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Abstract

Persistent inter-state disparity in terms of economic and agricultural growth has emerged as a key issue in recent discussions of development policy. The disparity in the growth pattern among states might exist when some states shift from natural resource (mainly land) based growth path to technology based growth process. The present paper examines the factors that influence the differential growth patterns among states in the agriculture sector. Two states - Andhra Pradesh and Orissa - have been considered for detailed analysis as they have followed divergent trajectories of agricultural growth. In Andhra Pradesh the agricultural growth process has been accelerated by the utilization of science-based technologies and crop diversification. The growth experience of Orissa, on the other hand, continues to be constrained by natural resources (mainly, land and rainfall), which is reflected in a lower rate of growth.

Keywords : Agriculture, Andhra Pradesh, Orissa, sources of growth, phases of growth, break points

JEL Codes : Q00, Q13, Q18

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Analysis of Agricultural Performance in Andhra Pradesh and Orissa: 1960-61 to 2005-06

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1. Introduction

Indian agriculture at the time of independence was stagnant with large inter regional disparity. As a response to different public policy interventions in the agrarian economy, the sector witnessed a remarkable increase in the performance in the post colonial period (Rao and Despande, 1986)[1], though with considerable divergence (Ghosh et al., 1998; Marjit and Mitra, 1996; Dasgupta et al., 2000). The states with higher income were growing at a faster rate as compared to the low income states (Rao et al., 1999; Bhattacharya et al., 2004). The differential performance among the states has been explained by mainly six factors: diverse natural conditions like the amount of rainfall (Chand et al., 2007; Virmani, 2005), differences in the state policy for agriculture in terms of land reform (Srivastava, 1993; Suri and Raghavulu, 1996), public investment in irrigation (Kalirajan and Shand, 2006; Alagh, 1980), introduction of new technology (Yechuri, 1976; Bhala and Singh, 1997; Mukherjee and Kuroda, 2002; Ghosh, 2006), private initiative in terms of crop diversification and investment in well irrigation (Acharya, 2003) and land settlement policies introduced during the colonial period (Banerjee and Iyer, 2004).

This paper addresses the question of interregional disparity in agriculture from a different perspective. The main question explored in the paper is the following: are the states that witness lower rates of growth caught in a Ricardian natural resource trap? Endowment of natural resources (physical area, soil fertility and rainfall) are essential for production, but also have implications for the growth process, when they are considered as the major source of long term growth without substitution of manmade capital for the natural resources and increasing the role for private initiatives. Economies can grow by exploiting natural resources; but the growth will be low due to

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[1] Rao and Deshpande (1986) have shown that the growth rate of crop output was 0.4 per cent between 1891 and 1946 which rose to 2.6 per cent between 1949-50 and 1983-84.

the diminishing marginal product of land. Moreover, such economies are observed to have lower rates of growth of output, but a relatively higher rate of growth of population which leads to the Ricardian natural resource trap. The natural resource constraint could be relaxed by substitution of manmade or science based capital (for instance, large dams could be a substitute for uncertain rainfall). This might lead to a higher growth rate. The question relevant to this paper is that whether those states that experience higher rates of growth have substituted man made capital and/or given more importance to private initiative thus avoiding the Ricardian trap.

The main objectives of the paper are: (i) to examine the structural break points in the growth of agricultural sector in the states of Andhra Pradesh and Orissa and to identify the different phases in agricultural performance; (ii) to understand the factors which have played important role in the performance of agriculture in different phases. Andhra Pradesh is generally considered as a middle income state with a relatively high growth rate (the GSDP growth rate of the state was 6.5 during 1995/96 - 2005/06). Orissa, on the other hand, is a low income state with a decelerating agricultural sector (with a GSDP growth rate of 4.21 during 1995/96 - 2005/06).

The paper is organized in seven sections including introduction. Section 2 provides a general overview of Indian agriculture and the different phases of its growth. The data and the methodology used for the analysis are discussed in section 3. The fourth section presents the growth profile of agricultural income in the selected states. Sections 5 and 6 discuss the factors affecting agricultural income in each phase for Andhra Pradesh and Orissa respectively, and the last section presents the conclusions of the study.

2. Phases in Indian Agriculture

The agrarian structure and the corresponding institutions inherited from the colonial rule were not favorable for sustainable growth. Specifically, it is the nature of land rights, i.e., the dominant presence of intermediaries and unprotected tenants, that did not generate the corresponding incentive to invest. Land reform was advanced as a necessary step towards changing the nature of existing land rights thus creating the initial conditions for economic growth. According to Besley and Burgess (2000) the states which have implemented land reforms, and, more specifically tenancy reforms,

have attained higher growth. The production techniques in use at the time of independence were also primitive and corresponding changes in technique were slow due to the 'trial and error' process of learning by the system. According to Hayami (2001) in the process of development, the societies substituted man-made capital for natural resources. Thus land productivity could be increased by substituting scientific knowledge and industrial inputs (which he calls 'science based agriculture') with natural soil fertility. This process of substitution led to an increase in commercialization of agriculture leading further to greater market orientation and diversification of the agricultural system (Timmer, 1997; Pingali, 1997).

The process of commercialization involves not only increased market orientation, but also substitution of traded inputs - products of science-based agriculture - for non traded inputs and the decline of integrated farming system. The process of growth in the overall economy and the resultant dietary transition and, more importantly, rising opportunity cost of farm labour were impetus for commercialization (Pingali, 1997). The public policies that facilitated this transition assigned a more central role to private initiatives to respond to the signals from outside the households.

Public policies have witnessed changes in the post independence period. Immediately after independence the state attempted to generate private property right on land (through land reform) and intervened in the credit (provision of institutional credit) and product markets (regulated markets). The land reform policies were able to remove the intermediaries. Some states like West Bengal and Kerala were able to implement the tenancy reforms. But others including Bihar, Orissa and Rajasthan experienced only a marginal impact of reform measures (Suri and Raghavulu, 1996). The growth (decline) in the agrarian sector, due to an expansion (contraction) in the area under cultivation was generally identified with the generic name 'area led' growth process (Vaidyanathan, 2000). All the states did not perform similarly in this phase, the area expansion and the arrangement of land settlement was not similar for all the states.

The economy faced a major food crisis in the mid-1960s, which necessitated a change in public policy to introduce science-based technology into agriculture or initiate the Green Revolution to increase the yield of some crops and generate growth without bringing in a major change in the property rights. This marked the second phase of agriculture policy in the country with its

focus on 'yield led growth' (Deshpande, et al., 2004). In this period, the state provided institutional support for the cultivation of major crops like paddy and wheat. The support was in terms of subsidized provision of inputs and managing the uncertainty in the output markets. Agrarian reforms during this period took a back seat while research, extension, input supply, credit, marketing, price support and technology dissemination were the prime concerns of the policy makers (Rao,1996).

The spread of Green Revolution technology was different for different states. During the mid-1960s the new high yielding variety (HYV) seed-fertilizer technology, which was highly irrigation intensive, was confined to the irrigated areas of Punjab, Haryana and western Uttar Pradesh in north-west India. These regions registered significant acceleration in crop production (Subrahmanyam and Sekhar, 2003). In the 1970s the technology further spread to coastal Andhra Pradesh and Tamil Nadu, eastern Uttar Pradesh and some parts of Rajasthan. The spread of the technology took place later in the case of the eastern states.

The third major source of growth was the increasing market orientation of farmers and the resultant diversification of the cropping pattern. The phase of market driven growth set in after the 1980s[2] by generating demand for various commercial crops and new crops (Deshpande et al., 2004). The integration of the markets - both national and international - was expected to lead to increased specialization and crop diversification towards high valued crops. This could be termed as 'diversification-based growth' process in Indian agriculture. But the process of diversification was different for different states. Between 1980-81 and 1998-99, there was considerable increase in crop diversification in the states of West Bengal, Assam and Maharashtra. There was also a marginal increase in crop diversification in Karnataka, Gujarat, Rajasthan and Andhra Pradesh. In other states the degree of crop diversification declined during this period (Acharya, 2003).

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[2] There has been a considerable increase in subsidies and support to agriculture sector during this period. While public sector spending in infrastructure development of agriculture started showing a decline in real terms, investments by farmers continued to rise (Mishra and Chand, 1995; Chand, 2001).

3. Methodology and Data Base

In this paper income originating from agriculture has been used as an indicator to analyze the performance of the economy[3]. The rate of growth of the Net State Domestic Product (NSDP) originating from agriculture was estimated by using an exponential function. It was observed that the trend in state incomes originating from agriculture was not smooth and continuous suggesting the existence of breaks in the series or phases of the growth process. It must be noted that empirical studies on the growth performance have attempted to identify breaks in the growth process to demarcate different phases in the performance of an economy that have distinct nature and patterns of growth. There are two methods for the identification of breaks in the growth trajectory: (i) to identify the turning points based on point(s) of inflection in the graph of the series; and (ii) to test statistically significant differences in the parameters across two periods. Chow test[4] is one of the methods used to test parameter stability in any given period of analysis.

The present study calculated Chow statistic to test the stability of the coefficient of regression equation. The idea of the breakpoint Chow test is to fit the equation separately for each sub-sample and to see whether there are significant differences in the estimated equations. A significant difference indicates a structural change in the relationship[5]. The Chow test assumes that point(s) of structural break are known. We have applied the test to all possible data points to identify break points in the data series. Repeated application of the test might give a break in consecutive years. In such a case, the value of F-statistics is used to validate the break year. Since the

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[3] There are different indicators on the performance of the agrarian economy like growth in income originating in agriculture, value of agrarian outputs value, of capital formation in agriculture etc.

[4] Chow test is used widely in India to examine structural breaks in the aggregate economy (Virmani, 2005), agriculture (Virmani, 2004; Sawant et.al. 1999), industry (Subrahmanian and Azeez, 2000), health (Rao and Yoonus, 2008), pharmaceuticals (Shanmugasundaram, 2008), and micro finance (Shetty, 2008). Chow test has also been used to find the structural break in world agriculture (Pfaffenzeller et.al., 2009).

[5] For example, one can use this test to examine whether the growth rate of income was the same before and after the Green Revolution (Gujarati, 2004). While the test indicates if two regressions are different, it can not show whether the difference is on account of the intercept or the slope or both.

estimates of structural break come with an associate confidence interval one need not hold fast to the point estimate. After the identification of the breaks and the phases we estimated the growth rates for each separate phase.

After the identification of phases, the factors influencing the growth process in each phase are studied in terms of simple regression analysis. For this purpose different models have been estimated. The model of the best fit is presented in the paper. The impact of the independent variables (inputs) on the dependent variable (income originating in agriculture) in each phase is examined by taking multiple regression analysis by using ordinary least squares (OLS).

The general frame work of the model is: $\ln Y = c + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i}$

Where Y is the dependent variable, X_i indicates the explanatory variables, c is the constant term and β_1, β_2 are the coefficients of the independent variables. For all the models Y is agricultural income and X represents the factors influencing the growth rate. Since the regression was estimated in logarithmic form, the regression coefficients are output elasticities with respect to factor inputs. With a view to identify the important variables, the regression equations were estimated by taking the variables in all possible combinations. Some models showed serious problem of autocorrelation which is overcome by including auto regressive term AR (1) as explanatory variable.

The variables included here for the analysis are divided into three sets: those influencing area expansion, yield expansion and reflecting the role of private initiative. The variables reflecting area led growth are land under cultivation (gross cropped area [GCA], net sown area [NSA], and area sown more than once) and rainfall. The variables reflecting yield-based growth are usage of modern inputs (HYV seeds, modern irrigation systems, and fertilizer consumption). The factors reflecting private initiative are land under well irrigation (unlike canal irrigation well irrigation reflects private initiative to increase production) and crop diversification towards cash crops. A closed classification of the above type has problems as variables over groups maybe colinear (for example, an increase in irrigational facilities, supposedly private, leads to an increase in the land cultivated and/or increase

in the area double cropped). Given these limitations, the paper aims at providing some trends in the growth profiles of the selected states and the factors that influence the growth experience.

Time series data of the income originating from agriculture was collected for the period 1960-61 to 2005-06 at constant prices (1993-94 as the base year) from the *Statistical Abstract* published by Director of Economic and Statistics of the respective states. The data for all the inputs also covered the period from 1960-61 to 2005-06. The data regarding rainfall, land utilization, irrigation and area under HYVs too were collected from the *Statistical Abstracts.* The data on consumption of fertilizer was collected from the *Fertilizer Statistics of India.*

4. Agricultural Performance of Andhra Pradesh and Orissa by Phase

The annual rate of growth of agricultural NSDP over the period 1960-61 and 2005-06 was higher in the state of Andhra Pradesh (2.42) as compared to Orissa (1.14). But the growth rates do not show a smooth and continuous trend in both the states. There are periods of acceleration and deceleration in agricultural NSDP. This forms the basis for the identification of phases in the growth profile. The two states have witnessed three phases during the periods of analysis, but the break periods were different for both.

The repeated application of Chow test led to the identification of multiple breaks in the agricultural NSDP series of Andhra Pradesh concentrated in two bands. The first band of break points is discernible during the period 1973-74 to 1976-77. Based on the value of F-statistic the year 1975-76 was identified as a structural break year at one per cent level of significance (the F-statistic value is 5.41 and the probability value is 0.015). The second band of points in the series is witnessed between 1987-88 and 1991-92. The year 1989-90 was identified as the break year based on F-statistic at one per cent level of significance (the F-statistic value is 4.74 and the probability value is 0.012). The three phases in the growth profile of Andhra Pradesh are identified as 1960-61 to 1974-75, 1975-76 to 1988-89 and 1989-90 to 2004-05 (Table 1 and Figure 1a).

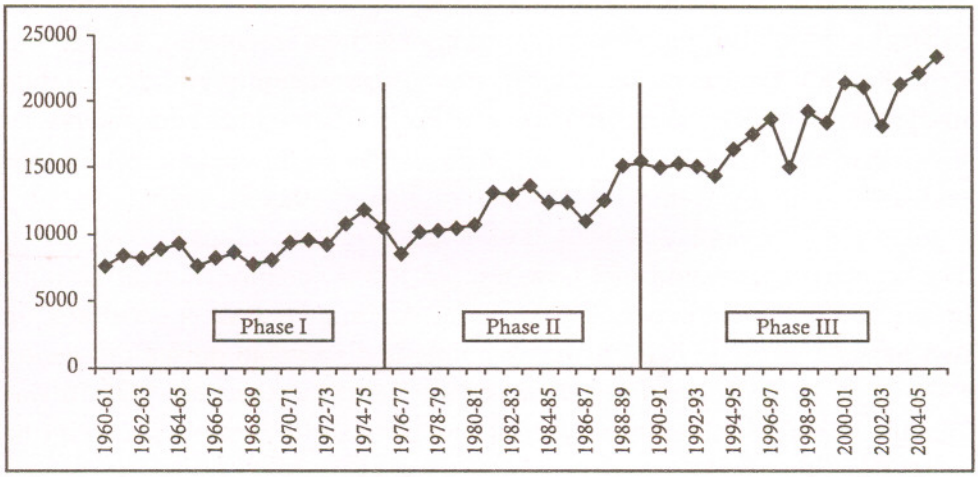
Table 1: Disease Burden Estimation

Phases	Andhra Pradesh	Orissa
Phase-I	*1960-61 to 1974-75* 2.01 (3.57)	*1960-61 to 1975-76* 2.20 (4.88)
Phase-II	*1975-76 to 1988-89* 2.76 (5.66)	*1976-77 to 1991-92* 1.72 (2.30)
Phase-III	*1989-90 to 2005-06* 2.80 (8.21)	*1992-93 to 2005-06* 0.26 (0.33)
1960-61 to 2005-06	2.42 (20.19)	1.14 (7.77)

Source: *Statistical Abstract of Andhra Pradesh* and *Statistical Abstract of Orissa*, various issues.

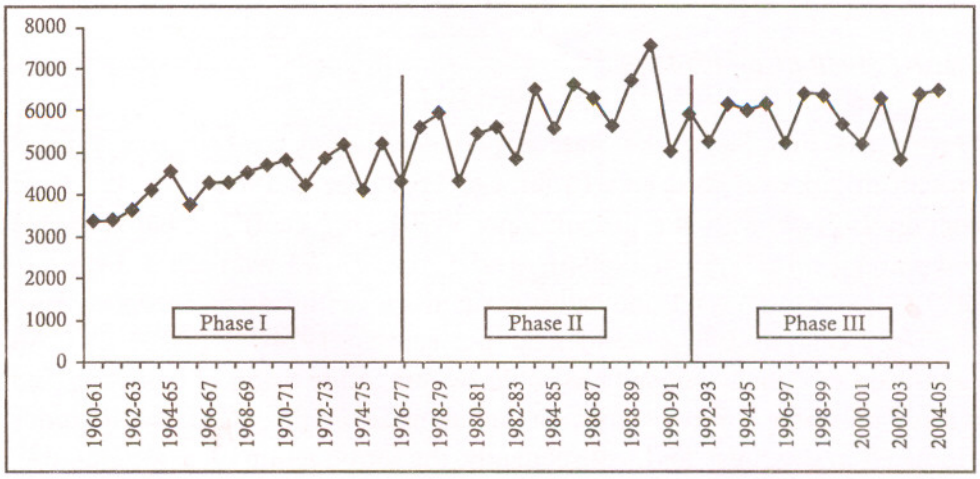
Note: Figures in brackets are values of t-statistic.

Figure 1a: Trend of Agricultural Income in Andhra Pradesh



Source: *Statistical Abstract of Andhra Pradesh,* various years.

Figure 1b: Trend of Agricultural Income in Orissa



Source: *Statistical Abstract of Orissa*, various issues.

The agricultural income series of Orissa also witnessed multiple break points, which are clustered around few years. In the graph plotting F-statistics over time there are two periods which have relatively high F-statistics value. The first series of break ranged between 1975-76 to 1977-78 with the break year identified as 1976-77 (the F-statistic value is 5.78 and the probability value is 0.008 at one per cent significance level). The second set spanned 1988-89 to 1993-94, the break year being 1992-93 (F-statistic value is 8.77 and the probability value is 0.006). The three phases of agricultural income growth in Orissa as per our analysis are: (i) 1960 61 to 1975-76, (ii) 1976-77 to 1991-92; and (iii) 1992-93 to 2005-06 (Table 1 and Figure 1b).

The agrarian sector in Andhra Pradesh has a higher growth rate as compared to that of Orissa for the entire period. The rate of growth of agricultural income increased over the three phases in Andhra Pradesh. The rate of growth increased from 2.01 to 2.76 and to 2.80 over the three phases (Table 1). On the contrary the growth rate of Orissa witnessed a continuous decline – from 2.20 to 1.72 and further to 0.26 over the three periods.

5. Factors Influencing Agricultural Growth Rate in Andhra Pradesh

Phase-I (1960-61 to 1974-75)

During the first phase the state experienced a relatively higher rate of growth in gross cropped area (from 43.29 per cent in 1960-61 to 48.12 per cent in 1974-75 with the growth rate of 0.41 per cent) compared to net sown area (from 39.51 in 1960-61 to 41.51 in 1974-75 with the growth rate of 0.17 per cent). This indicates an increase in the double-cropped land (2.25 per cent in 1960-61 and 6.52 per cent in 1974-75) (Table 2). An expansion of double-cropped are could be due to provision of irrigation and release of water for two crops or an increase in the demand for goods produced in dry areas and, consequently, the introduction of a second crop. However, the total area under irrigation did not show significant increase in this phase, though the composition of sources of irrigation underwent changes. There was a growth of 4.07 per cent in the case of land irrigated by wells, whereas the share of land irrigated by canals rose only by 1.21 per cent (Table 2). The land under tanks witnessed a decline of 3.05 per cent. Generally, in areas with government led canal irrigation water was released for more than one crop leading to increase in the double cropped lands. As the net sown area did not register an increase the compositional change in sources of irrigation could have led to conversion of dry lands into wetlands and consequent increase in double-cropping, thus changing the cropping pattern in the state.

Table 2: Growth Rates by Phase: Andhra Pradesh

	Phase-I	Phase-II	Phase-III
Gross Cropped Area	0.41 (2.18)	-0.11 (-0.39)	-0.33 (-1.68)
Net Sown Area	0.17 (1.13)	-0.33 (-1.35)	-0.41 (-2.23)
Area Sown more than Once	2.34 (3.25)	1.31 (1.80)	-0.17 (-0.41)
Net Irrigated Area	0.40 (1.24)	0.78 (1.89)	-0.51 (-1.52)

[contd...

Table 2 contd...]

	Phase-I	Phase-II	Phase-III
Area under Canal Irrigation*	1.21 (3.09)	0.005 (0.02)	-1.82 (-9.36)
Area under Tank Irrigation*	-3.05 (-5.32)	-2.66 (-3.57)	-3.97 (-8.86)
Area under Well Irrigation*	4.07 (9.53)	3.20 (7.68)	3.48 (14.27)
Consumption of Fertilizer	-	9.45 (10.97)	2.05 (5.84)
Area under HYVs	-	3.36 (10.21)	-0.94 (-2.17)
Area under Foodgrains	-0.26 (-1.25)	-1.71 (-5.52)	-0.88 (-3.21)
Area under Oilseeds	3.33 (9.12)	4.35 (9.25)	-1.04 (-2.46)
Area under Cash Crops	1.01 (1.73)	4.62 (7.05)	2.81 (4.23)
Other Crops	0.20 (0.54)	1.88 (5.04)	0.81 (0.63)

Source: *Statistical Abstract of Andhra Pradesh*, various issues.

Note: *Percentage of area irrigated by Canal/ Tank/ Well to Net Irrigated Area; Figures in brackets are the values of t-statistic.

Paddy continues to be the most important crop cultivated in the state followed by jowar. The proportion of land allocated in 1960-61 to paddy and jowar was 25.06 per cent and 23.10 per cent respectively (Table 3). By the end of the phase, these two crops continued to dominate the state's agriculture though with different growth experiences. While there was an increase in the land under paddy to 30.05 per cent, the land under jowar declined to 17 per cent by 1974-75. The growth rate of area under rice was positive and insignificant (0.56 percent) and for maize and pulses, positive and significant (0.95 per cent and 1.23 per cent respectively). Groundnut also witnessed increase in the land under cultivation during the phase (from 6.79 per cent in 1960-61 to 11.07 per cent in 1974-75). This shows that

there was no significant increase in the land under cultivation in that phase. In other words, the achieved growth was not specifically due to the increase in the land under cultivation. The factors that appeared to have influenced this phase are compositional change in irrigation and increase in the area under paddy crop, and, to a lesser extent, substitution of other high valued products in the place of inferior cereals.

Table 3: Change in Area under Important Crops by Phase: Andhra Pradesh

Crop	Phase-I		Phase-II		Phase-III	
Foodgrains	**77.39**	**71.94**	**75.78**	**63.45**	**60.89**	**51.77**
Paddy	25.06	30.05	29.22	30.76	29.84	25.81
Pulses	10.58	10.96	10.39	12.37	12.47	12.70
Jowar	23.10	17.21	18.42	9.02	8.09	4.63
Ragi	3.12	2.74	2.62	1.24	1.11	0.89
Bajra	5.23	4.74	4.53	1.75	1.46	0.75
Oilseeds	**12.89**	**16.94**	**14.95**	**22.96**	**23.95**	**25.21**
Groundnut	6.79	11.07	10.26	17.58	17.21	14.61
Cash Crops	**3.83**	**5.01**	**4.16**	**6.33**	**7.23**	**13.04**
Cotton	2.80	3.12	2.01	4.78	4.90	10.94
Chilies	1.03	1.26	1.17	1.55	1.88	2.07
Other Crops	**4.96**	**4.94**	**4.98**	**7.07**	**7.24**	**9.86**

Source: *Statistical Abstract of Andhra Pradesh*, various issues.

Regression analysis was conducted to substantiate the result wherein the independent variables considered were area under double cropping, well irrigation[6] and area under paddy (proxy for the cropping pattern in the state)[7]. The result shows that net income from agriculture in Andhra Pradesh was positively and significantly influenced by both area under well irrigation

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[6] During Phase I, there was an increase in the area under well irrigation.

[7] Net irrigated area was found highly correlated with GCA, NSA and area under paddy with correlation coefficients 0.89, 0.89 and 0.90 respectively. Again high correlation was observed between canal irrigation area sown more than once (0.88).

and area under paddy during 1960-61 and 1974-75 (Table 4). The coefficient of income with respect to well irrigation and area under paddy indicate that for every 10 per cent increase in these variables the income would increase by 5.9 per cent and 6.3 per cent respectively. The area under double cropping was found to have a positive, but insignificant impact on the income in the first phase. Overall, the results suggest that growth in the first phase was generated mainly due to increase in land under paddy cultivation and irrigation. In other words, one would say that the state was not facing any natural resource constraint during this period.

Table 4: Factors Influencing Agricultural Income of Andhra Pradesh: Regression Results

Variables	Phase-I	Phase-II@	Phase-III
C	4.46 (3.71) [0.00]	0.55 (0.37) [0.72]	2.25 (2.56) [0.03]
Area Sown More than Once	0.07 (0.34) [0.74]		
Area under Well irrigation	**0.59*** (3.42) [0.01]	0.16 (0.63) [0.54]	**`0.49**** (2.15) [0.05]
Area under Paddy	**0.63***** (1.89) [0.07]	**0.63**** (2.21) [0.04]	0.20***** (1.86) [0.08]
Area under HYV seeds		**0.67**** (2.17) [0.05]	
Fertilizer Consumption			**0.82**** (2.92) [0.02]
R2	0.88	0.89	0.91
DW	1.69	1.98	2.10

Notes: (i) Parenthesis ( ) contain values of t-statistics and [ ] probability values.
(ii) * Significant at 1%; ** Significant at 5%; *** Significant at 10%.
(iii) Regression exercises were carried out with variables like net irrigated area, area sown more than once and area under HYVs. Only area under HYV came out as significant. The Table presents the results of the model of best- fit.

Phase-II (1975-76 to 1988-89)

The second phase corresponds with the agrarian policy regime of provision of subsidized science-based inputs to farmers and price control for the agrarian output. Correspondingly, the use of modern inputs has increased during the phase. The area using HYV seeds increased from 30 per cent in 1975-76 to 57 per cent in 1988-89 (at a growth rate of 3.36 per cent). Consumption of fertilizer too shows a positive and significant growth rate (9.45 per cent) - the per hectare consumption of fertilizer rose from 25 kg in 1975-76 to 108kg in 1988-89 (Table 2). The increased area under HYV seeds and fertilizer could be due to increased land brought under cultivation or by shifting cultivation from traditional crops to high yielding varieties.

During this phase there was a decline in the GCA from 47.93 per cent to 43.20 per cent. The rate of decline was higher for NSA (-0.33%) as compared to GCA (-0.11%) (Table 2). This led to a marginal increase in the area double cropped in the state from 6.50 per cent to 7.59 per cent by the end of the phase. The annual growth rate of double cropped area was 1.31 per cent during the period. Thus compared to the first phase the annual growth rate of area under double cropping showed a deceleration. The contribution of land to the acceleration in the growth rate of agricultural income is observed as minimum in this phase. While there was a decline in the land under cultivation, land under irrigation as a share to GCA increased from 30 per cent in 1975-76 to 39 per cent in 1988-89. The increase in the net area irrigated was mainly due to significant increase in the area under well irrigation (16.91 per cent in 1975-76 to 26.62 per cent 1988-89, the growth rate being 3.20 per cent). The area covered by canals registered marginal decline (0.005 per cent) during this phase.

Along with the increase in the importance of irrigation there was also a shift in the cropping pattern towards oilseeds and cash crops and a decline in the area under food grains. The share of land under paddy increased marginally from 29 per cent to 30 per cent and pulses from 10 per cent to 12 per cent in between 1975-76 and 1988-89. Among the food grains, the area allocated to paddy increased while those allocated to inferior cereals declined whereas the area under groundnuts increased significantly (10.26 per cent to 17.58 per cent). Thus, the contribution of land to the acceleration

in the growth rate of agricultural income was negligible in this phase. Increase in the use of modern inputs and changes in cropping pattern appear to have contributed to the growth during this phase.

Due to problems of high multicollinearity among modern inputs, only one, i.e. land under HYV seeds, was used in the regression model. The independent variables for the model were area under well irrigation, area under paddy and area under HYV seeds. The regression result has high R^2 value (0.89). The estimated coefficients for area under well irrigation and area under HYV seeds was positive and significant (0.63 and 0.67 respectively) as expected. Both were significant at 5 per cent level. The coefficient value implies that with 10 per cent increase in the area under paddy and HYV seeds the income from agriculture would increase by 6.3 per cent and 6.7 per cent respectively. Area irrigated by wells showed positive but insignificant impact on income.

The above analysis shows that there was substitution of modern inputs for traditional inputs during the phase. The land based growth impetus did not prevail anymore in the second phase. Land as an input for agricultural income was not significant; there was only an insignificant shift in cultivation from dry lands to wet lands. With the provision of irrigation there was marginal increase in the area under double cropping. Among the modern inputs, area under HYV seeds was found as having highly significant impact compared to fertilizer consumption. Given that the government plays an important role in the provision of modern inputs this implies that there was increase in public investment in agriculture. Thus the phase 1975-76 to 1988-89 can be explained as modern inputs-led growth phase in Andhra Pradesh with government intervention. The phase also witnessed diversification of area under food grains towards oilseeds and cash crops.

Phase-III (1989-90 to 2005-06)

This phase is generally identified as the neo-liberal phase wherein the state withdrew from its role as the coordinator of production activity to a facilitator and the private initiative was given predominance. In this phase, the area under food grains declined from approximately 60.89 per cent in 1989-90 to 51.77 per cent in 2005-06. Area under paddy declined from 29.84 per cent to 25.81 per cent during this period (Table 3). However, there was a major increase in the area under cash crops (7.60 per cent in 1989-90 to

13.50 per cent 2005-06) with a growth rate 2.81 per cent. The important cash crops that registered an increase in area were cotton and chillies. There was a decline in gross cropped area and net sown area in this phase. The share of GCA declined from 48.32 per cent to 45.63 per cent and that of NSA from 40.43 per cent to 37.65 per cent in the state. The area sown more than once did not show much change in the phase.

Compared to the other phases the total land irrigated also witnessed a marginal decline. But the composition of irrigation demonstrated a continuation of the trend as seen in the second phase. Well irrigation continued to be an important source of irrigation when compared to the other sources. Percentage of area irrigated by canal as a share of total net irrigated area was 44.05 per cent in 1989-90; it declined to 34.30 per cent in 2005-06. The percentage of area under tanks was 24 per cent in 1989-90, which declined to 11.63 per cent at the end of the phase. However, the percentage of area under well irrigation increased from 28.19 to 49.33 at the end of the phase. Unlike the second phase, in the third phase the rate of decline in canal and tank irrigation was more prominent compared to the increase in the area under well irrigation (Table 2). While this phase showed a significant increase in the consumption of fertilizers from 115.58 kg per hectare in 1989-90 to 213.00 kg per hectare in 2005-06, the area under HYV seeds as a percentage to GCA declined from 55.5 per cent to 52.44 per cent.

The independent variables considered for the regression model for the third phase were land under irrigation by wells, fertilizer consumption and area under paddy cultivation (area under paddy was significantly correlated to GCA, NSA and total net irrigated area with correlation coefficients 0.83, 0.90 and 0.93 respectively). The coefficient of income with respect to fertilizer consumption and land under well irrigation was 0.82 and 0.49 respectively. Thus, with 10 per cent increase in fertilizer consumption and land under well irrigation the income would increase by 8.2 per cent and 4.9 per cent respectively (Table 4). This indicates that the third phase in Andhra Pradesh was a phase of private investment in agriculture.

6. Factors Influencing Agricultural Growth Rate in Orissa

Phase-I (1960-61 to 1976-77)

The period between 1960-61 and 1976-77 witnessed a positive, but insignificant increase in the GCA (growth rate of 0.51 per cent) and a decline in NSA (growth rate of -0.07 per cent). Thus there was insignificant increase in the area under double cropping in the state (Table 5). However, during this phase the extent of land irrigated as a share of net sown area rose from 10.59 per cent to 15.12 per cent with an annual rate of growth of 4.73 per cent. The composition of irrigation also underwent a change in the phase[8].

Table 5: Growth Rates by Phase: Orissa

	Phase-I	Phase-II	Phase-III
Gross Crop Area	0.51 (1.29)	1.57 (7.37)	-1.76 (-5.81)
Net Sown Area	-0.07 (-0.49)	0.41 (3.82)	-0.93 (-10.89)
Area Sown more than Once	5.01 (1.66)	4.60 (6.51)	-3.56 (-4.13)
Total Net Irrigated Area	4.73 (11.21)	4.88 (19.51)	2.04 (12.10)
Area Irrigated by Major Sources	1.17 (4.23)	-1.31 (-5.47)	0.31 (2.18)
Area Irrigated by Flow Irrigation	-0.76 (-1.21)	-1.24 (-3.30)	0.02 (0.14)
Area Irrigated by Lift Irrigation	10.23 (4.41)	1.66 (2.66)	0.55 (5.47)
Other Irrigation Sources	-1.87 (-1.63)	4.81 (5.61)	-1.87 (-1.63)

[contd...

[8] The data relating to the irrigation sources for the state Orissa is provided in terms of major, minor and other irrigation sources. Minor irrigation is further divided into lift irrigation and flow irrigation.

Table 5 contd...]

	Phase-I	Phase-II	Phase-III
Consumption of Fertilizer	-	9.63 (17.23)	4.85 (7.83)
Area under HYV Seeds	-	9.13 (15.84)	1.19 (3.65)
Area under Foodgrains	1.88 (6.92)	0.74 (3.75)	-1.53 (-6.47)
Area under Oilseeds	4.68 (8.64)	5.81 (9.11)	-4.36 (-6.62)
Area under Cash Crops	2.86 (4.78)	-0.96 (-2.09)	2.68 (4.15)
Area under Other Crops	-9.04 (4.31)	4.54 (9.52)	-2.72 (-2.74)

Source: *Statistical Abstract of Orissa*, various issues.
Note: (i) * Percentage of area irrigated by Major/Flow/Lift irrigation sources to total Net Irrigated Area.
(ii) Figures in brackets are values of t-statistic.

The share of land irrigated by major sources like canal and minor sources like lift irrigation increased significantly in this phase (the growth rate being 1.17 per cent and 10.23 per cent respectively) though the area irrigated by flow irrigation and other sources declined marginally with a growth rate -0.76 per cent and -1.87 per cent respectively. That the share of neither gross nor net sown area showed a significant increase during the phase suggests that the area under double cropping increased further indicating conversion of dry land into wet land. Such conversion led to a change in the cropping patter wherein land allocated to food grains, oilseeds and cash crops increased significantly. In case of food grains the percentage of land allocated for paddy remained almost constant (61.87 per cent in 1960-61 and 60.57 per cent in 1976-77). The share of land under pulses and inferior cereals increased during this phase.

Cash crops that accounted for only a small proportion of the total cropped area in the state increased from 1.30 per cent and 1.89 per cent respectively in 1960-61 and 1975-76 (Table 6). Among these crops mesta, sugarcane and tobacco (the crops that have a very marginal share - less than

0.50 per cent - in the total cropped area), witnessed increase in their shares whereas cotton and jute registered decline. The percentage area under other crops to the total GCA was around 22 per cent at the start of the phase, but declined to 7 per cent towards the end.

Table 6: Change in Area under Important Crops by Phase: Orissa

Crop	Phase-I		Phase-II		Phase-III	
Foodgrains	**72.46**	**83.91**	**83.75**	**73.83**	**73.77**	**78.02**
Paddy	61.87	60.57	60.76	46.30	47.19	59.00
Pulses	8.05	14.66	13.42	21.82	21.07	17.64
Maiza	0.36	1.53	1.72	1.81	1.80	2.11
Ragi	1.08	3.12	3.53	2.51	2.43	2.45
Oilseeds	**3.57**	**6.42**	**5.90**	**11.74**	**11.60**	**9.47**
Groundnut	0.39	1.41	1.45	3.63	3.88	4.56
Cash crops	**1.39**	**1.89**	**2.14**	**1.59**	**1.33**	**1.60**
Cotton	0.13	0.05	0.06	0.06	0.07	0.38
Jute	0.66	0.49	0.65	0.38	0.31	0.52
Other Crops	**22.45**	**7.30**	**7.76**	**12.26**	**12.71**	**10.45**

Source: Same as Table 5.

Regression analysis was conducted to identify the factors influencing the income originated from agriculture in the first phase (Table 7). The independent variables were identified based on the phase-wise analysis and checking for the problem of multicollinearity. The area under food grains and net irrigated area were highly correlated (the coefficient being 0.85). In order to avoid multicollinearity the model considered variables like GCA, area under lift irrigation and area under rice. GCA and lift irrigation came out as positive but insignificant explanatory factors, whereas the area under rice emerged as positive and significant. The estimated equation showed that with 10 per cent increase in area under rice the income would increase by 17.9 per cent.

Table 7: Factors Influencing Agricultural Income of Orissa: Regression Results

ORISSA	Phase-I	Phase-II	Phase-III
C	-6. 74 (-1.58) [0.14]	-11.56 (-1.36) [0.20]	-27.35 (-1.94) [0.09]
GCA	0.01 (0.03) [(0.97]	**1.32**** (2.46) [0.02]	
Lift irrigation	0.00 (-0.09) [0.93]		**0.72**** (2.21) [0.05]
Area under HYVs seeds		-0.18 (0.87) [0.40]	-0.56 (-1.31) [0.23]
Area under Rice	**1.79*** (2.99) [0.01]	0.99 (1.01) [(0.33]	**4.33**** (2.59) [0.02]
R^2	0.65	0.65	0.66
DW	2.15	1.79	2.19

Notes: (i) Parenthesis ( ) contain values of t-statistics and [ ], probability values.
(ii) * Significant at 1%; ** Significant at 5%; *** Significant at 10%.
(iii) Regression exercises were carried out with all possible combinations of factors. The Table presents the results of the model of best- fit.

It may be noted that there was an increase in public investment in major irrigation sources in Orissa during the first phase. With an increase in the area under irrigation, there was increase in the area under pulses and inferior cereals and a marginal decline in land under paddy. Even though the share of area under paddy had declined, it was still significantly higher compared to other cereals, thus revealing a positive and significant impact of paddy cultivation on agricultural income. Rainfall as an exogenous factor also affected the income from agriculture in the first phase. A model was run by considering rainfall as independent variable but unlike Andhra Pradesh the coefficient of income with respect to rainfall came out to be significant.

Phase-II (1977-78 to 1991-92)

The second phase mainly coincides with the green revolution period in Orissa[9] with significant increase in the application of modern inputs. The area under HYV seeds and consumption of fertilizers increased significantly in this phase (Table 5). The consumption of fertilizers per hectare of land increased by 9.63 per cent from 8.59 kg in 1976-77 to 19.96 kg in 1991-92. Area under HYV seeds as a percentage to total cultivable area in the state rose from 8.99 per cent in 1976-77 to 27.61 per cent (growth rate of 9.13 per cent). Modern inputs depend on proper irrigation facility for better results and the expansion of area under HYV seeds was possible either by an increase in the area under cultivation or by conversion of dry lands into wet lands. This was illustrated by the significant increase in the land under cultivation during this phase. There was positive and significant increase in both gross cropped area (1.55 per cent) and net sown area (0.41 per cent). The share of land under GCA was 46.39 per cent in 1976-77, which increased to 63.20 per cent in 1991-92. Net sown area as a percentage of total geographical area registered insignificant increase during the period. The increase in the GCA was more rapid than in the NSA. This implied that there was significant increase in the area under double cropping in the state. The percentage area under double cropping to total geographical area was 8.57 per cent at the beginning of the phase; it increased to 22.42 per cent by the end of the phase.

During this phase, the land use pattern showed an expansion in both the actual area under cultivation as well as cropping intensity. With an increase in the GCA the state witnessed an expansion in the area under food grains and oilseeds, while the land under cash crops declined (Table 6). Among food grains the share of area under pulses and maize to GCA showed significant increase (from 13.42 per cent to 21.82 per cent and from 1.72 per cent to 1.81 per cent respectively), whereas area under paddy as a percentage to GCA declined drastically (from 60 per cent to 46 per cent). The extent of land irrigated also registered a positive and significant increase (from 19.76 per cent to 28.12 per cent). The composition of total irrigated area changed with a decline in the percentage share under major irrigation (from 58.12 per cent to 48.55 per cent) and flow irrigation (from 23.38 per

[9] The spread of Green Revolution was not homogenous for all the states (Subrahmanyam and Sekhar, 2003). In the late 1970s it spread towards eastern Indian states of Bihar, West Bengal, Orissa and Assam.

cent to 19.33 per cent). Correspondingly there was an increase in the share of lift irrigation (from 8.97 per cent to 13.37 per cent).

The regression results of the factors affecting agricultural income in the second phase are presented in Table 7. Area under irrigation was correlated with the consumption of fertilizer (0.85), area under HYV seeds (0.86) and area under food grains (paddy) (0.98). Thus the last three factors formed the explanatory variables for the model. The results revealed that with 10 per cent increase in the GCA the income would increase by 13.2 per cent. It may be noted that area under paddy witnessed positive but insignificant growth. The coefficient of income with respect to area under HYV seeds was negative and insignificant implying that though the use of modern inputs increased between the late 1970s and early 1990s, its effect on agricultural income was not significant.

The above analysis broadly suggests that there was an increase in application of modern inputs in the state. The expansion of the area under cultivation in the second phase was significantly higher compared to the first phase. While the area under food grains declined, there was an increase in the area under oilseeds. Among food grains, the percentage of area under paddy declined, while that under pulses increased. The land under cultivation and area under food grains positively and significantly impacted agricultural income during the second phase. Also the increased use of modern inputs did not impact agricultural income significantly. This suggests that Green Revolution had minimal impact on agriculture in Orissa. There was no substitution of land-based growth process with technology based growth process.

Phase-III (1992-93 to 2005-06)

During the third phase there was a significant decline in the rate of growth of GCA and NSA (Table 5). The area sown more than once also witnessed a significant decline. But the area under irrigation - both major and minor, i.e., flow and lift - witnessed a considerable increase. With significant increase in the area under irrigation the application of modern inputs registered a rise in the third phase. The growth rate of area under HYVs (1.19 per cent) and consumption of fertilizer (4.85 per cent) was positive and significant.

Increase in the irrigation potential and the increased use of modern inputs ideally could have led to the increase in the production of market oriented

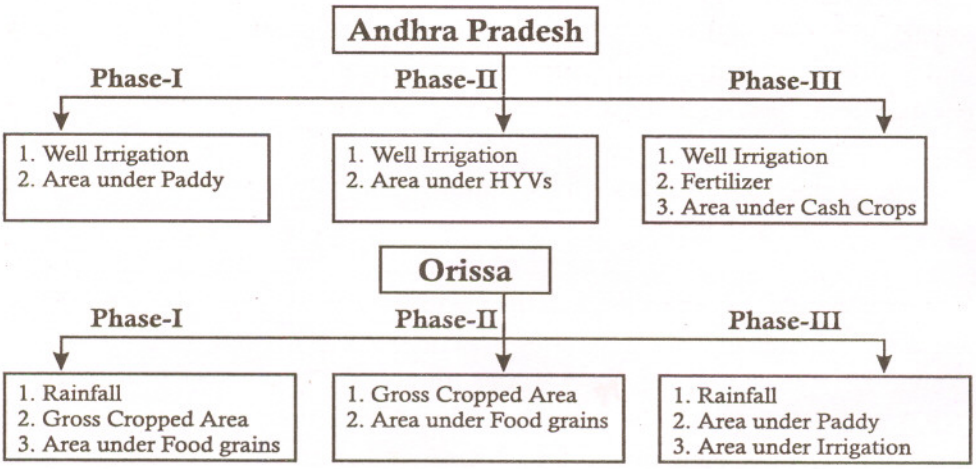
crops rather than traditional crops. However in the case of Orissa the share of food grains to GCA increased from 73 per cent to 78 per cent between 1992-93 and 2005-06 (Table 6). Among food grains, the share of area under jowar, pulses and other cereals had declined significantly, whereas the area under rice registered a significant increase (from 47.19 per cent to 59 per cent) in total area cultivated. Also, total area under cash crops showed a positive and significant growth (2.68 per cent) during this phase, primarily due to the increase in area under cotton (which increased from 0.06 per cent of GCA to 0.38 per cent).

The explanatory variables used in the regression exercise for the third phase are area irrigated by lift irrigation, area under HYVs and area under rice (Table 7). As area under food grains shows multicollinearity with NSA (0.93) and GCA (0.98), we have considered area under rice as it covered more than 75 per cent of the land. Area under irrigation correlated with area under oilseeds (0.94) and with area under food grains (0.91). Hence, we have considered area under lift irrigation as an explanatory variable. The coefficient of income with respect to area irrigated by lift irrigation and area under rice was 0.72 and 4.33 respectively. Both are significant at 5 per cent level. The results show with 10 per cent increase in lift irrigation and area under rice, the income would increase by 7.2 per cent and 43.3 per cent respectively.

The third phase in Orissa witnessed decline in land under cultivation and specialization in paddy cultivation. Even if there was decline in the area under cultivation its importance in the state's agricultural income remained prominent. Thus the decline in the rate of growth of income from agriculture in the third phase might be due to the decline in the land under cultivation. There was an increase in the use of modern inputs but it hardly affected the income from agriculture. The factor that showed highly significant impact on income was the amount of rainfall. The utilization of modern inputs did not help the agricultural sector much in the state and the income from agriculture was highly influenced by rainfall.

The factors affecting agricultural incomes of Andhra Pradesh and Orissa across the three phases are presented in Chart 1. It depicts that there was a change in the input requirement for agricultural growth in Andhra Pradesh over time, while in Orissa the land related factors played an important role in explaining the growth pattern of the aggregate income.

Chart 1: Factors Affecting Agricultural NSDP in Andhra Pradesh and Orissa: Comparison



7. Conclusion

The two states that we examined in this paper represent different growth trajectories. The performance of the agricultural sector in Orissa reveals a secular decline over phases, while Andhra Pradesh shows acceleration over phases with a marginal increase in growth rate in the third phase as compared to the second. The performance of Orissa's economy across phases continues to be constrained by land related factors. Andhra Pradesh has moved out of such constraints with the help of modern inputs and market interaction influencing the performance of the agrarian economy.

The analysis further raises some questions: what are the factors responsible for relaxing the land constraints in Andhra Pradesh and not in Orissa? Has the economy of Andhra Pradesh witnessed a transformation which was incomplete in the case of Orissa? Is the evolving structure of agrarian sector in Andhra Pradesh more conducive for the introduction of modern technology when compared to Orissa or are the differences in the state policies responsible for differences in performance? Does history matter in the sense that a higher proportion of land is under *Ryotwari* system in Andhra Pradesh when compared to Orissa and land reform is more successful in Andhra Pradesh providing more incentives to agents to innovate? Are the structures of the two economies different (for instance, Orissa has a larger proportion of tribal population, higher proportion of marginal and non-workers and linkages with industry are weak)? These aspects need to be studied in detail.

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The major areas of research at the Institute are the following:

1. **Natural Resources Management, Agriculture and Climate Change**
   Research under this area concerns the broad realm of environment and development. Studies have focused on economic viability, equity, environmental impact assessment and institutional mechanisms. Issues in common property land resources, land use and water harvesting have been researched extensively. Implications of climate change risks for Asia and the adaptation and mitigation strategies at the local levels have begun to be studied.

2. **Industry, Infrastructure, Trade and Public Finance**
   The main themes include policy dimensions concerning the micro, small and medium enterprises, industrial clusters and intellectual property rights. Studies on basic infrastructure and linkages between infrastructure and regional growth have also been carried out. Trade and development and public finance are new areas of interest.

3. **Employment, Migration and Urbanisation**
   Studies under this theme relate to employment, labour, diversification of economic activities and migration. International migration has emerged as an additional theme along with urban services and aspects of urban economy and governance.

4. **Poverty and Human Development**
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5. **Regional Development, Institutions and Governance**
   Recent studies enquire into regional underdevelopment and the dynamics of local level institutions. Tribal area development mainly relating to livelihood promotion and human resource development has been a focus area. Recent analyses have also looked into Panchayati Raj Institutions, Forest Rights Act, MGNREGA and Right to Education Act.

Much of the research informs national and regional policies. The Institute also undertakes collaborative research and has a network with governments, academic institutions, international organisations and NGOs. A foray into specialized training and doctoral programme has just been made.

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