farmers in the state grow highland cereals and pulses for food security, partial substitution of foodgrains with non-foodgrains is considered to be a more appropriate measure for achieving crop diversification and sustainable agricultural growth in the state.

Growth Trends in Production of Major Crop Groups across the Physiographic Zones of Odisha

Table 4 presents the growth trends in production of major crop groups across the four physiographic zones in the state. Across all the zones, production of cereals and pulses has been quite remarkable during the overall period. During period 1993-94 to 2010-11, the growth rate has been observed highest for EG zone (4.16%), followed by NP zone (2.88%), CTL zone (2.27%), and CP zone (2.08%). A steady growth has also been observed during the sub-periods across all the zones in the production of cereals, whereas growth in the production of pulses in all the zones other than

Table 3. Growth trends in area under major crop groups across the physiographic zones of Odisha: 1993-2011

Period	Cereals	Pulses	Foodgrains	Oilseeds	Fibres	Vegetables	Condiments & spices
Northern Plateau (NP) zone							
1993-2004	0.17	-0.34	0.48	2.00	-3.56	2.00	-2.33
2004-2011	-0.63	1.91	-0.28	2.54	-0.31	1.23	0.72
1993-2011	-0.23	0.79	0.10	2.27	-1.94	1.61	-0.81
Central Table Land (CTL) zone							
1993-2004	-0.19	0.72	0.04	-0.80	1.60	1.77	-1.68
2004-2011	-0.36	3.11	0.73	1.08	-0.09	6.38	2.30
1993-2011	-0.27	1.92	0.38	0.14	0.76	4.08	0.31
Eastern Ghat (EG) zone							
1993-2004	0.69	0.50	0.44	-1.39	3.78	0.96	-1.65
2004-2011	0.64	4.78	1.80	1.29	2.05	2.87	1.18
1993-2011	0.67	2.64	1.12	-0.05	2.91	1.91	-0.23
Coastal Plains (CP) zone							
1993-2004	-1.95	3.13	-0.60	-1.96	-2.48	1.32	-2.25
2004-2011	0.05	2.94	0.81	1.34	-2.95	1.24	0.04
1993-2011	-0.95	3.03	0.10	-0.31	-2.72	1.28	-1.11

Source: Authors' calculations based on data collected from *Odisha Agriculture Statistics*, Directorate of Agriculture and Food Production, Odisha

Table 4. Growth trends in production of major crop groups across physiographic zones of Odisha: 1993-2011

(in per cent)

Period	Cereals	Pulses	Foodgrains	Oilseeds	Fibres	Vegetables	Condiments & spices
Northern Plateau (NP) zone							
1993-2004	2.97	-2.68	2.46	-4.60	-3.14	0.49	0.75
2004-2011	2.80	3.72	0.31	1.85	0.63	2.77	0.84
1993-2011	2.88	0.52	1.39	-1.37	-1.25	1.63	0.79
Central Table Land (CTL) zone							
1993-2004	2.18	0.81	2.41	-1.01	0.37	-0.01	-0.23
2004-2011	2.36	5.06	-0.62	2.85	-0.14	6.64	2.11
1993-2011	2.27	2.93	0.89	0.92	0.12	3.32	0.94
Eastern Ghat(EG) zone							
1993-2004	3.49	1.50	3.09	-1.09	-0.90	1.37	-0.22
2004-2011	4.83	3.74	4.29	0.94	1.86	3.19	0.87
1993-2011	4.16	2.62	3.69	-0.08	0.48	2.28	0.33
Coastal Plains(CP) zone							
1993-2004	3.02	3.09	3.18	-0.92	0.05	-0.18	0.53
2004-2011	1.14	1.53	1.18	1.13	0.87	3.18	0.31
1993-2011	2.08	2.31	2.18	0.11	0.46	1.50	0.42

Source: Authors' calculation based on data collected from *Odisha Agriculture Statistics*, Directorate of Agriculture and Food Production, Odisha

NP, has not been notable during the overall period. However, a significant increment in the growth of production of pulses has been observed for NP, CTL, and EG zones in Period-II. A similar pattern of growth has been observed in the production of foodgrains. A large degree of variation has been observed in the production of oilseeds across the zones during the overall period and sub-periods of the study. However, during Period-II, production of oilseeds has been positive for all the zones. A similar trend has been observed in the production of fibre crops across the zones and over the time periods. A significant increase in the growth of vegetables production across all the zones has been observed in Period-II. The growth rate has been highest in CTL zone (6.64%), followed by EG zone (3.19%), CP zone (3.18%), and NP zone (2.77%) during Period-II. The growth in condiments & spices in all the zones has remained sluggish during the overall as well as for the sub-periods. A stumpy percentage of land-use for production of condiments & spices and traditional production methods may be responsible for slack production growth of this crop group.

Growth Trends in Yield of Major Crop Groups across Physiographic Zones of Odisha

Table 5 presents the zone-wise growth in the yield of foodgrain and non-foodgrain crops in the state for the period 1993-2011. A perusal of Table 5 reveals a declining trend in the yield of cereals in all the zones, particularly in Period-II vis-à-vis Period-I, except in EG zone. The yield rate for pulses has increased in Period-II vis-à-vis Period-I in all the zones except CP zone. A similar trend is observed in the yield of foodgrains across all the zones and over the time period; however, the productivity of foodgrains has increased significantly in the EG zone, particularly during Period-II. The growth in the yield of oilseed crops has been quite impressive during Period-II as compared to Period-I of the study. A similar trend is observed in the yield of fibre crops across all the zones and over the time period.

Under non-foodgrain crops, the yield of vegetables has been predominant and occupies an important place in diversification of agriculture. However, a declining trend has been observed in the productivity growth of

Table 5. Growth trends in yield of major crop groups across physiographic zones of Odisha: 1993-2011

(in per cent)

Period	Cereals	Pulses	Foodgrains	Oilseeds	Fibres	Vegetables	Condiments & spices
Northern Plateau (NP) zone							
1993-2004	2.80	-2.65	2.03	-2.87	0.10	4.01	2.51
2004-2011	0.60	2.75	-0.47	1.36	1.42	1.57	3.42
1993-2011	1.70	0.05	0.78	-0.76	0.76	2.79	2.96
Central Table Land (CTL) zone							
1993-2004	2.98	0.19	2.55	-1.38	0.34	2.39	-2.92
2004-2011	0.34	3.00	-0.36	2.88	0.49	0.88	4.49
1993-2011	1.66	1.59	1.10	0.75	0.42	1.64	0.78
Eastern Ghat(EG) zone							
1993-2004	2.77	0.83	2.71	-0.78	-6.76	4.28	0.51
2004-2011	5.47	1.56	5.25	2.52	2.76	0.66	4.49
1993-2011	4.12	1.19	3.98	0.87	-2.00	2.47	2.50
Coastal Plains(CP) zone							
1993-2004	2.76	0.37	4.54	-0.14	-0.92	4.60	3.56
2004-2011	2.19	-1.09	1.39	0.51	1.67	1.44	2.90
1993-2011	2.48	-0.36	2.96	0.19	0.38	3.02	3.23

Source: Authors' calculations based on data collected from *Odisha Agriculture Statistics*, Directorate of Agriculture and Food Production, Odisha

vegetables across the zones during Period-II. Nevertheless, the overall growth in the productivity of vegetables has been quite satisfactory during the overall period across all the zones. The production of condiments & spices remained attractive over the years and the overall growth rate is reported to be 3.23 per cent in CP zone. Although condiments & spices are important cash crops in Odisha, results indicate that yield rate has not been remarkable across the zones other than NP and CP.

Determinants of Growth Rate in Area, Production and Yield of Odisha Agriculture

The above analysis has revealed that, agriculture in Odisha has experienced a high degree of variation in the growth of area, production and yield across the physiographic zones, therefore it is pertinent to identify the major determining factors so as to draw implications thereon. The study has examined the impact of different factors considering growth in area, production and yield for the overall period and Period-I (1993-94 to 2003-04) and Period-II (2003-04 to 2010-11) and detailed data are given in Annexure Tables A1, A2 and A3 for the respective time periods.

Model Specification and Variables

This study has examined the determinants of growth in area, production and yield in different crop groups at the state level through the neo-classical growth model, and the aggregate growth model can be specified as Equation (1):

$$Y = f(R, GCA, CI, GIA, FC, LR) \quad \dots (1)$$

where, Y is the growth rate (area, production and yield); R is the rainfall; GCA is the gross cropped area; CI is the cropping intensity; GIA is the gross irrigated area; FC is the fertilizer consumption; and LR is the literacy rate.

The growth rates in area, production and yield generally determine the overall performance of an agrarian economy and are treated as dependent variables in a broad analytical framework (Bhattacharya and Bhattacharya, 2007). The consumption of fertilizers and cropping intensity are taken as the main technological variables. The rationale for including rainfall in the production function is that a significant proportion of cultivated area depends on rainfall, and its variation affects the crop output

Table 6. Variables and their measurements

Variables	Notations	Method of measurement
Growth rates in area, production and yield	Y	Annual compound growth rates of area, production and yield
Rainfall (R)	X ₁	Actual rainfall as the ratio to normal rainfall
Gross cultivable area (GCA)	X ₂	Gross cultivable area as a ratio to the total geographical area
Cropping intensity (CI)	X ₃	The ratio of gross cultivable area to net cropped area
Irrigation (I)	X ₄	The gross irrigated area as a ratio to the gross cropped area
Fertilizer consumption (FC)	X ₅	Total fertilizer consumed for crop production as a ratio to the gross cropped area
Literacy rate (LR)	X ₆	Literacy rate

substantially. Similarly, as the gross cultivated area has shown very little fluctuation over time, it has been taken as proxy for available land for cultivation. The gross irrigated area represents water-use from all the sources of irrigation for crop production. Education has a significant impact on agricultural productivity, which may boost farm productivity through refining the quality of labour, and increasing the access to information and awareness programmes on agricultural practices. Thus, literacy rate has been considered as an important variable in the study. Notwithstanding the limitations, the selected variables do have a good capacity to present the true picture of overall agricultural performance of the state.

Table 6 presents all the variables, dependent and independent, and the methods of their measurement.

Model Specification

To examine the impact of macroeconomic factors on the growth of area, production and yield in Odisha agriculture, study has been carried out using ordinary least squares (OLS) estimation of the multiple regression model with k explanatory variables as specified in Equation (2):

$$Y_t = \alpha + \beta_1 X_{1t} + \beta_2 X_{2t} + \beta_3 X_{3t} + \dots + \beta_k X_{kt} + e_t \quad \dots (2)$$

where, X_{it} is the t^{th} observation on the first explanatory variable (for $t = 1, \dots, N$ observations)

All independent variables are in the logarithmic form and model has been estimated through the ordinary least squares (OLS) method. The empirical models have been designed to ensure that the potential econometric problems—specification bias and simultaneity—are taken into account.

Regression Results

The present data set, the F -test results have suggested that the OLS model is efficient. Thus, economic interpretation of the results is based on the OLS model. Table 7 presents the results at the aggregate level for Period-I and Period-II. The key variables of interest of this study are growth rate of area, production and yield and the macroeconomic factors affecting the same. The results regarding the effect of macroeconomic factors on growth of area under cultivation are presented in column 2 of Table 7 for the Period-I. The coefficient of macroeconomic factors, i.e. rainfall, gross cropped area, gross irrigated area, fertilizer consumption, and literacy rate are positive and significant, except for cropping intensity. The results regarding the effect of macroeconomic factors on growth of production are presented in column 3 of Table 7 and the coefficients of macroeconomic factors are positive and significant. Furthermore, the results regarding the effect of macroeconomic factors on growth of yield are presented in column 4 of Table 7 for the Period-I. The coefficients of all the macroeconomic factors are positive and significant. A similar type of results have been observed for the Period-II.

Growth of Odisha Agriculture: Some Concerns

It is pertinent to note that a varying and unsustainable growth in area, production and productivity of crops has been recorded over the years in the state. Given the fact that foodgrains cover more than 75 per cent of the cultivated area across the zones, an unevenness is observed in the regional growth of foodgrains in the state. This is due to the uneven distribution of resource endowments, climate, soil type,

Table 7. Factors affecting growth rate in area, production and yield of Odisha agriculture during Period-I (1993-94 to 2003-04) and Period-II (2003-04 to 2010-11)

Variable	Growth rates in Period-I (1993-94 to 2003-04)			Growth rates in Period-II (2003-04 to 2010-11)		
	Area	Production	Yield	Area	Production	Yield
Rainfall (R)	0.32*** (4.78)	0.35*** (4.81)	0.30*** (4.75)	0.28*** (3.78)	0.29*** (3.81)	0.27*** (3.76)
Gross cultivable area (GCA)	0.035* (2.21)	0.032* (2.21)	0.030* (2.19)	0.031* (2.20)	0.021* (1.89)	0.019* (1.81)
Cropping intensity (CI)	0.01 (0.76)	0.21** (2.76)	0.11* (2.56)	0.02 (0.76)	0.12** (2.71)	0.09** (1.78)
Gross irrigated area (GIA)	0.73*** (2.04)	0.63*** (1.94)	0.68*** (1.84)	0.71*** (2.03)	0.66*** (1.93)	0.69*** (1.99)
Fertilizer consumption (FC)	0.31*** (2.39)	0.30*** (2.38)	0.30*** (2.39)	0.21*** (2.19)	0.20*** (2.09)	0.20*** (2.10)
Literacy rate (LR)	0.21*** (2.49)	0.29*** (2.43)	0.26*** (2.45)	0.18*** (2.39)	0.21*** (2.40)	0.20*** (2.39)
Constant	0.55*** (11.6)	0.53*** (11.5)	0.51*** (11.2)	0.49*** (10.40)	0.44*** (9.34)	0.46*** (9.84)
F-stat	8.57***	8.41***	8.39***	8.23***	8.12***	8.06***
R-squared	0.76	0.74	0.72	0.69	0.56	0.62
Adj. R-squared	0.71	0.63	0.69	0.54	0.51	0.59
No. of observations	30	30	30	30	30	30

Note: The figures within the parentheses are the values of t-statistics

***, **, and * indicate significance at 1 per cent, 5 per cent, and 10 per cent levels, respectively.

rainfall, temperature, water resources, topography, historical and institutional and socio-economic factors. Along with these, there are some macro factors which include decline in cultivated land, increase in small and marginal farmers and slow growth of cropping intensity.

It is observed from Table 8 that both gross cropped area and net area sown have declined by 6.31 per cent and 13.65 per cent, respectively during the period 1993-94 to 2010-11 (Annexure Table A4). Increasing diversion of agricultural land to non-agricultural uses due to increasing industrialization, expanding urbanization and rising trend of barren land appear alarming that has led to a decline in area under cultivation. The role played by the adverse weather conditions and the slow pace of expansion of irrigation network cannot be ignored in this perspective. Furthermore, the number of small and marginal farmers has also increased by a significant percentage (9.61%) during 2001-2011, which has led to low levels of risk

taking capacity, technology adoption, farm mechanization and fertilizer application, resulting in low levels of investment as also the low farm crop productivity. Along with these, the growth of intensive cultivation is very slow in the state reported as 12.08 per cent in cropping intensity during 1993-94 to 2010-11.

The slow growth of two agricultural output growth enhancing inputs, viz. irrigation and fertilizer, are considered to be the most immediate and important determining factors responsible for sluggish agricultural production in Odisha. Though fertilizer consumption has increased by 207 per cent, the absolute amount of consumption per hectare is much lower than at the national level. Although net irrigated area and gross irrigated area have increased by 26.88 per cent and 26.46 per cent, respectively, a large part of the cultivated land depends on monsoon. The low level of consumption of power which is critical for mechanization of agriculture, indicates the lack of

Table 8. Changes in the growth of major key indicators of Odisha agriculture during 1993-94 to 2010-11

Key indicators	(in percentage)	
	1993-94 to 2010-11	2001- 2011
Net area sown (NAS)	-13.65	
Gross cropped area (GCA)	-6.31	
NAS as a% of GCA	-7.84	
Cropping intensity (CI)	12.08	
Net irrigated area (NIA)	26.88	
NIA as a% of GCA	35.42	
Gross irrigated area(GIA)	26.46	
GIA as a% of GCA	34.97	
Fertilizer consumption (kg/ha)	207.18	
Power consumption for agriculture purpose	-75.00	
No. of small and marginal farmers		9.61

Source: From various reports of *Odisha Agriculture Statistics*, Directorate of Agriculture and Food Production, Government of Odisha.

modernization of the agriculture sector in the state. The percentage of power consumption for agricultural purposes has declined over the period of time by 75 per cent. As multiple demands for land increase, less land is devoted to the agricultural sector. Therefore, intensive cultivation of available land seems to be a viable strategy for increasing the gross cropped area along with mechanization and modernization of agriculture for augmenting agricultural production in the state.

Summary and Conclusions

Decomposition of growth in agricultural sector of Odisha is of considerable interest for the researchers and policy makers. A breakdown of growth in the agricultural sector into various components, area, production and yield facilitates the future course of action with alternative targets and policies. The study has revealed that the main source of growth in production of foodgrains, especially cereals, during the period 1993-94 to 2010-11 has been the growth in yield. It seems that the agricultural price policy and supplying the significant amount of inputs, especially fertilizers

at the subsidized rate have been the key factors to promote the farmers to increase the production of foodgrains. Moreover, among non-foodgrain crops, the production of crops, except vegetables, has grown at a low rate during this period. The agricultural growth during this period has been because of the area effect while the government policies have out-focused non-foodgrain crops, particularly oilseeds and fibres.

The study has concluded that, there are at least three major causes of worry about the agriculture sector of Odisha. First, the relatively high growth rate of foodgrains production in Odisha has been achieved mainly through area effect. This pattern of growth can no longer continue without a new strategy for agricultural development emphasizing on increasing land productivity. Second, although, contribution of technology inputs towards sustainable output growth has been recognized, growth in the yield rate in Odisha agriculture has generally been rather slow. Third, Odisha agriculture differs regionally due to the differences in geographical area, climate and natural resources and thus production characteristics. It is time to reform this sector and accord importance to food safety issues to meet the growing demand for quality food through replacing subsidies with investments and infrastructure development.

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Annexure Table A1

District-wise area, yield rate and production of all crop groups during 1993-94 to 2010-11 in Odisha

District	1993-94			2003-04			2010-11		
	Area (^{'000} ha)	Yield (kg/ha)	Production (^{'000} tones)	Area (^{'000} ha)	Yield (kg/ha)	Production (^{'000} tones)	Area (^{'000} ha)	Yield (kg/ha)	Production (^{'000} tones)
Balasore	433.9	2185.0	1124.3	330	2894	810	320	3003	846
Bhadrak	265.6	2181.1	524.0	202	3055	522	208	3379	638
Bolangir	472.2	1831.3	729.9	421	2542	669	470	3058	1147
Sonepur	184.7	1966.5	341.4	172	2702	481	206	2896	608
Cuttack	371.2	2290.0	925.2	290	2872	546	305	3695	745
Jagatsinghpur	225.2	2086.1	463.4	178	3132	365	179	3594	469
Jajpur	316.1	2159.3	597.8	258	3187	532	260	3206	585
Kendrapara	293.3	2135.7	589.8	230	2865	509	256	3627	592
Dhenkanal	336.4	2284.3	605.1	255	2675	556	234	3253	582
Angul	331.5	2247.9	570.4	292	2580	477	283	3058	500
Ganjam	755.2	1858.5	1247.8	692	2811	1328	689	2598	1130
Gajapati	121.9	1767.7	175.2	122	2814	310	137	2915	374
Kalahandi	568.7	1745.8	700.0	520	2655	753	590	3414	1314
Nuapara	246.6	1744.0	297.9	255	2406	398	262	2779	434
Keonjhar	412.2	1664.5	642.2	409	2734	880	391	3266	1082
Koraput	415.1	1971.6	671.7	368	2393	599	372	3569	820
Malkangiri	194.4	1898.0	274.8	215	2579	390	216	3072	513
Nawarangpur	267.2	1803.0	428.8	279	2430	510	271	3003	794
Rayagada	268.3	1592.3	321.5	237	2436	400	237	3187	562
Mayurbhanj	544.3	2216.8	1118.3	488	2862	1063	424	3138	807
Kandhamal	227.7	2027.3	310.5	160	2568	346	171	4286	604
Boudh	124.7	1974.1	163.0	120	2556	272	130	3167	348
Puri	296.7	1659.7	541.4	232	2817	553	256	3188	524
Khurda	225.1	2312.4	470.3	212	2645	444	192	3487	546
Nayagarh	209.2	2397.6	336.3	215	2864	314	216	3595	442
Sambalpur	266.1	2633.6	583.6	263	2719	589	264	2675	476
Bargarh	487.3	1981.8	986.4	440	2768	879	441	2894	931
Deogarh	92.8	2196.1	172.3	106	2738	245	96	2736	172
Jharsuguda	103.4	2590.5	254.5	115	2701	302	94	2822	129
Sundargarh	404.2	1650.6	596.0	364	2801	599	371	2884	640

Notes: All crop groups include; Cereals, Pulses, Oilseeds, Fibres, Vegetables, Condiments & spices

Source: Odisha Agriculture Statistics published by Directorate of Agriculture and Food Production, Government of Odisha, Bhubaneswar

Annexure Table A2**Performance of major key indicators of Odisha agriculture during 1993- 94 to 2010-11**

Year	% of deviation in rainfall	NAS	GCA	NAS % of GCA	CI	NIA	NIA % of GCA	GCA	GIA % of GCA	FC (kg/ha)	% of power consumption for agricultural purpose
1993-94	-5.39	6278	9691	64.78	149	1643	16.96	2456	25.34	20	5.6
1994-95	13.16	6279	9691	64.79	155	1627	16.79	2467	25.46	23	6.6
1995-96	7.04	6210	9668	64.23	158	1690	17.48	2629	27.20	25	6.5
1996-97	-34.11	5968	8216	72.64	154	2263	27.55	3357	40.86	39	2.8
1997-98	-0.42	6122	8644	70.82	141	1599	18.49	2318	26.82	35	3.6
1998-99	-23.40	6048	8428	71.76	139	1650	19.57	2358	27.98	36	4.8
1999-00	-4.45	6071	8558	70.94	140	1662	19.42	2506	29.28	42	3.9
2000-01	-31.11	5845	7942	73.60	135	1596	20.10	2156	27.15	41	3.1
2001-02	9.04	5845	8802	66.41	151	1752	19.91	2546	28.92	41	2.8
2002-03	-32.01	5680	7853	72.33	138	1247	15.88	1712	21.80	39	2.1
2003-04	12.23	5795	8638	67.09	149	1737	20.11	2518	29.15	39	1.8
2004-05	16.38	5739	8718	65.83	152	1846	21.17	2691	30.86	43	1.9
2005-06	4.71	5691	8928	63.74	157	1923	21.53	2965	33.21	46	1.7
2006-07	15.96	5654	8960	63.10	158	2002	22.34	3149	35.15	47	1.4
2007-08	9.67	5624	9016	62.38	160	2027	22.48	3308	36.70	52	1.2
2008-09	4.99	5604	9071	61.78	162	2081	22.94	3177	35.03	62	1.3
2009-10	-6.11	5574	9074	61.43	163	2059	22.69	3039	33.49	60	1.3
2010-11	-10.90	5421	9080	59.70	167	2085	22.97	3106	34.21	63	1.4

Source: From various reports of *Odisha Agriculture Statistics*, Directorate of Agriculture and Food Production, Government of Odisha, Bhubaneswar

Notes: NAS = Net area sown; GCA = Gross cropped area; CI = Cropping intensity; GIA = Gross irrigated area; NIA = Net irrigated area, and FC = Fertilizer consumption (area in '000 ha)

