A STUDY ON IMPACT OF MODERN TECHNOLOGY ON GROUNDNUT PRODUCTION OF ORISSA

A THESIS SUBMITTED TO
THE ORISSA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY, BHUBANESWAR
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

MASTER OF SCIENCE IN AGRICULTURE
(AGRICULTURAL STATISTICS)

By

Kirti Chandra Behera

Department of Agricultural Statistics
COLLEGE OF AGRICULTURE
Orissa University of Agriculture and Technology
BHUBANESWAR
2000

THESIS ADVISOR

Dr. (Mrs.) SURUCHI JENA

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THESIS ADVISOR
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In the memory of

my

Late GRAND PARENTS

Dr. (Mrs.) S. Jena
Associate Professor,
Department of Agricultural Statistics,
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Bhubaneswar.

CERTIFICATE

This is to certify that the research work recorded in this thesis entitled **"A STUDY ON IMPACT OF MODERN TECHNOLOGY ON GROUNDNUT PRODUCTION OF ORISSA"** submitted in the partial fulfilment of the requirements for the award of the degree of **MASTER OF SCIENCE IN AGRICULTURE (AGRICULTURAL STATISTICS)** to the Orissa University of Agriculture and Technology, Bhubaneswar is an authentic record of *bona fide* research work carried out by **KIRTI CHANDRA BEHERA** under my guidance and supervision.

The results of investigation reported in this thesis have not so far been submitted for any other degree or diploma or published in any other form. It is further certified that such assistance and help availed during the course of investigation have been duly acknowledged by him.

Bhubaneswar
Dated, the 7 th Dec., 2000

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CHAIRMAN
Advisory Committee

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

Name of the student : **Kirti Chandra Behera**

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ABSTRACT

A STUDY ON IMPACT OF MODERN TECHNOLOGY ON GROUNDNUT PRODUCTION OF ORISSA

An attempt has been made to study the impact of modern technology on groundnut production of Orissa during pre-technology (1968-69 to 1977-78) and post-technology (1978-79 to 1997-98) period in the present study. The study is mainly based on (i) estimation of compound growth rates of area, yield and production (ii) acceleration/deceleration in rate of growths (iii) impact of modern technology on groundnut production and (iv) contribution of area, yield and their interaction effect on change in average production and suitable methods have been applied.

The results of the study revealed that the increase in production of groundnut during post-technology period was due to increase only in area under the crop rather than increase in yield. Significant growth rate of area under the crop was responsible for the high growth rate in production. But yield rate remained more or less stagnant during the post-technology period. Though there was increasing trend in area and production of the crop in post-technology period, significant deceleration was observed in both the rate of growth of area and production. The non-significant deceleration in growth rate of yield indicated yield was more or less stagnant during this period.

Chow's test confirmed the significant difference in production process between pre- and post-technology periods. Significant increase in production in post-technology period was only due to significant increase in area and no technological change on production was observed during this period. All most same type of results were recorded for kharif as well as rabi groundnut production.

The decomposition analysis also confirmed that area contributed more than eighty five per cent to the change in average production in post-technology period. So the modern technology implemented in the state for groundnut crop may be simply termed as area-augmenting technology in stead of yield-augmenting technology. Seed-fertilizer technology may be formulated by the state agencies on the basis of soil structure, irrigation and climatic variations at regional levels in order to enhance the yield rate of groundnut.

INTRODUC1

Chapter - I

INTRODUCTION

INTRODUCTION

1.1 OILSEEDS SCENARIO IN INDIA

Oilseeds form the second largest agricultural commodity after cereals in India, sharing 19 per cent of the country's gross cropped area and accounting for nearly 9 per cent of the gross national product and 10 per cent of the value of all agricultural products. India occupies a distinct position not only in terms of area under oilseeds but also in terms of diversity in cultivated oilseeds. It is blessed with the agro-ecological conditions favourable for growing nine major oilseeds including seven edible oilseeds- groundnut, rapeseed-mustard, soybean, sunflower, safflower, sesamum and niger and two non-edible sources namely castor and linseed.

The oilseeds scenario in India has undergone a significant change in recent years, thanks to the various incentives and institutional support given by the government for the development of this sector, following the contribution of the Technology Mission on Oilseeds (TMO) which created conditions that could harness the best production, processing and storage technologies. The oilseed production increased from a mere 10.83 million tonnes from 19.02 million hectares during 1985-86 to 25.68 million tonnes from 27.45 million hectares during 1998-99. India has assured the place of importance as the leading producer of oilseeds and place of pride for occupying first place in the production of groundnut, rapeseed-mustard and sesamum, second position in respect of castor seeds, third in coconut, fourth in cottonseed and fifth in linseed.

1.2 TECHNOLOGY

Technology is a stock concept indicating the body of knowledge that can be applied in productive processes. Technical change implied changes in the stock.

Technical changes are reflected in change in production functions. This is purely a technical concepts that must be modified to account for economic viability.

1.2.1 Concept of Technological Change in Crop Production

Technological change is one of the most crucial factors determining the pattern and pace of agricultural growth. It includes all the available means which improves the efficiency of converting scarce resources into products which satisfy human wants. It manifests itself in the use of new inputs and knowledge leading to an upward shift of the production function in the long run. Technological advance has two general properties.(1) It refers to the shift with a given input of resources or the same output is produced with a smaller amount of inputs.(2) A technological change affecting individual input is referred to as input resources or input-augmenting. New agricultural technology has facilitated saving of important resources taken individually (land, labour, capital). For instance, introduction of bio-chemical technology (comprising HYV seeds and chemical fertilizers) represents land saving or land-augmenting innovation and the introduction of machines such as tractors, threshers and harvesters represents technological changes of labour-saving type.

1.2.2 Components of Technological Change

Spectacular changes in food grain production and productivity were recorded in the wake of the technological breakthrough in Indian Agriculture since the mid-sixties. The bulk of the increase in total agricultural production resulted from increased productivity per hectare. The improvement in agricultural productivity can be traced to developments in a number of directions. The most significant was the use of HYV seeds of different crops particularly paddy, wheat, groundnut etc. Along with the use HYV seeds increased use of irrigation water, fertilizers, manures, insecticides, fungicides and weedicides have also been responsible for raising productivity. Improved tools, implements and also some forms of heavy machinery and equipment have been brought into use for improving agricultural production through higher yields as well as by bringing cultivable waste lands under the plough. The improvements have taken place in the methods of soil, and water management and in agricultural practices like seed treatment, inter cultivation, weeding, line sowing etc.

1.3 IMPACT OF TECHNOLOGICAL CHANGE

The increasing use of modern inputs signalled the beginning of a structural change in Indian Agriculture, which in turn increased the independence of farm and non-farm sectors. Spectacular increases in production and productivity were attained in the wake of the break through in production technology.

The growth of oilseeds production in the last 13 years is due to a combination of several factors. Nearly 52 percent of the increase was contributed by area expansion and 48 percent by productivity improvement. The area increase came where the oilseed crops were superior option to traditional crops. Farmers always searched for technological options and practices which brought them higher returns and readily responded to various economic incentives. The expansion in area has occurred in oilseed crops which have either shown a higher growth rate of productivity due to technological development or whose relative prices with competing crops have moved in their favour or higher growth rates in yields were combined with higher prices resulting in sharp increases in total profitability.

The area under irrigation in oilseeds increased from 17 per cent during 1985-86 to 26 percent in 1997-98. Production of certified /quality seeds of oilseed crops increased from 4.83 lakh quintals in 1995-96 to 12.53 lakh quintals in 1996-97. During the past two decades, over 240 improved varieties/hybrids have been developed in annual oilseeds, which have shown 9 to 38 percent yield superiority over the local cultivars. There was better transfer of technology through front-line demonstrations as it was done under real farm situations, the productivity potentials and profitability of improved oilseeds crop production technologies. These demonstrations overwhelmingly convinced the farmers of the efficacy of improved technologies, thereby promoting their adoption. In addition, extensive training of extension functionaries helped in quick and effective dissemination of technologies to farmers.

Coming to Orissa, oilseeds occupy 11 per cent of state's gross sown area and account for more than 5 per cent of country's oilseed area. The production of oilseeds by the end of 4th plan (1973-74) was 2.86 lakh tonnes which increased to 3.28 lakh tonnes by the end of 5th plan period (1978-79) and to 6.82 lakh tonnes by the end of the 6th plan period (1984-85) from an area of 9.19 lakh hectares and consequently increased to 11.47 lakh hectares in 1995-96 with an increase of 55%. But productivity increased from 654 kgs per hectare to 767 kgs per hectare, an increase of only 16%. Out of the four major oilseeds namely groundnut, mustard, sesamum and niger, the productivity of groundnut only is comparable with the all-India average of 1014 kgs per hectare. In Orissa, oilseeds are predominantly grown under rainfed and residual moisture conditions and that too in marginal and sub- marginal lands having poor soils, also majority of the farmers who grow oilseed crops do not pay enough managerial attention to the crop.

Among the edible oilseeds, groundnut is the most important due to its high percentage of oil content as 100 kg pods contain about 27.36 litters oil. It is also treated as poorman's milk as one hundred grams of groundnut seeds give 570 calories of energy where as one cup of pure milk generally gives 70 calories. As pure milk is much more expensive and not readily available to the common people, groundnut will meet both the ends. Moreover, extract of groundnut oil i.e. oilcake, by-product of crop i.e. plants and husk are used as excellent and palatable cattle feed and as fuel by the poor villagers respectively. Like principal crop paddy, groundnut has also various returns to the cultivators and it is treated as a cash crop.

Groundnut contributes more than 36 per cent to the oilseed output India. Orissa accounted for 1.1 per cent of the total all-India acreage of groundnut and contributed 0.8 percent to national production and it occupies the 7th position with respect to per hectare yield among different states in India.

Improved varieties (AK 12-24 and JL-24) of groundnut were introduced in the state during mid-seventies. The crop is grown in the state under varying agro-climatic conditions, soil, rainfall and level of development varied significantly across different agro-climatic zones. It is traditionally grown in kharif season in the state and rabi groundnut cultivation was totally unknown till 1962-63. Consequent upon the Chinese aggression in 1962, intensive cropping was started in the state and rabi groundnut cultivation was attempted first in the coastal districts. Success of the crop under residual soil moisture during rabi and sustained efforts of the agriculture department resulted in a large scale coverage of the crop on silted and sand cast areas adjacent to river embankments. The state grows more than three lakh hectares of groundnut at present and the crop accounts for 28% of area and 57% of total production of oilseeds in the state. Cuttack, Sambalpur, Dhenkanal, Ganjam & Puri districts have contributed 68% of the total groundnut production during 1997-98.

1.4 IMPORTANCE OF THE STUDY

Against this background, the present study intends to analyse the performance of groundnut production in Orissa during pre-and post-technology periods and to examine whether the trend in area, yield and production of groundnut of the state has accelerated or decelerated after introduction of modern technology. The prime aim is to study the effect of modern technology on groundnut production.

1.5 SPECIFIC OBJECTIVES OF THE STUDY

Considering the importance and need, the present study has been undertaken with the following objectives.

1. To examine the changes in mean of area, yield and production of groundnut of Orissa during pre- and post-technology periods.
2. To examine the reliability of the fitted equations.
3. To estimate compound growth rates of area, yield and production of groundnut during the pre- and post-technology periods.
4. To examine the acceleration and deceleration in the above growth rates during the above two periods.
5. To estimate the effect of technological change on groundnut production.

6. To evaluate the magnitude of instability in the production of groundnut during pre- and post-technology periods.

7. To examine the relative contribution of effects of basic components area, yield and their interaction to the change in average production of groundnut during pre- and post-technology periods.

The above objectives have been tested by using appropiate null hypotheses against their alternative hypotheses.

1.6 LIMITATIONS OF THE STUDY

1. The results are based on secondary data and subject to reliability of the secondary data.
2. Data pertaining to undivided districts (Cuttack, Sambalpur, Dhenkanal, Ganjam and Puri) have been collected for the district wise analysis.
3. It was hypothesised that production of groundnut is influenced by increase in irrigated area, fertilizer use, high yielding varieties, etc. Since all these factors are highly correlated, but due to non-availability of data pertaining to all the above variables, it was considered that, the time trend would be an important independent variable to catch all technological factors in the model.

1.7 PLAN OF WORK

The report of the study has been organised into five clearly defined chapters. The first chapter contains introduction highlighting the importance of oilseed crops in the national economy, the production performance of important oilseed crops, concept of technology and technological change, objectives and limitations. In the second chapter a critical review of literature relevant to the problems and objectives are presented. The third chapter presents methodology which includes the data base, analytical procedure followed and the statistical analysis made in the present study. The fourth chapter deals with the results and discussion with respect to the objectives of the study. Finally the fifth chapter contains the summary of the main findings, conclusion and suggestions on the present study. Literature cited has been given at the end of this chapter.

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Chapter - II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Review of past work done by various researchers at the state and national level helps organising newly designed research programme in proper lines. Selection of appropriate analytical procedure is also strengthened through review of pertinent literature. Moreover, it helps the researchers to formulate objectives and develop hypotheses.

The review of literature deals with work on the broad aspects relating to the problems of growth rates, impact of technology and other allied subjects. The relevant literatures on

2.1 Growth rates of area, production and productivity

2.2 Reliability of fitted equations.

2.3 Technological change in crop production

2.4 Instability in crop production.

2.5 Decomposition of crop production into different components

have been critically examined in the present chapter in order to know the work under taken earlier in the above fields.

2.1 Growth rates of area, production and productivity

Rath (1980) estimated compound growth rates of area, yield and production of important crops of India for different periods. He observed that during the decade ending 1964-65, the growth rate of production of non-food grain crops was higher (3.46 percent) than of food grains (2.7 per cent). During post 1964-65 years the position was reversed. The major cereals , like rice, wheat, millets and maize registered a growth rate of more than 3 per cent during decade ending 1964-65. It was found that in the post 1965 period, with the advent of the new HYVs, only wheat and ragi have been able to improve their past performance. The study indicated that the growth rates of production of other cereals declined during this period due to decrease in area. Pulses as a group showed no increasing trend in production. The growth rates of per hectare yields of most non cereals have been lower during the period 1964-65 to 1977-78.

Alagh and Sharma (1980) examined the growth of crop production in India for three time periods, viz., period I (1960-61 to 1969-70), period II (1969-70 to 1978-79) and period III (1960-61 to 1978-79). They concluded that green revolution started having an appreciable effect on the Indian economy only since 1969-70. The estimated growth rates in period II were higher than period I. Growth was more evenly spread in Period II as compared to period I. The variation of food grains out put around the trend was much higher than the estimated trend growth.

Sawant (1983) while investigating the hypothesis of deceleration in Indian agriculture observed that decelerating trend in the growth of food grains production was set by the beginning of the sixties after an impressive performance of growth during the fifties which was mainly due to expansion in area. Deceleration in the growth of food grains production was arrested with the onset of the green revolution in Indian agriculture but reversal of the process of deceleration could not be sustained without interruption beyond 1970-71. For the period from 1950-51 to 1980-81, statistical evidence did not support the hypothesis of either acceleration or deceleration in growth .The study further revealed that food grains production increased at the rate of 2.24 per cent during the entire post-green revolution period. The major contribution to growth was from wheat followed by jowar and rice. Production of maize remained almost stagnant but that of bajra declined substantially. All the four non-foodgrain crops viz., groundnut, cotton, jute and sugarcane registered significant positive growth in the entire post 1967-68 period.

In his study, Mahendradev (1985) examined the performance of all crops in Indian agriculture in late 1970s as compared to early 1970s and early 1960s. His study included 189 districts and 56 agro-climatic regions. It was concluded that technology and demographic forces were operating against the negative growth regions. Increases in yield through technological factors was offset by population growth in low and very low regions. Technology and demographic forces were operating in favour of very high and high growth regions.

Ninan (1987) studied growth and area responses of edible oilseeds for the period 1954-55 to 1983-84 and sub-periods corresponding to pre- and post-green revolution period of Indian agriculture. It was reported that growth performance of oilseeds varied from state to state which affected the overall national performance. Rabi oilseeds have performed better than kharif oilseeds. Green revolution appeared to have affected the growth performances of oilseeds, with the output of most edible oilseeds having either declined, stagnated or reporting lower growth rates during the post-green revolution period as compared to their performance in pre-green revolution period. He concluded that area has been the main source of growth in out put of most edible oilseeds, yield being of secondary importance.

Singh *et al.* (1989) worked out linear growth rates of area, yield and production of important oilseed crops for major oilseeds producing states of India for pre and post -green revolution periods. Their study showed that linear growth rate of production for total oilseeds remained the same in both the periods. Before green revolution the annual growth rate of area was 3.14 per cent and declined to 1.1 per cent after green revolution period. However, growth rate of productivity of oilseeds improved from -0.80 per cent to 0.98 per cent after the introduction of new crop production technology. The decrease in area was attributed to diversion of land from oilseed crops to wheat and paddy. During post-green revolution period the growth rate of production of groundnut in the entire country decreased and there was slight improvement in production growth rate of rapeseed and mustard.

Moorti *et al* (1991) in their analysis on trends in the production of oilseed in Himachal Pradesh observed a disquieting and gloomy trend. They found that maximum decrease was observed for groundnut where area, production and productivity decreased by 5.03, 13.42 and 7.91 per cent per annum, respectively. There has been significant increase in the area under rapeseed and mustard but this increase is offset by very high negative growth in productivity which resulted in the decrease in production. The area, production and productivity of all oilseeds show negative trends of 1.1, 2.96 and 2.87 per cent per annum, respectively. Among oilseed crops groundnut and linseed were found to have greater fluctuations in comparison to other crops. There was some stability in the area, but production and productivity of oilseeds exhibit glaring fluctuations from year to year.

Saha and Swaminathan (1994) in their study on agricultural growth in West Bengal in the 1980s, estimated the growthrates on agricultural production districtwise and cropwise (and for rice,seasonwise) and compared the growth rates with those for the period up to 1980.From 1965 through 1980, the growth of agricultural production in West Bengal was low, and much lower than in the rest of the country. The situation changed distinctly in the 1980s. Agricultural growth accelerated and West Bengal did better than other eastern states and the rate of growth of foodgrains production was the highest among the ma jor states in the country.

Palanisamy (1995) in his study on Economic analysis of groundnut production in Tamilnadu found that the annual average area under groundnut in Tamilnadu was 10715159 ha with variation of 10.12 per cent. The main yield of groundnut was 11026.11 kg/ha with a variation of 15.95 per cent. In the state yield had grown by 1.2 per cent per annum. Because of negative growth rabi in area under groundnut, the production of groundnut remained stagnant with a little variation.

In all districts except Coimbatore the growth rate of yield was positive but not significant which confirmed the need for intensive cultivation following recommended package of practice. The yield effect on the production of groundnut was just enough to compensate the reduction of area under groundnut.

Mishra and Sahu (1995) in their study found that their has been a significant increase in the production and area of edible oilseeds in Madhya Pradesh, The increase in production has come on account of both the factors, viz., increase in productivity and increase in area under cultivation. The increase in area may be due to substitutes from other crops and due to increase in overall area under cultivation. Madhya Pradesh witnessing a soya revolution but this revolution is ahead by increase in productivity which should have been the case. Therefore, they concluded that the main constraint for increasing oilseed production in Madhya Pradesh is technology.

2.2 Reliability of fitted equations

Reliability is a phenomenon of high degree accuracy and measures the level of acceptance. In agriculture reliability of growth curves used for estimation of growth rate of certain character under study is more important than just fitting mathematical equations arbitrarily to the time series data. Drought situation during the year 1965-66 of India demanded confidant and trustworthy estimation for policy decision (Reddy, 1978). Thus there is a need of an in-depth study on the reliability of different growth curves or equations which are used for estimation of growth rates.

Reliability of equations fitted to the data for estimating the growth rates has been studied by Krishnaji (1980) through R^2 (square of correlation coefficient) and $\bar{R}^2$ (Adjusted R^2). R^2 explains the proportion of total variability in dependent variable that is explained by independent variables. If R is near to one, then fitting of equation to the data is more reliable (Chatterjee and Price, 1977)

On the other hand , if R^2 are same for two fitted equations, it is difficult to choose which one is more reliable (Dandekar, 1980). In this case $\bar{R}^2$ may be different and can be used to choose the most reliable one.

2.3 Technological change in agricultural production

2.3.1 Technological change in terms of change of inputs, change in growth rates and charge in productions.

Dixit and Singh (1974) measured the technological change through change in production (in physical/ price term) and cropping pattern, while Singh (1981) measured the technological change by considering (i) The differences of growth rates of output for pre-and post-technology periods and (ii) increase in utilisation of major inputs like HYV seeds, fertilisers, pesticides, irrigation, credit and other infrastructures.

Growth rates of food grain production were higher (in post-green revolution period) and growth was more evenly spread in post-green revolution period (Alagh and Sharma, 1980; Singh, 1981). It was due to both expansion of area and yield rate.

In Orissa, the annual growth of the technofactors like area under HYV, consumption of fertilisers during triennium ending post-technology period (1970-73 to 1980-83) were 39.03 per cent and 6.38 per cent respectively. During the same period the percentage of gross irrigated area to gross cropped area was raised to 22.21 per cent from 17.20 per cent, while shift in percentage of area under HYV to gross cropped area was from 4.52 per cent to 17.67 per cent, cropping pattern was raised from 121 to 130 per cent (Singh et al.,1989)

Orissa achieved relatively lower growth in crop out-put because of less acceptance of new technology covering HYV seeds, chemical fertilisers, irrigation, plant protection measures, farm mechinaries, and implements (Singh and Chand, 1989). So they recommended for special agricultural extension and research efforts to popularise adoption of new crop production technology.

Jena and Mitra (1990) found that the CGRS of area and production of groundnut for post-technology period were 9.89 per cent and 10.01 per cent respectively. Both istimates were higher than those of pre-technology period (6.22 % and 9.15 %) However for both the techno-periods, the growth estimates of area and production were highly significant. But in case of productivity, it was 2.66 per cent with high significance level during pre-technology period against 0.21 per cent (not significant) during post-technology period. The difference in production between the techno-periods was also significant as indicated by Chow's F-test.

Thus new technology approach in Orissa has failed to boost up the productivity level of groundnut even though the crop itself has importance due to its production at national level.

Tripathy and Ballabh (1991) have examined the supply response of oilseed crops in India with particular reference to groundnut. They found that the coefficient on the index of relative price (X_1) was positive and significant. However, an interesting feature was that the lagged groundnut area (X_2) was neither significant nor did it give constantly positive relationship. From the area growth rates it was found that the growth rate of the area was highest in district Amreli. In South Arcot district, on the other hand, there was a negative coefficient though insignificant on the lagged area. Looking into the growth of area it was found that though the overall growth rate was positive yet during period II the area was decreasing at a compound growth rate of 3.38 per cent per year. Hence the negative sign on the (X_2) variable indicated that there was no technological improvement in the production of groundnut in this district.

Kuchhadiya *et al.* (1992) found that the average mean values of area, production and productivity of oilseed crops under study were higher during the post-green revolution period except the mean value of area under sesame crop. The increase in mean values of productivity during the second period was the highest in case of castor (210.53 per cent) among all the oilseed crops. Except the area under groundnut and sesame, the variability in area, production and productivity of all the four oilseeds increased during the post-green revolution period. The compound growth rates of productivity of castor and rapeseed-mustard increased during the second period as compared to the first period. The impact of technological change could be observed only in case of castor during the period under study. They have concluded that there is a need to evolve stable new high yielding pest and disease resistant and quick maturing varieties of groundnut, sesame and rapeseed and mustard which can reduce imports to a greater extent.

Tripathy and Gowda (1993) have used *Nerlovian lagged* adjustment model to examine the area response of groundnut in Orissa. The results of multiple linear regression revealed that the lagged area, lagged price, price risk and irrigation had positive and significant impact on the area under groundnut. The effect of rainfall turned out to be negative but statistically not significant, implying that excess rainfall during sowing time inhibited area expansion of groundnut. Among different regression coefficients irrigation had larger value. It indicated that irrigation favourably influenced the area under groundnut in the state during the post-green revolution period.

2.3.2 Technological change by fitting production function

Technological change has been measured by fitting a linear function of $\log Y = a + b_1 t + b_2 t D$ (Alagh and Sharma, 1980) where D is dummy variable for technological change having values zero and one for pre-and post-technology periods, respectivity. Y is production and t in year a, b_1 and b_2 are constant terms to be measured.

Technological change on groundnut production of Orissa had been examined by Jena and Mitra (1990) by fitting production function $Y = \alpha \cdot X^{\beta} \cdot e^{\lambda t} \cdot \mu t$ separately for the period before and after new technology, where Y is the total production, X is total crop area in a year and t is the time period for analysis. Also a modified form of the equation i.e. $Y = \alpha \cdot X^{\beta} \cdot e^{\lambda t} \cdot e^{\delta D} \cdot \mu t$ (by introducing an indicator variable D which takes values 0 and 1 representing respectively the period before and after new technology started) had been fitted to the production data, the technological change had been measured and the technological change was tested by Chow's test. They found that technological change has no significant effect on production of groundnut in Orissa. There was significant effect of area on production for the pre- and post-techno periods and also the entire period under study.

By using the above model, Kuchhadiya *et al.*(1992), for groundnut production in Gujurat, found that the contribution of land to the production of groundnut was highly significant for all the periods. Negative and non-significant time trend indicated that there was no technological effect on productivity of groundnut crop.

2.4 Instability in area, production and productivity

New technology despite its favourable impact on production, has brought in its considerable instability in output besides natural factors. Sen (1971) pointed out that instability is an unavoidable accompaniment of growth, where as relative stability is a phase of stagnancy. Instability could be reduced by stabilisation of inputs (Hazell, 1982). Increased instability in cereals production was due to need of more costly inputs and more succeptibility to pests and moisture stresses (Reddy and Hirenath, 1984)

Statistics like standard deviation (S.D.), variance and coefficient of variation are generally used to measure instability. S.D. measures the variation in observation, while coefficient of variation measures the variation in a series.

Das (1978) examined the nature and extent of instability in both food grains production and total agricultural production in eastern India, during 1950-51 to period before and after new technology started) had been fitted to the production data, the technological change had been measured and the technological change was tested by Chow's test. They found that technological change has no significant effect on production of groundnut in Orissa. There was significant effect of area on production for the pre- and post-techno periods and also the entire period under study.

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Das (1978) examined the nature and extent of instability in both food grains production and total agricultural production in eastern India, during 1950-51 to

1973-74. He applied Chow's test to test the stability of the coefficients of the regression equations for peak points and trough points. He observed that in Assam, Bihar and Orissa, there was increasing instability and in West Bengal, there was declining instability in the production of food grains.

Mehra (1981) observed that during the decade 1967-68 to 1977-78 the standard deviation and coefficient of variation of production of all the crop aggregate increased as compared with the period 1949-50 to 1964-65. A break down of production variability into area and yield variability showed that fluctuation in yield has been the dominant force. It was found that for crop aggregates the standard deviation of yield increased for crops as a whole and for food grains but not for non-food grains. Among the food grains bajra, maize and jowar crops , where need technology had played a part , showed large increase in absolute and relative yield variability. But wheat and rice crops, where new technology has been wide spread, showed only a small increase in absolute yield variability. The findings of her study highlighted the need for strengthening the elements of need technology that help to reduce variability of yield.

Pal and Sirohi (1989) conducted a study to analyse the sources of change in instability in crop production in Indian states for two time periods (1950-51 to 1964-65 and 1967-68 to 1983-84). The findings of this study showed that after adoption of HYVs there was no major change in the probability of shortfall in production. The instability in production increased in comparatively less irrigated crops.

Kaushik (1990) examined growth and instability of oilseeds production in India from 1968-69 to 1991-92 and two subperiods viz., Period - I (1968-69 to

1979-80) and Period - II (1980-81 to 1991-92). She observed that in Period -I, the output of rapeseed-mustard, groundnut and pulses had registered the highest degree of instability and that of rice and food grains the lowest. The magnitude of instability in the output of all crops except rice, groundnut and total oilseeds declined during the second period relative to the first and the fluctuations in yield of crops turned out to be the dominant force behind this instability. During the second period, the synchronised movements in area and yield were responsible for increased instability in groundnut, rapeseed mustard and total oilseeds production. During the period 1968-69 to 1991-92, the magnitude of fluctuations was the highest in the case of rapeseed mustard followed by groundnut and the lowest for wheat and yield fluctuations contributed most in the output fluctuations for all crops.

Tripathy and Gowda (1993) have made an attempt to study the growth instability and area response of groundnut in Orissa during the post-green revolution period (1970-71 to 1989-90). The study period was further divided into sub-periods, i.e. period -I (1970-71 to 1979-80) and Period -II (1980-81 to 1989-90). they reported that variability of groundnut production had increased in Bolangir, Dhenkanal, Ganjam, Kalahandi, and Keonjhar and Mayurbhanj districts in both the periods. In the second period yield was found to be more stable in the coastal districts. There has been appreciable increase in the possibility of shortfall in the production of groundnut in the state during the second period. The intensity of shortfall had increased in eight districts. The possibility of shortfall in production was high in three major groundnut producing districts namely, Sambalpur, Balasore and Cuttack in the second period.

Palanisamy (1995) examined the growth and the extent of instability in groundnut production in Tamil Nadu by using coefficient of variation (C.V.) and Coppock Instability Index (C.I.I.). The study revealed that the increase in production levels of groundnut was achieved much through the contribution of yield of groundnut with considerable stability rather area contribution.

2.5 Decomposition of agricultural production into different components

Now a days study on impact of area, yield and there interaction on change in average crop output due to adoption of modern technology has much importance. The decomposition analysis estimates each component more accurately than usual production function.

Minhas and Vaidyanathan (1965) used the decomposition model to examine the sources of changes in crop production in India from 1951-54 to 1958-61. Their study indicated that out of the total increase in output, approximately 45 per cent was attributed to area growths, 46 per cent to increase in yield, 8 per cent to changes in cropping pattern and only one per cent to interaction term between yield and cropping pattern. Further, they studied the regional pattern of sources of growth in production and it was found that in Punjab, Rajsthan, Assam, and West Bengal, the contribution of area was substantially higher (above national average). whereas in Madras, Kerala, Madhya Pradesh, Bihar and Orissa, the contribution of yield was higher than the national average. In Punjab, Madras, Gujurat, Maharastra, Andhra Pradesh, and West Bengal, the contribution of cropping pattern changes was highest.

An attempt was made by Misra (1971) to measure the contribution of different components of growth to output for two different phases covering the period 1949-52 to 1956-59 and 1959-62 to 1966-69 in different districts of Gujurat. The study showed that in majority of the districts in both the time periods yield contributed more raising from 49 to 90 per cent in the post-technology period whereas contribution of area decreased from 38.55 to -1.71 per cent in the second period. In majority of the districts, the contribuion of cropping patttern was not comparatively higher but there was little change in the cropping pattern.

Estimation of different sources of the increased instability in the context of new technology in production of food grain in India was studied by Hazell (1982). He measured contribution of components to change in average production of food grains and the contribution of components to change in the variance of productions between two techno-periods (1954-55 to 1964-65 and 1967-68 to 1977-78).

Mitra and Jena (1991) used the Minhas' Additive Decomposition model to find out the two basic components and their interaction on groundnut production of Orissa for periods (triennium ending 1950-53 to 1962-65, 1967-70 to 1983-86 and 1967 -70 to 1983-86). The effect of area component was found to be highest (80.55 per cent) during period II but it was reduced to 51.34 per cent for the entire period under study . The effect of yield component was observed to have highest contribution (24.79 per cent) in period I and then reduced drastically to 4.11 per cent in period III. This may be attributed to climatic variation, lack of timely supervision and proper care after the sowing operation.

Cauvery (1991) conducted a study on groundnut production in Tamil Nadu and showed that growth behaviour of the three components namely area, yield and cropping pattern when considered independently, major contribution to increased groundnut production came through yield effect. The encouraging factor was again the positive changes in crop pattern towards increased production of this crop. In the state as a whole the contribution of yield is positive (112.40) while in the four districts it is significantly positive (220.47). One is therefore, led to believe that the yield factor has inevitably overlooked the other variables while the contribution of area in total groundnut. Output is negative the contribution of cropping pattern has a positive effect justifying the fact that the impact of cropping pattern on total groundnut output is more as compared to acreage. However, the change in the magnitude of cropping pattern was marked by the more pronounced effect of yield of the crop. In the case of 4 districts the contribution of area is strikingly negative (-110.11) and it is also a discouraging factor (-27.26) as far as the state is concerned.

Mundinamani *et al.* (1995) in their study on growth performance of oilseeds in Karnakaka found that, the production of groundnut during pre-green revolution period was affected by the negative growth in area and yield in the entire study area except Dharwad district where are effect was stronger than yield and interaction effects. During post-green revolution period yield effect was found to be positive in Bijapur and Dharwad districts and negative in Raichur district. The contributions of area and yield were about equal at the state level. During over all period the drastic reduction in groundnut area and yield in Bijapur district, change in output was mainly contributed by area. In Raichur district the area and yield have almost equal contribution to total changes in groundnut output. At the state level, the effect of area was found to be higher than that of yield.

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Chapter - III

MATERIALS AND METHODS

MATERIALS AND METHODS

3.1 DATA BASE

The present study is mainly based on secondary data pertaining to production and productivity of groundnut of Orissa. Time series data on area, yield and production of groundnut and other agricultural statistics were obtained from "Agricultural Statistics of Orissa - At a Glance, 1997-98" and various issues of "Orissa Agricultural Statistics" published by "Directorate of Agriculture and Food Production , Govt. of Orissa".

As the new technology appeared in the state in the mid seventies, the effects of which can be marked by the increased production by the end of 5th plan period, to study the effect of new technology, the entire study period (1968-69 to 1997-98) has been divided into pre-technology and post-technolgy periods. Again the post-technology has been devided into two sub-periods.

Period I : From 1968-69 to 1977-78 representing *pre- technology* period.

Period II : From 1978-79 to 1987-88 representing *first post- technology period*

Period III : From 1988-89 to 1997-98 representing *second post-technology* period.

3.2 Analytical Tools and Techniques

3.2.1 Growth Model

The following types of growth models have been used.

i) Linear Model

$$Y = a + bt + e_t$$

ii) Quadratic Model

$$Y = a + bt + ct^2 + e_t$$

iii) Exponential Model

$$Y = a . e^{bt} . e^{u}$$

$$\Rightarrow \ln Y = \ln a + bt + u$$ (In natural logrithmic form)

Where y = area /yield/production

t = time variable in years (t = 1, 2, 3.............)

e^u = random residual and $e^u \sim (0, \sigma e^2)$

e_t = error term and $e_t \sim (0, \sigma e^2)$

and a, b are the parameters to be estimated from the data.

3.2.2 Reliability of fitted equations

Reliability of equations fitted to the data has been tested by R^2 (Square of correlation coefficient), Adjusted R^2 (denoted by $\bar{R}^2$), Standard Error (S.E.) and Residual Mean Square (R.M.S.).

Where,

$$R^2 = 1 - \frac{RSS}{TSS} = 1 - \frac{\sum e_i^2}{\sum (\ln Y_i - \ln \bar{Y})^2}$$

$$\bar{R}^2 = 1 - (1 - R^2)\frac{(n-1)}{(n-m)}$$

Where, m = Number of constants

n = Number of observations

TSS = Total sum of squares

RSS = Residuals sum of squares

Student's 't' -test has been used to test the hypothesis i.e.,

Null Hypothesis H_o : $R^2 = 0$

Alternative Hypothesis H_1 : $R^2 \neq 0$

$$|t| = \frac{R}{\sqrt{1 - R^2}}\sqrt{n-2}$$ with (n-2) d.f. and n being the number of observations.

$$R.M.S. = \frac{1}{n}\sum e_i^2 = \frac{1}{n}\sum\left(Y_i - \hat{Y}_i\right)$$

Where Y_i = Observed values

$\hat{Y}_i$ = Expected values

3.3.3 Compound Growth Rates

Out of the three growth models fitted, exponential growth model $\ln Y = a + bt + u$ has been used for estimating Compound Growth Rate (C.G.R.) and is denoted by 'g'.

Compound growth rate (per cent per annum) = $g = (e^b - 1) \times 100$

Where 'b' is the estimated regression coefficient. Significance of 'g' has been tested by 't'-test using the null hypothesis

$$H_0 : g = 0$$

Against, $H_1 : g \neq 0$

$$|t| = \frac{g}{SE(g)} \text{ with } (n-2) \text{d.f.}$$

To test the difference between two estimated growth rates for two periods, t-test has been applied under the assumption of the null hypothesis

$$H_0 : g_1 = g_2$$

again $H_1 : g_1 \neq g_2$

$$|t| = \frac{g_1 - g_2}{\sqrt{V(g_1) + V(g_2)}} \text{ with } (n_1 + n_2 - 4) \text{ d.f.}$$

3.3.4. Acceleration or deceleration in the growth rate

Second degree exponential function i.e $Y = AB^t C^{t^2}$ has been fitted for estimating the rate of acceleration or deceleration in the growth of groundnut production.

$$Y = AB^t C^{t^2}$$

In natural logarithm, $\ln Y = a + bt + ct^2$

Where $a = \ln A$

$b = \ln B$

$c = \ln C$

Where 'c' indicates the rate of acceleration or deceleration. The uniformity of the rate of growth has been tested considering whether 'c' is significantly different from zero under the hypothesis

$$H_0 : c = 0$$

Against, $H_1 : c \neq 0$

Positive or negative value of 'c' indicates the rate of acceleration or deceleration.

3.3.5 Technological change

Technological change has been examined by fitting the following two production function models.

$$Y = \alpha .\ x^{\beta} .\ e^{\lambda t} .\ \mu_t \ \ldots\ldots\ldots\ldots\ldots (1)$$

$$Y = \alpha .\ x^{\beta} .\ e^{\lambda t} .\ e^{\delta D} .\ \mu_t \ \ldots\ldots\ldots\ldots (2)$$

Where Y = Total production in '000 tonnes

x = Total crop area in '000 Ha in a year

t = Time period for analysis (1,2,....................)

D = Indicator/dummy variable which takes values 0 for pre-technology period and 1 for post-technology period.

α, β, λ and δ have their usual meanings while μ_t distributed normally and independently.

Two production functions in natural logarithmic scale similar to (1) were fitted separately for the two periods. The functions fitted in natural logarithmic scale are

$$\ln Y_1 = \ln \alpha_1 + \beta_1 \ln x + \lambda_1 t + e_1 \ \ldots\ldots\ldots\ldots (3)$$

$$\ln Y_2 = \ln \alpha_2 + \beta_2 \ln x + \lambda_2 t + e_2 \ \ldots\ldots\ldots\ldots (4)$$

Where the subscripts 1 and 2 are used to represent the pre- and post-technology periods.

The assumption of a common technology during each period implies that $\ln \alpha_1 = \ln \alpha_2$; $\beta_1 = \beta_2$ and $\lambda_1 = \lambda_2$. Under the assumption that there is no structural change in groundnut production during the period under study, following null hypotheses are to be tested with the help of 't' statistic and Chow's test.

(i) $H_0 : \ln \alpha_1 = \ln \alpha_2$

(ii) $H_0 : \beta_1 = \beta_2$

(iii) $H_0 : \lambda_1 = \lambda_2$

Chow's F- test

$$F = \frac{[RSS - (RSS_1 + RSS_2)]/k}{(RSS_1 + RSS_2)/(n_1 + n_2 \quad -2k)} \quad \text{at } (k,\ n_1 + n_2 - 2k\ )\ \text{d.f.}$$

Where RSS - Residual sum of squares for entire study period.

RSS_1 - Residual sum of squares for pre-technology period.

RSS_2 - Residual sum of squares for post-technology period.

k- number of parameter to be estimated.

n_1 &n_2 - number of observation for the pre-and post-technology periods.

The test statistic 't' has been derived as the ratio of absolute difference of the estimates of parameters under the hypotheses to the standard error of the difference of the estimates. The significant difference between the coefficients of the two periods (pre- and post-technology) may be attributed as the change in production process after the implementation of modern technology. Model (2) has been fitted to study the change in production due to change in time.

3.3.6. Instability

To measure the instability in area and yield (being principal components of production) Coefficient of Variation (C.V.) and Coppock Instability Index (C.I.I.) have been used.

i) Coefficient of Variation (C.V.)

$$C.V. = \frac{S.D.}{Mean} \times 100$$

ii) Coppock Instability Index (C.I.I.)

The algebraic form is

$$\ln v = \frac{\sum\left(\ln \frac{Y_t + 1}{Y_t} - m\right)^2}{N - 1}$$

these Coppock Instability Index = C.I.I. = $\left[(\text{Anti} \ln \sqrt{\ln v}) - 1\right] \times 100$

Where Y_t = Area or yield of groundnut crop in t^{th} year

N = Number of years

M = Arithmatic means of the difference between the ln v of Y_t and Y_{t+1}; Y_{t+1} and Y_{t+2} etc.

3. 3.7 Decomposition Analysis

For examining the relative contribution of area, yield and their interaction on change in average production, Minahs' Additive Decomposition model has been adopted.

Let Po and Pn be the base and final year of production considering three yearly average and expressed as

$P_0 = A_0 \times Y_0$

and $Pn = An \times Yn$

Where (A_0, An) and (Y_0, Yn) represent the area and yield for the base year and the final year respectively.

Again $\Delta Y = Yn - Y_0$;

$\Delta A = An - A_0$

and $\Delta P = Pn - P_0$

Where $\Delta P = A_0 \cdot \Delta Y + Y_0 \cdot \Delta A + \Delta A \cdot \Delta Y$

= yield effect + Area effect + Interaction effect.

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Chapter - IV

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

The results of the study are presented and discussed in this chapter under the following broad headings, keeping in view the objectives of the study.

4.1 Change in groundnut production

4.2 Reliability of fitted equations

4.3 Estimation of compound growth rates

4.4 Acceleration and deceleration in rate of growth

4.5 Effect of modern technology on groundnut production

4.6 Instability in groundnut production

4.7 Decomposition analysis of average change in groundnut production.

4.1 Change in groundnut production

Change in climatic condition and change in input technology are the major responsible factors for variation in the time series trend of yield as well as production of groundnut crop. In general, change in production means change in area and/or change in yield rate.

Table 4.1 indicates the percentage changes in area, yield and production of groundnut crop during the periods under study.

The above table reveals that there was a high percentage of increase in both area (184.61 per cent) and production (186.85 per cent) in period II over period I, while the change for yield was - 0.55 per cent indicating negligible decrease in yield rate during period II. But subsequently for the period III over period II, the percentage change in area and production reduced to 29.57 per cent and 32.58 per cent respectively where as there was a positive increase of 2.03 per cent in yield.

TABLE 4.1 CHANGES IN MEAN OF AREA, YIELD AND PRODUCTION OF GROUNDNUT IN ORISSA

Area in 000'ha
Yield in kg per ha
Production in 000' mt

Items	Period-I (Pre-technology period)	Period -II (1st technology period)	Period-III (2nd technology period)	Period-II + Period-III (Post- technology period)	% charge of period-II over Period-I	% Change of period-III over period-II	% change of post technology period over pre-technology period
Mean area	91.00	259.00	335.59	297.29	184.61	29.57	226.69
Mean Yield	1280.30	1273.30	1299.20	1286.25	-0.55	2.03	0.46
Mean reduction	116.40	333.90	442.75	388.32	186.85	32.58	190.66

Considering overall post-technology (period II & period III) over pre-technology period (Period I), percentage increase in area was more (226.69 per cent) in comparison to that of increase in production (190.66 per cent), while the percentage increase in yield was negligible (0.46 per cent).

This concludes that increase in production was due to increase only in area under groundnut rather than increase in yield.

4.2 Reliability of fitted equations

Reliability is a phenomenon of high degree accuracy and measures the level of acceptance. In agriculture, reliability of growth curves used for estimation of growth rates of certain characters under study is more important than just fitting mathematical equations arbitrarily to the time series data.

For estimation of growth rates, three types of growth models viz., Linear model, Quadratic model and Exponential model have been fitted to the data. The regression coefficients obtained from the above three growth models along with R^2, $\bar{R}^2$ and S.E. for area, yield and production have been presented in Table 4.2.1, Table 4.2.2 and Table 4.2.3.

Reliability of equations fitted to the data for estimating growth rates has been considered on the basis of value of R^2 (Square of correlation coefficient), $\bar{R}^2$ (Adjusted R^2) along with minumum Standard Error (S.E.) and Residual Mean Square (R.M.S.). As a result, exponential curve has been selected to estimate compound growth rates for the present study.

TABLE 4.2.1 RELIABILITY OF FITTED EQUATIONS TO TIME SERIES DATA ON AREA

AREA	Type of courve fitted	Coefficient 'b'	'c'	R^2	$\overline{R}^2$	S.E.	R.M.S.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Period I	Linear	5.7091** (0.4815)		0.9462**	0.6394**	4.3735	19.1273
	Quadratic	4.0874NS (2.2085)	0.1477NS (0.1957)	0.9502**	0.9360**	4.4960	20.2136
	Exponential	0.0632** (0.0052)		0.9485**	0.9421**	0.04729	0.0022
Period II	Linear	26.5091** (1.6052)		0.9715**	0.9679**	14.5800	212.577
	Quadratic	24.3424** (7.6101)	0.1970NS (0.6742)	0.9718**	0.9638**	15.4925	240.019
	Exponential	0.1078** 0.0081		0.9565**	0.9511**	0.0738	0.0054
Period III	Linear	-13.6000** (1.9444)		0.8595**	0.8419**	17.6607	311.9
	Quadratic	0.2333NS (7.5647)	-1.2576NS (0.6702)	0.9065**	0.8798**	15.4002	237.1671
	Exponential	-0.0418** (0.0061)		0.8555**	0.8375**	0.0551	0.0030
Period (II + III)	Linear	7.3593** (2.4313)		0.3373(NS)	0.3005(NS)	62.6986	3931.11
	Quadratic	47.618** (3.1256)	-1.9171** (0.1446)	0.9416**	0.9347**	19.1559	366.952
	Exponential	0.0307** 0.0091		0.3865(NS)	0.3524(NS)	0.2348	0.0288
Entire period	Linear	11.5667** (1.2134)		0.7644**	0.7560**	57.5249	3309.12
	Quadratic	26.0699** (0.0699)	-0.4678** (0.1321)	0.8391**	0.8272**	48.4082	2343.35
	Exponential	0.0632** (0.0057)		0.8159**	0.8093**	0.2691	0.0724

* Significant at 5% level of significance

** Significant at 1% level of significance.

NS Not significant

Figures in parenthesis indicate S.E. of the coefficients.

Fig. 1 Models fitted to time series data of area

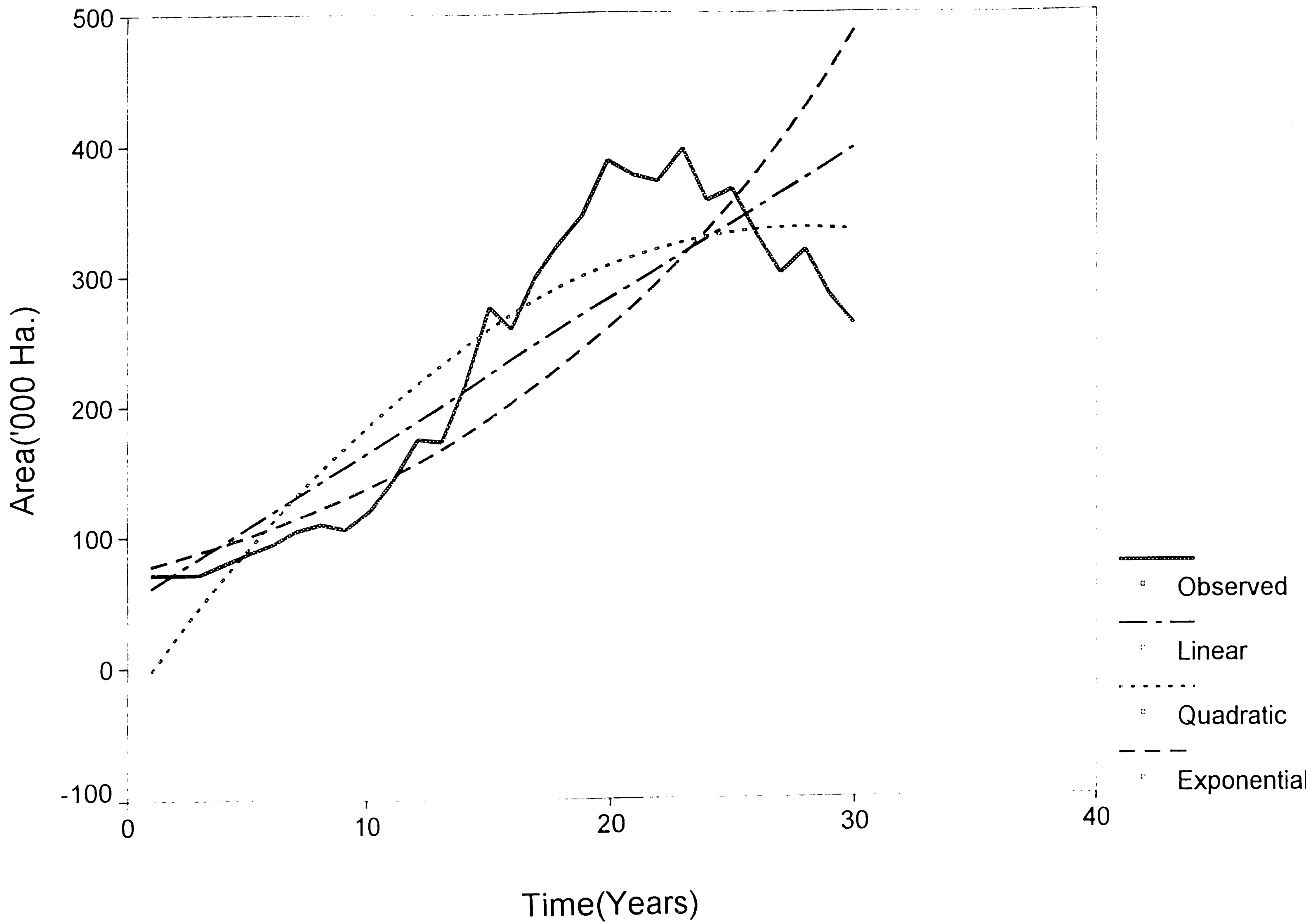


TABLE 4.2.2 RELIABILITY OF FITTED EQUATIONS TO TIME SERIES DATA ON YIELD

YIELD	Type of courve fitted	Coefficient		R^2	$\bar{R}^2$	S.E.	R.M.S.
		'b'	'c'				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Yield Period I	Linear	-0.1636(NS) (13.4865)		0.00002(NS)	-0.1249(NS)	122.4949	15005.49
	Quadratic	132.7530** (38.4779)	-12.0833** (3.4090)	0.6422*	0.5399NS	78.3328	6136.032
	Exponential	-0.0002(NS) (0.0104)		0.00006(NS)	-0.1249(NS)	0.0949	0.0090
Period II	Linear	24.5879(NS) (24.5955)		0.1110(NS)	-0.00007(NS)	223.3997	49907.45
	Quadratic	111.1295NS (112.4093)	-7.8674NS (9.9590)	0.1838NS	-0.0493NS	228.8413	52368.33
	Exponential	0.0252(NS) (0.0234)		0.1271(NS)	0.0179(NS)	0.2125	0.0452
Period III	Linear	-15.8303(NS) (14.8742)		0.1240(NS)	0.1045(NS)	135.1014	1825.403
	Quadratic	67.5030NS (63.1562)	-7.5257NS (5.5954)	0.3058NS	0.1075NS	128.5725	16530.885
	Exponential	-0.0135(NS) (0.0120)		0.1372(NS)	0.0293(NS)	0.1091	0.0119
Period (II + III)	Linear	3.0338(NS) (7.1566)		0.0099(NS)	-0.0451(NS)	184.5509	34059.055
	Quadratic	52.6738NS (28.3986)	-2.3638NS (1.3136)	0.1683NS	0.0705NS	174.0465	30292.197
	Exponential	0.0039(NS) (0.0066)		0.0193(NS)	-0.0315(NS)	0.1699	0.0288
Entire period	Linear	1.1564(NS) (3.4209)		0.0041(NS)	-0.0315(NS)	162.1794	26302.157
	Quadratic	7.9492NS (14.3378)	-0.2191NS (0.4488)	0.0128NS	-0.0603NS	164.4310	27037.570
	Exponential	0.0009(NS) (0.0031)		0.0037(NS)	-0.0319(NS)	0.1463	0.0214

* Significant at 5% level of significance

** Significant at 1% level of significance.

NS Not significant

Figures in parenthesis indicate S.E. of the coefficients.

Fig. 2 Models fitted to time series data of yield

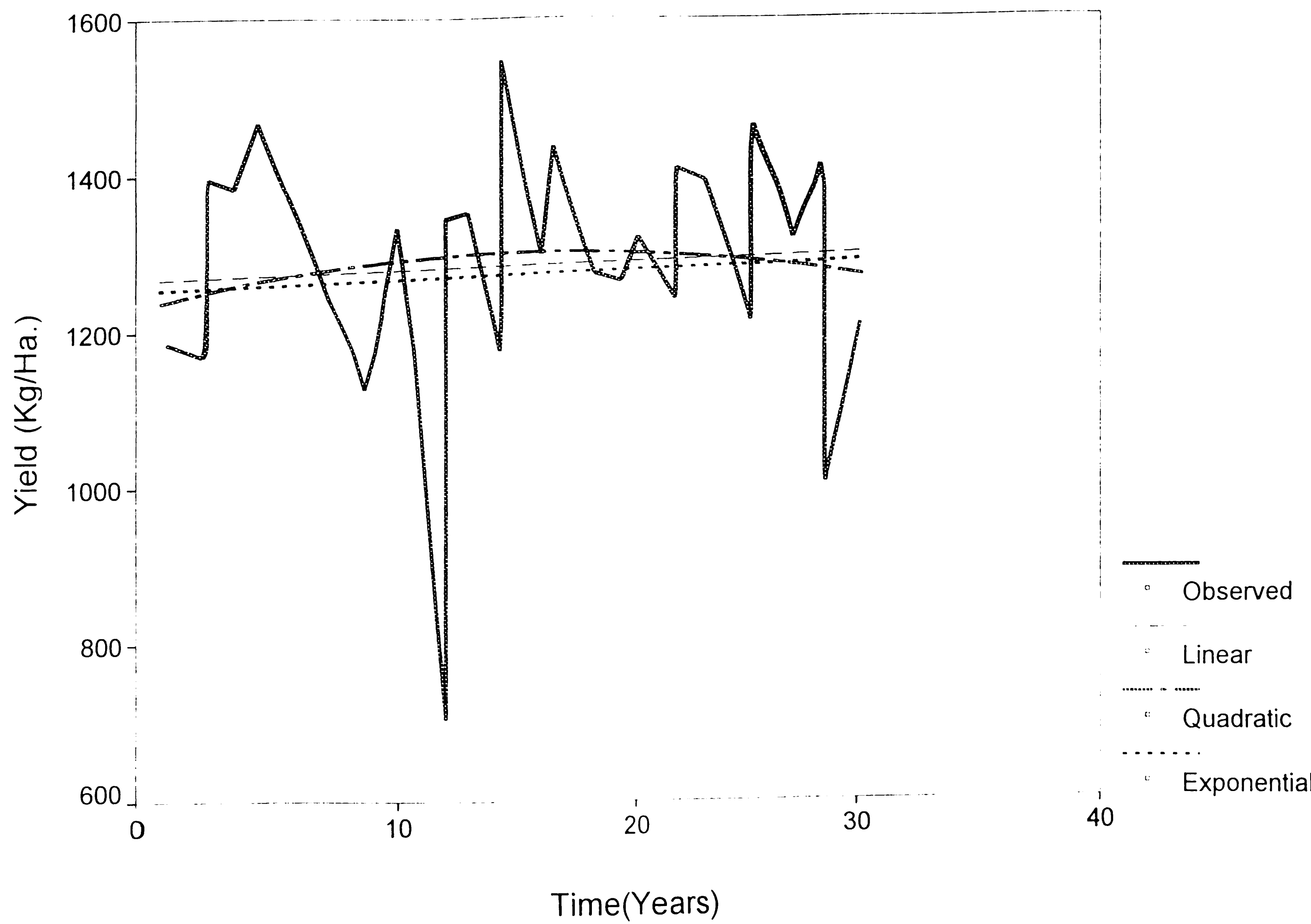


TABLE 4.2.3 RELIABILITY OF FITTED EQUATIONS TO TIME SERIES DATA ON PRODUCTION

PRODUCTION	Type of courve fitted	Coefficient		R^2	$\bar{R}^2$	S.E.	R.M.S.
		'b'	'c'				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Period I	Linear	6.9454** (1.4495)		0.7416*	0.7093*	13.1655	173.3318
	Quadratic	16.8621** (5.7451)	-0.9051NS (0.5090)	0.8216**	0.7706**	11.6957	136.7905
	Exponential	0.0633** (0.0125)		0.2504*	0.7192*	0.1172	0.0137
Period II	Linear	38.9879** (4.1670)		0.9163*	0.9058**	37.84	1432.55
	Quadratic	55.8629** (18.7671)	-1.5341NS (1.6627)	0.9253**	0.9040**	38.2058	1459.682
	Exponential	0.1329** (0.0223)		0.8159**	0.7929**	0.2028	0.0411
Period III	Linear	-22.1273** (6.9307)		0.5603(NS)	0.5053(NS)	62.9511	3962.845
	Quadratic	31.4853NS (25.6892)	-4.8714* (2.2759)	0.7340**	0.6580*	52.2978	2735.061
	Exponential	-0.0566** (0.0186)		0.5354(NS)	0.4774(NS)	0.1694	0.0287
Period (II + III)	Linear	10.2835** (4.0641)		0.2624(NS)	0.2214(NS)	104.8039	10983.858
	Quadratic	74.5932** (7.1962)	-3.0624** (0.3329)	0.8766**	0.8621**	44.1037	1945.14
	Exponential	0.0349** (0.0131)		0.2840(NS)	0.2443(NS)	0.3368	0.1134
Entire period	Linear	15.3922** (1.9279)		0.6948(NS)	0.6839(NS)	91.3979	8353.59
	Quadratic	35.7279** (7.0426)	-0.6559** (0.2204)	0.7702**	0.7532**	80.7669	6523.30
	Exponential	9.0645** (0.0069)		0.7571(NS)	0.7485(NS)	0.3273	0.1071

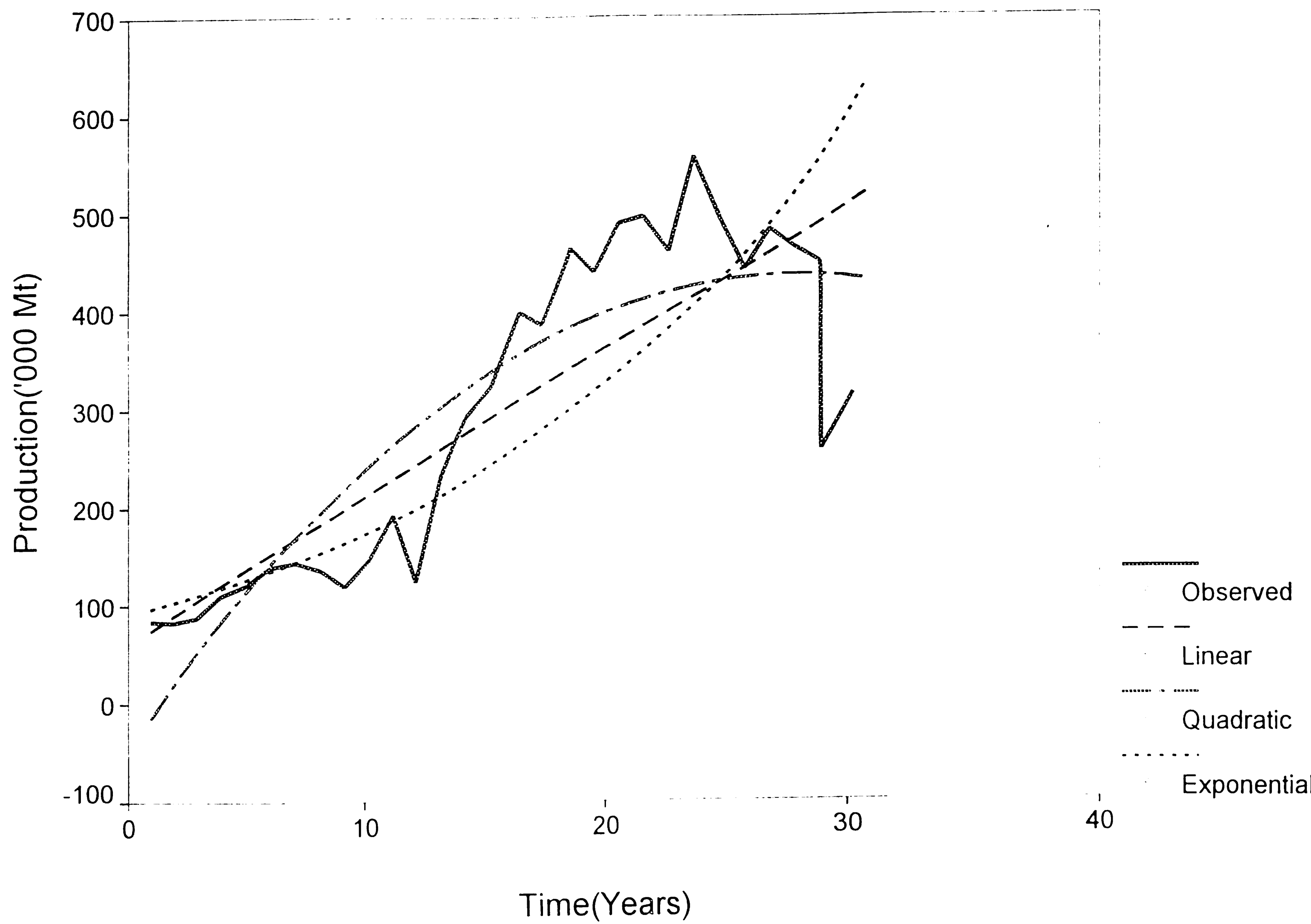
* Significant at 5% level of significance

** Significant at 1% level of significance.

NS Not significant

Figures in parenthesis indicate S.E. of the coefficients.

Fig. 3 Models fitted to time series data of production



4.3 ESTIMATION OF COMPOUND GROWTH RATES

Growth rates are commonly used as summerization of trends in time series data. Productivity indices and output series are usually discussed in term of changing growth rates over various periods of time. Policy decisions are often based on such growth rate estimates. Keeping this in view, an attempt has been made in this chapter, (a) to estimate compound growth rates of area, yield and production and (b) to provide some sound advice on the matter such as a quantitative assessment of the growth rates of area, yield and production and contribution of various factors to the enhanced output of groundnut.

The annual compound growth rates of area, yield and production of groundnut were estimated by using exponential growth curve $Y=a \cdot e^{bt}$ as discussed in methodology (Chapter III) and presented in Table 4.3.

AREA

The compound growth rate of area was found to be 11.3872 per cent in period II while it was 6.5269 per cent during period I. In both the periods growth rates were found to be highly significant, indicating significant increase in coverage of the crops. But in period III, the growth rate of area was significantly decreased to -4.0909 per cent. This may be due to shifting in cropping pattern i.e. shifting to more remunerative vegetable crops.

However, there was a significant growth rate of area (3.1141 per cent) during the post-technology period. This is due to significant increase in growth rate of area during the first technology period (Period II) over period I.

YIELD

The growth rates of yield were estimated to be -0.0223 per cent and -1.3453 per cent during period I and period III respectively where as positive growth rates

TABLE 4.3 COMPOUND GROWTH RATES OF AREA, YIELD AND PRODUCTION OF GROUNDNUT IN ORISSA

Items	Period I (Pre-technology period)	Period II	Period III	Period II + III (Post- technology period)	Change in growth rates		
					P II over P I	P III over P II	Post- technology period over pre-technology period
Area	6.5269** (0.5220)	11.3872** (0.8160)	-4.0909** (0.6087)	3.1141** (0.9148)	4.8603** {5.0174}	15.4781* {15.2041}	-3.4128** {3.2402}
Yield	-0.0223 (N.S) (1.0502)	2.5574(N.S) (2.3674)	-1.3453(N.S) (1.2081)	0.3931(N.S.) (0.6609)	2.5797(N.S) {0.9960}	-3.9027(N.S) {1.4683}	0.4154 NS {0.3246}
Production	6.5334** (1.2989)	14.2196** (2.2580)	-5.5079** (1.8831)	3.5518* (1.3145)	7.6862* {2.9506}	-19.7275** {6.7096}	-2.9816NS {1.6134}

* Significant at 5% level of significance

** Significant at 1% level of significance

NS Not significant

Figures in ( ) indicate standard Error(S.E.) of growth rates

Figures in { } indicate the corresponding 't' values.

of 2.5574 per cent and 0.3931 per cent were estimated for period II and post-technology period respectively. In all the cases the growth rates are not significant. Even, the change in C.G.R. for period II over period I and for the period III over period II were positive but not significant. This indicates that yield rate was more or less stagnant in all the periods.

PRODUCTION

The growth rates of production were highly significant for period I (6.5334 per cent) and period II (14.2196 per cent). The change in C.G.R.S. for period II over period I was also significant as indicated by more than two fold increase in growth rate in period II. This was due to contribution of area only as indicated by the C.G.R. of area in period II. But in period III the growth rate was significantly reduced to -5.5079 per cent. The significant decrease in growth rate of area during this period was mainly responsible for such depression in production. In over all post-technology period the growth rate of production (3.5518) was significant due to the significant growth rate in period II.

So it is clear that during the post-technology period, significant growth rate of area under the crop was responsible for the high growth rate in production. Inspite of stangnancy in yield rate, the coverage under groundnut increased from year to year. It may be due to the fact that people opted for this crop as it was more remunarative than other crops and importance as an oilseed crop.

Significant growth rates of production in period I and period II supports the percentage change in growth rate of production for period II over period I and period III over period II.

4.4 Acceleration and deceleration in rate of growth

To examine the acceleration/deceleration in rate of growth of area, yield and production of groundnut crop, second degree exponential function of the form $Y = AB^{t} C^{t^2}$ i.e. $\ln Y = a+bt+ct^2$ (in the form of natural logarithm) was fitted. Here coefficient of t^2 i.e. 'c' indicates the rate of acceleration/deceleration depending upon its corresponding positive/negative value under the condition that the coefficient of t i.e. 'b' is positive and significant. The analytical results are presented in Table 4.4.

TABLE 4.4 ACCELERATION AND DECELERATION IN RATE OF GROWTH OF AREA, YIELD AND PRODUCTION OF GROUNDNUT

		Coefficient			R^2	$\bar{R}^2$
		a	b	c		
AREA	Period I	4.1501	0.0611*	0.0002(N.S.)	0.9486**	0.9339**
			(0.0248)	(0.0022)		
	Period II	4.8091	0.1611**	-0.0048(N.S.)	0.9689**	0.9599**
			(0.0328)	(0.0029)		
	Period III	5.9383	0.0078(N.S.)	-0.0045*	0.9191**	0.8960**
			(0.0217)	(0.0019)		
	Period (II + III)	4.7731	0.1842**	-0.0073**	0.9667**	0.9628**
			(0.0092)	(0.0004)		
	Entire period	3.7767	0.1595**	-0.0031**	0.9334**	0.9285**
			(0.0144)	(0.0004)		
YIELD	Period I	6.9468	0.1026**	-0.0093**	0.6404*	0.5379*
			(0.0299)	(0.0026)		
	Period II	6.8408	0.1011(N.S.)	-0.0069(N.S.)	0.1877(N.S.)	-0.0444(N.S.)
			(0.1077)	(0.0095)		
	Period III	7.1084	0.0516(N.S.)	-0.0059(N.S.)	0.3051(N.S.)	0.1066(N.S.)
			(0.0514)	(0.0045)		
	Period (II + III)	6.9365	0.0503(N.S.)	-0.0022(N.S.)	0.1810(N.S.)	0.0846(N.S.)
			(0.0261)	(0.0012)		
	Entire period	7.1136	0.0047(N.S.)	-0.0001(N.S.)	0.0069(N.S.)	-0.0067(N.S.)
			(0.0129)	(0.0004)		
PRODUCTION	Period I	4.1871	0.1636**	-0.0091(N.S.)	0.8500**	0.8072**
			(0.0477)	(0.0042)		
	Period II	4.7458	0.2608**	-0.0116(N.S.)	0.8558**	0.8146**
				(0.0083)		
	Period III	5.5789	0.2164(N.S.)	-0.0208(N.S.)	0.1830(N.S.)	-0.0504(N.S.)
			(0.1932)	(0.0171)		
	Period (II + III)	4.9060	0.1982**	-0.0079**	0.5214*	0.4651*
			(0.0511)	(0.0024)		
	Entire period	4.0304	0.1542**	-0.0029**	0.8022**	0.7875**
			(0.0259)	(0.0008)		

* Significant at 5% level of significance

** Significant at 1% level of significance

NS Not Significant

Fig. 4 Acceleration/deceleration in rate of growth of Area

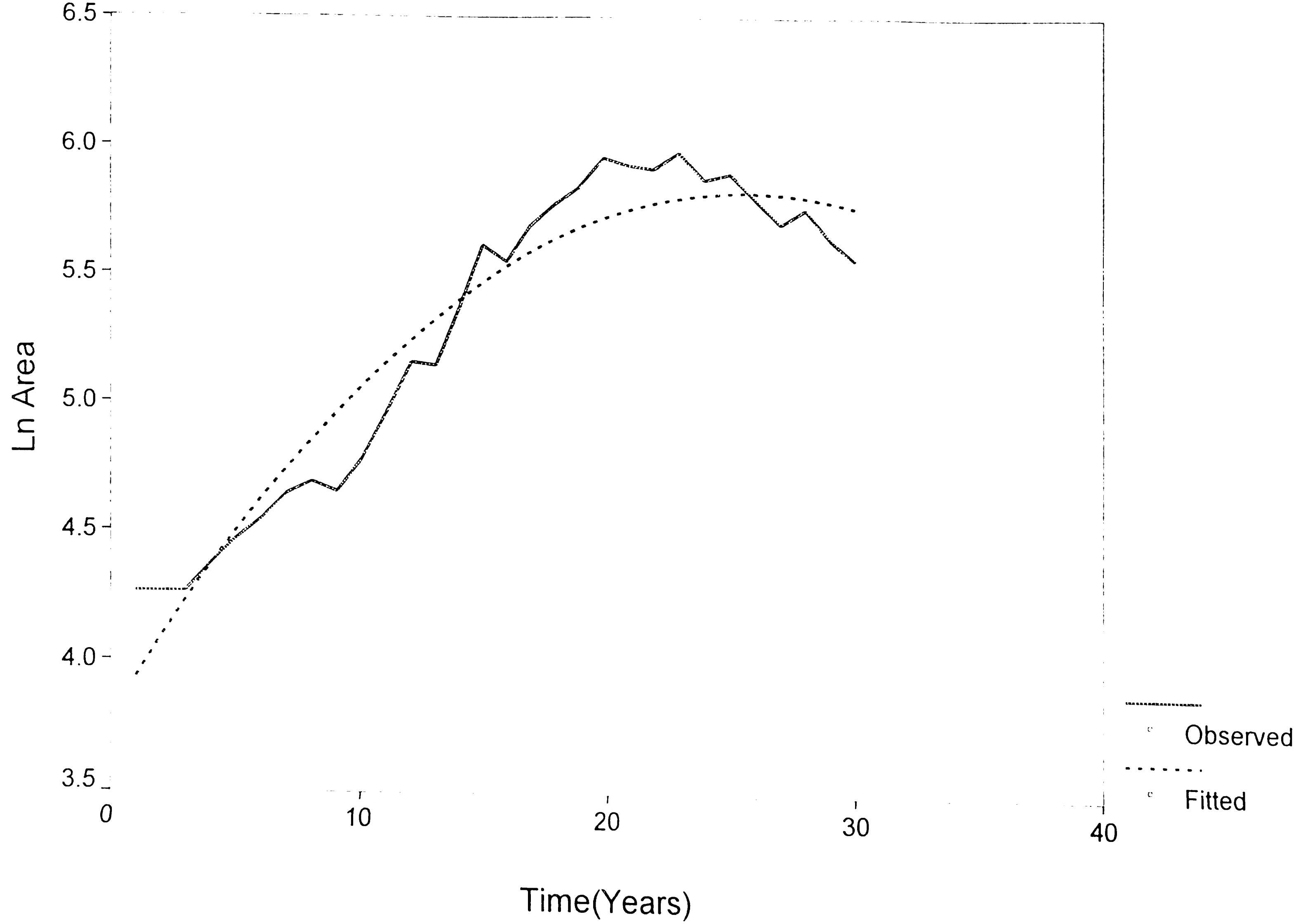


Fig. 5 Acceleration/deceleration in rate of growth of yield

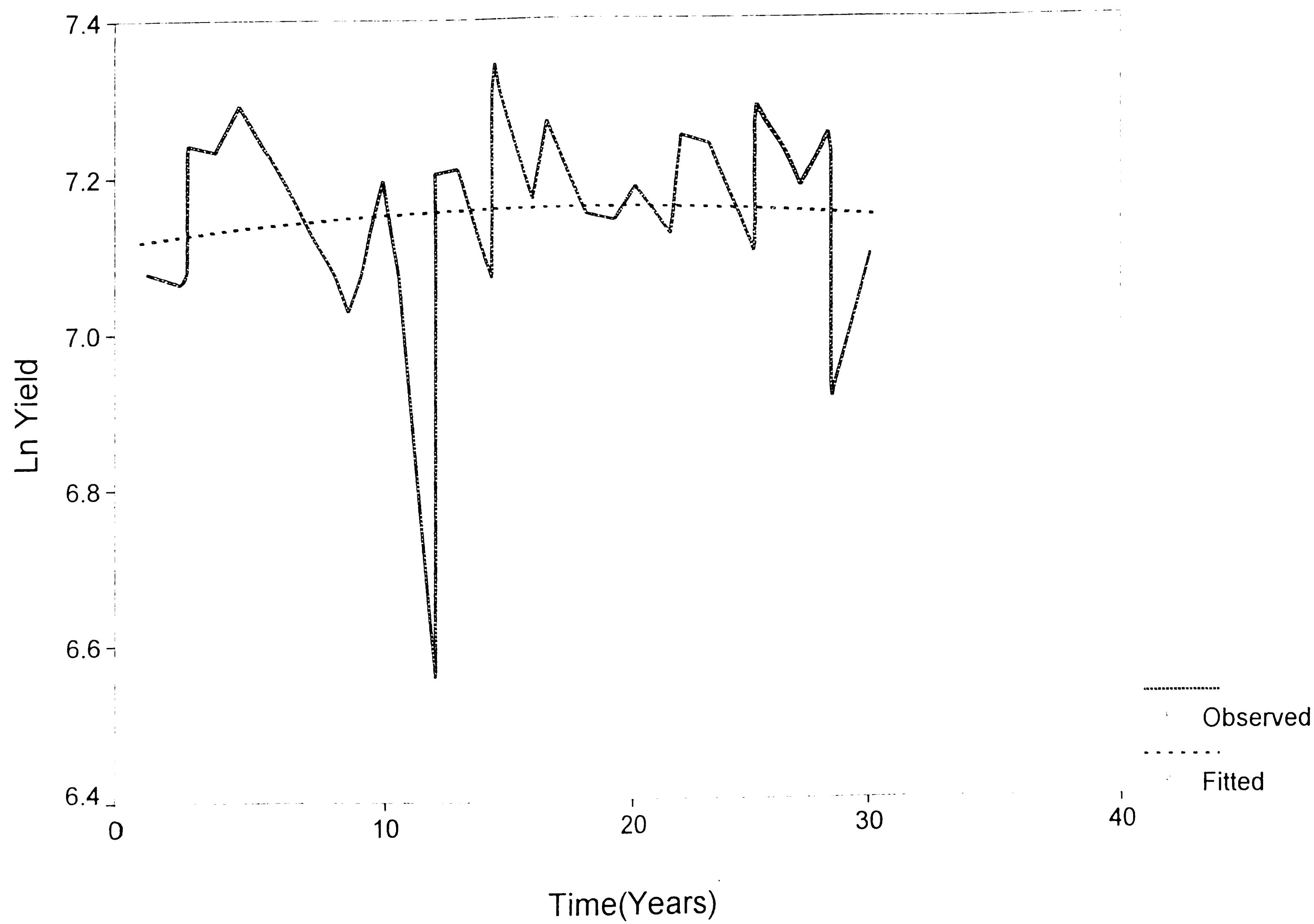
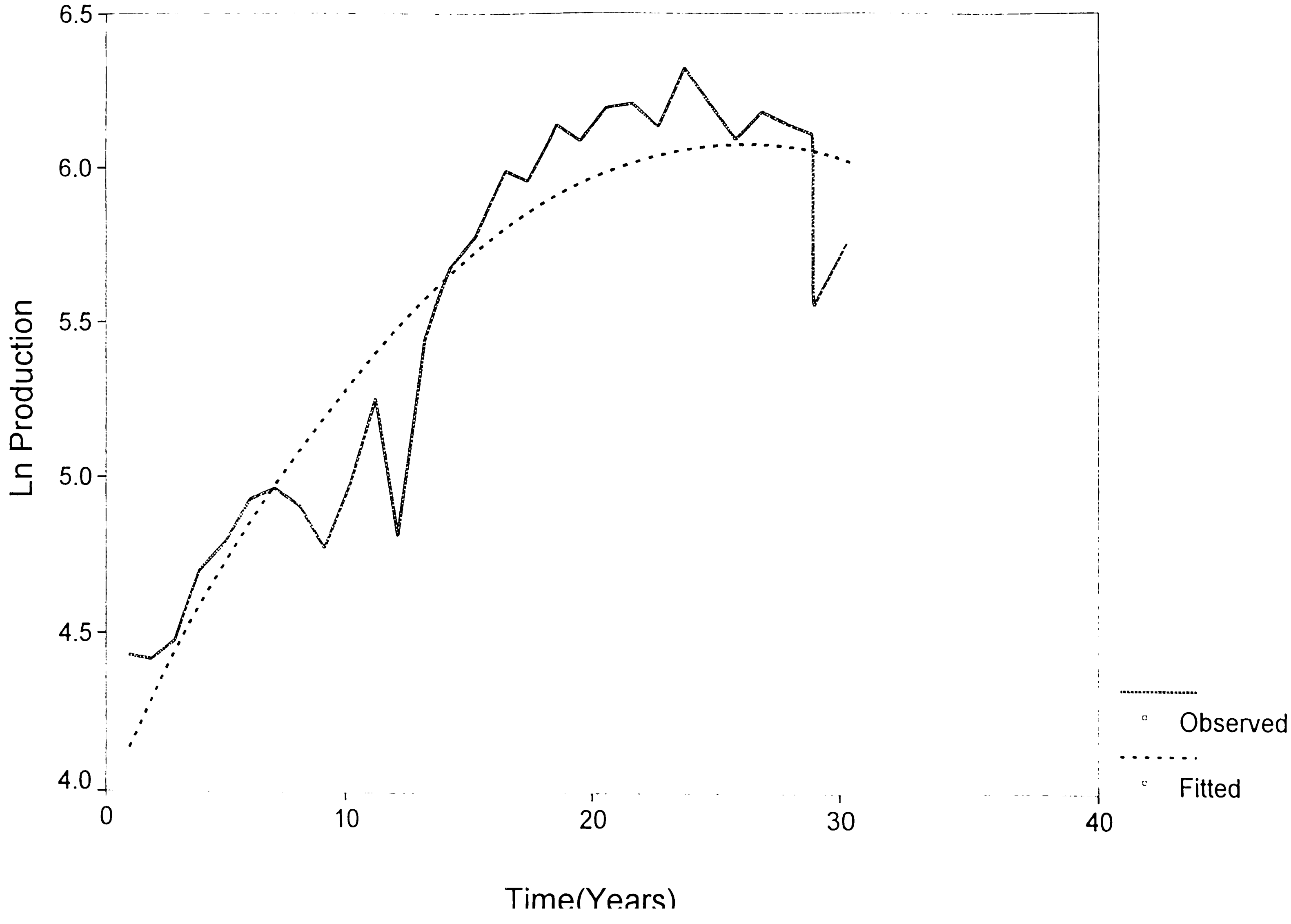


Fig. 6 Acceleration/deceleration in rate of growth of production



AREA

The table reveals that there was no significant acceleration in rate of growth of area during period I while there was no significant deceleration in rate of growth of area during period II (first techno-period). This indicates decrease in rate of growth of area under the crops had just started from this period. During period III (Second techno period) the change in rate in area was not prominent. But for entire post-technology period (Period II + Period III) significant deceleration in area was noticed and as a result same type of deceleration was observed for the entire period under study (1968-69 to 1997-98).

YIELD

Highly significant negative values of 'c' in period I indicated a significant deceleration in rate of growth of yield, whereas Period II and period III witnessed no distinct deceleration in rate of growth of yield. As a result, post-technology period and also the entire period under study exhibited same type of change in rate of growth.

This concludes that the rate of growth of yield had started decelerating from pre-technology period and it was more or less stagnant during post-technology period. As a result there was non-significant of compound growth rate of yield for the same period in Table 4.1.

PRODUCTION

Negative and non significant coefficient of t^2 for period I and period II indicated deceleration had started in rate of growth of production from period I and continued till the end of period II. For period III the acceleration/deceleration in rate of growth was not predictable. But in post-technology period, the rate of deceleration in production was significant. As a result of which the remarkable deceleration in production in entire period under study was observed. Significant deceleration in rate of growth of area under the crop was mainly responsible for the deceleration in rate of growth of groundnut production during the post technology period as well as the entire period under study.

4.5 EFFECT OF MODERN TECHNOLOGY ON GROUNDNUT PRODUCTION

Technological change is one of the most crucial factors determining the pattern and pace of agricultural growth. It includes all the available means which improve the efficiency of converting scarce resources into products satisfying human wants. A technological change affecting individual input is inferred to as input-saving or output-augmenting. Thus, modern technology has to facilitate the saving of important resources taken individually, i.e, land, labour and capital and has to enhance productivity as well as production of a crop.

The modern technology in groundnut in Orissa appeared in mid seventies. In reality, the effect of this technology was marked during 1978-79. So it is essential to measure the effects of new technology introduced in the state on groundnut production.

To estimate the technological changes over the different periods, regression analysis was performed for groundnut crop and the analytical results are presented in Table 4.5.1.

TABLE 4.5.1 EFFECT OF MODERN TECHNOLOGY ON GROUNDNUT PRODUCTION OF ORISSA

	Parameters	Coefficients	S.E.	|t|	F	R^2	Chows Test
n=10 Period I	α_1	-2.0475	0.0290	0.6760 NS	19.5689**	0.8483**	
	β_1	1.5522	0.7304	2.1250 NS			
	λ_1	-0.0348	0.0474	0.7350 NS			
n=10 Period II	α_2	4.2421	5.0990	0.8320 NS	15.5711**	0.8165**	
	β_2	0.1545	1.0370	0.1490 NS			
	λ_2	0.1163	0.1143	0.0170 NS			
n=10 Period III	α_3	-2.2611	6.1979	0.3650 NS	6.1171***	0.6361*	
	β_3	1.4315	1.0264	1.3950 NS			
	λ_3	0.0033	0.0464	0.0700 NS			
n=20 Period (II+ III)	α_4	-0.9831	0.9759	1.0080 NS	34.7671**	0.8035**	14.5538**
	β_4	1.2216	0.1822	6.7050 **			
	λ_4	-0.0025	0.0089	0.2850 NS			
n=30 Entire period	α	0.4516	0.7769	0.5810 NS	78.9421**	0.8539**	
	β	0.9494	0.1797	5.2830 **			
	λ	0.0015	0.0126	0.1210 NS			
	α	0.2062	1.0781	0.1910 NS	50.9343**	0.8546**	
	β	1.0062	0.2494	4.0350 **			
	λ	0.0015	0.0128	0.1150 NS			
	δ	-0.0798	0.2385	0.3350 NS			

* Significant at 5% level of significance

** Significant at 1% level of significance

*** Significant at 2% level of significance

NS Not Significant.

The table reveals that the coefficient of area (β) and time trend (λ)for the periods I, II and III were found to be not significant. This indicates that both area and time trend had no significant impact on production in all the above three periods. The coefficients of area were estimated to be 1.5522 and 1.2216 for the pre- and post-technology period respectively, indicating the annual production increment for additional one unit of area. Though this incremental value was more in pre-technology period, it was significant in post-technology period. So in post-technology period, additional one unit of area had contributed significantly to the annual production increment. The coefficient of time trend for the two periods were -0.0348 and -0.0025 respectively indicating no impact on production. The coefficients of area and time trend for the entire period under study were 0.9494 and 0.0015 respectively, representing their incremental effects on production over thirty years. Out of the two estimates, the estimate of area on production was found to be significant whereas the estimate of time trend was not significant.

The significant value of Chow's test indicate that there was significant change in the production process in post-technology period over pre-technology period. Considering the non-significant value of δ (-0.0798), coefficient of dummy variable of the model II indicates that the average incremental value in annual production had not been associated with technological change. Moreover, the value of R^2 reflects the portion of production variation during different periods under study.

Therefore, it is concluded that there was only significant effect of area on production for the post-technology period.

As there was no effect of technological change on groundnut production for the pre- and post-technology periods, another attempt has been made to study the technological effect on kharif and rabi groundnut production. To estimate this technological effect, the above mentioned procedures have been adopted and the results obtained are presented in Table 4.5.2 and Table 4.5.3 for kharif and rabi groundnut production respectively.

For kharif season the value of coefficient of area indicated significant impact of area on production in pre-technology period (period I). In period II and III, the effect of both area and time trend were not significant. But in post-technology period area had a significant effect on production and no effect of time trend on production was observed.

Considering entire period under study, both fitted models explained that there was no effect of area on production but significant effect of time trend had been observed as indicated by the values of coefficients of time period. The significant value of Chow's test confirmed that there was significant difference in production process between the two periods. The value of δ (-0.4689), the coefficient of dummy variable in model-2 explained that the average incremental value in annual production had not been associated with technological change.

In period I, for rabi season, the area had a significant contribution on production in comparison to kharif season. In period II, neither area nor time factor had significant impact on rabi production. This was also same for kharif production.

TABLE 4.5.2 EFFECT OF MODERN TECHNOLOGY ON KHARIF GROUNDNUT PRODUCTION OF ORISSA

	Parameters	Coefficients	S.E.	|t|	F	R^2	Chows Test
n=10 Period I	α_1	-2.6989	2.6241	1.028 NS	6.2289***	0.6400*	
	β_1	1.6989	0.6476	2.623 ****			
	λ_1	-0.0258	0.0248	1.041 NS			
n=10 Period II	α_2	0.3681	2.8767	0.128 NS	14.9602**	0.8104**	
	β_2	0.8923	0.6764	1.3190 NS			
	λ_2	0.0347	0.0837	0.415 NS			
n=10 Period III	α_3	5.0444	3.6996	1.3630 NS	16.8349**	0.8249**	
	β_3	0.1104	0.6669	1.1660 NS			
	λ_3	-0.0663	0.0513	1.2920 NS			
n=20 Period (II+ III)	α_4	-2.9003	2.4389	1.1890 NS	7.4779**	0.4680 NS	
	β_4	1.5119	0.5077	2.9780 **			
	λ_4	0.0272	0.0282	0.9650 NS			
n=30	α	6.9604	3.2260	2.158 *	7.2995**	0.3509 NS	29.2302**
	β	-0.7903	0.7827	1.017 NS			
	λ	0.1223	0.0413	2.9610 **			
	α	6.1112	3.6138	1.691 NS	4.8419**	0.3584 NS	
	β	-0.5912	0.8761	0.675 NS			
	λ	0.1343	0.0472	2.845 **			
	δ	-0.4689	0.8515	0.5510 NS			

* Significant at 5% level of significance

** Significant at 1% level of significance

*** Significant at 2% level of significance

**** Significant at 3% level of significance

NS Not Significant.

TABLE 4.5.3 EFFECT OF MODERN TECHNOLOGY ON RABI GROUNDNUT PRODUCTION OF ORISSA

	Parameters	Coefficients	S.E.	$\lvert t \rvert$	F	R^2	Chows Test
n=10 Period I	α_1	1.0398	0.3059	3.400 **	240.8048**	0.9851**	
	β_1	0.8791	0.1467	5.990 **			
	λ_1	-0.0149	0.0246	0.607 NS			
n=10 Period II	α_2	3.9563	4.0677	0.973 NS	11.7292**	0.7202*	
	β_2	0.1213	0.9693	0.125 NS			
	λ_2	0.1112	0.0973	1.143 NS			
n=10 Period III	α_3	-0.6321	2.3883	0.265 NS	5.844****	0.6274*	
	β_3	1.2381	0.4669	2.651 ****			
	λ_3	-0.0284	0.0159	1.777 NS			
n=20 Period (II+ III)	α_4	-1.1286	1.1252	1.003 NS	27.8456**	0.7661**	
	β_4	1.3434	0.2471	5.393 **			
	λ_4	-0.0130	0.0121	1.080 NS			
n=30	α	0.8687	0.2167	4.008 **	405.7684**	0.9678**	1.8937 NS
	β	0.9071	0.0780	11.626 **			
	λ	0.00003	0.0088	0.040 NS			
	α	0.8088	0.3486	2.320 NS	261.0048**	0.9679**	
	β	0.8088	0.1277	7.213 **			
	λ	0.0001	0.0092	0.009 NS			
	δ	-0.0420	0.1891	0.222 NS			

* Significant at 5% level of significance
** Significant at 1% level of significance
*** Significant at 2% level of significance
**** Significant at 3% level of significance
NS Not Significant.

In period III, only area had a significant effect on rabi production while it had no significant effect in kharif. In post-technology period, though the area had significant impact on production, no effect of time trend was observed as indicated by the coefficient of time factor (-0.0130). Moreover, non-significant value of Chow's test proves that there was no significant difference in production process between the two periods. The negative estimate of 'δ' explains that the average incremental value in annual production was not associated with technology. So during rabi, through the area had a significant impact on production during post-technology period, technology had no impact on rabi groundnut production.

In order to estimate the technological effect on groundnut production at district level, five major groundnut growing districts (undivided districts of Cuttack, Dhenkanal, Sambalpur, Ganjam and Puri) have been considered only for the post-technology period (1978-79 to 1997-98). The analytical results are presented in Table 4.5.4.

District wise analysis revealed that area under the crop of the selected districts had significant effect on total groundnut production during the post-technology period. Considering the values of coefficient β, contribution of area towards production was highest in Cuttack district followed by Sambulpur, Dhenkanal, Puri and Ganjam respectively. Non-significant values of coefficient of time trend (λ) for all the districts indicated that there was no effect of time trend on groundnut production during the post-technology period. Similar type of results were obtained also for the total groundnut production of the state in post-technology period.

TABLE 4.5.4 EFFECT OF MODERN TECHNOLOGY TOTAL GROUNDNUT PRODUCTION OF FIVE MAJOR (GROUNDNUT GROWING) DISTRICTS DURING POST-TECHNOLOGY PERIOD (1978-79 TO 1997-98)

Districts	Parameters	Coefficients	S.E.	|t|	F	R^2
CUTTACK	α	-0.7190	0.9902	0.726 NS	15.8961**	0.6516**
	β	1.2710	0.2303	5.520 **		
	λ	-0.0069	0.0091	0.766 NS		
DHENKANAL	α	-0.2011	0.5551	0.362 NS	26.7755**	0.7590**
	β	1.1145	0.1672	0.666 **		
	λ	-0.0074	0.0127	0.583 NS		
GANJAM	α	0.1699	0 .3642	0.467 NS	48.8789**	0.8593**
	β	0.9751	0.0986	9.887 **		
	λ	0.0018	0.0072	0.258 NS		
PURI	α	0.2803	0.5639	0.497 NS	15.1376**	0.6404**
	β	0.9829	0.1963	5.006 **		
	λ	0.0090	0.0087	1.029 NS		
SAMBALPUR	α	-0.3404	0.7365	0.462 NS	34.6086**	0.8028**
	β	1.1492	0.2184	5.262 **		
	λ	0.0002	0.0110	0.016 NS		

* Significant at 5% level of significance
** Singificant at 1% level of significance
NS Not Significant.

TABLE 4.5.5 EFFECT OF MODERN TECHNOLOGY ON KHARIF GROUNDNUT PRODUCTION OF FIVE MAJOR (GROUNDNUT GROWING) DISTRICTS DURING POST-TECHNOLOGY PERIOD

Districts	Parameters	Coefficients	S.E.	|t|	F	R^2
CUTTACK	α_1	-0.2154	0.2412	0.843 NS	57.6589**	0.9335**
	β_1	1.1772**	0.1179	9.987 **		
	λ_1	-0.0141	0.0077	1.826 NS		
DHENKANAL	α_1	-1.6215	0.7551	2.147 NS	23.0076**	0.6985**
	β_1	1.4115**	0.2369	5.958 **		
	λ_1	0.0167	0.0181	0.921 NS		
GANJAM	α_1	-0.3141	0.4597	0.683 NS	41.9903**	0.8316**
	β_1	1.0792**	0.1241	8.699 **		
	λ_1	-0.0004	0.0092	0.041 NS		
PURI	α_1	0.0641	0.1582	0.405 NS	84.3688**	0.9085**
	β_1	1.0082**	0.0938	10.743 **		
	λ_1	0.0053	0.0075	0.709 NS		
SAMBALPUR	α_1	-0.6119	0.8020	0.763 NS	16.6684**	0.6622**
	β_1	1.2185**	0.2266	5.378 **		
	λ_1	-0.0031	0.0060	0.505 NS		

* Significant at 5% level of significance
** Significant at 1% level of significance
NS Not Significant.

TABLE 4.5.6 EFFECT OF MODERN TECHNOLOGY ON RABI GROUNDNUT PRODUCTION OF FIVE MAJOR (GROUNDNUT GROWING) DISTRICTS DURING POST-TECHNOLOGY PERIOD (1978-79 TO 1997-98)

Districts	Parameters	Coefficients	S.E.	|t|	F	R^2
CUTTACK	α_1	-0.4999	0.9594	0.521 NS	15.1158**	0.6401**
	β_1	1.2314**	0.2273	5.418 **		
	λ_1	-0.0073	0.0090	0.811 NS		
DHENKANAL	α_1	-0.6884*	0.2642	0.606 ***	87.0499**	0.9110**
	β_1	1.5018**	0.1728	8.691 **		
	λ_1	-0.0140	0.0148	0.949 NS		
GANJAM	α_1	0.7019	0.4215	0.665 NS	9.7738**	0.5348*
	β_1	0.8708**	0.1994	4.776 **		
	λ_1	0.0046	0.0098	0.472 NS		
PURI	α_1	1.8502	0.4977	3.718 **	3.9244*	0.3159 NS
	β_1	0.4488**	0.1604	2.797 **		
	λ_1	0.0039	0.0064	0.0017 NS		
SAMBALPUR	α_1	0.4179	0.0910	4.592 **	297 .8909**	0.9723**
	β_1	1.0562**	0.0499	21.183 **		
	λ_1	0.0009	0.0044	0.207 NS		

* Significant at 5% level of significance

** Significant at 1% level of significance

*** Significant at 2% level of significance

NS Not Significant.

Table 4.5.5 and Table 4.5.6 for district wise analysis (5 major districts) of kharif and rabi groundnut production respectively, reveals that there was no effect of time trend on production during post-technology period.

So it is concluded that, modern technology i.e. seed-fertilizer technology adopted in the state has no impact on kharif, rabi as well as total groundnut prodution of the state.

4.6 Instability in groundnut production

Instability which means the nature of fluctuation in groundnut production was remarkably observed after the introduction of seed-fertilizer technology in the state. In order to estimate the instability in time series data and in around the trend of groundnut production, Coefficient of Variation (C.V.) and Coppock Instability Index (C.I.I.) have been considered as statistical measures.

Arithmetic mean, coefficient of variation and Coppock Instability Index of area and yield of groundnut crop for different periods under study are presented in Table 4.6.

TABLE 4.6 COEFFICIENT OF VARIATION AND INSTABILITY INDEX OF AREA AND YIELD OF GROUNDNUT

	Area			Yield		
	Mean Area (000' ha)	Coefficient of variation (in percentage)	Coppock Instability Index (in (percentage)	Mean yield (kg/ha)	Coefficient of Variation (in percentage)	Coppock Instability Index (percentage)
Period I	91	18.5255	5.5782	1280.30	8.5578	7.8062
Period II	259	29.8263	10.3402	1273.30	16.6440	38.8685
Period III	335.59	12.5554	7.2762	1299.20	9.9376	17.6417
Period (II +III)	297.295	24.5774	11.7752	1286.25	13.6795	28.7059

AREA

There was remarkable increase in mean area under ground-nut in period III showing 335.59 thousand hectare in comparison to that of period I and period II. This indicates more coverage of area under the crop after advancement of modern technology. But coefficient of variation of period II (29.8263 per cent) explained the more variation in area in comparison to that of period I. Then the variation reduced to 12.5554 per cent during period III showing comparatively less variation in area in comparison to period I and period II. This may be due to climatic variations or may be due to substitution of groundnut area by any other remunerative crops. As a result, the variation in area during entire post-technology period was found to be nearly 24.5774 percent.

Similarly highest value of Coppock Instability Index (10.3402) in period II exhibited maximum fluctuation around the trend in area while it was minimum (nearly 5.58 percent) in period I. The instability index was estimated as about 7.28 percent in period III, showing less fluctuation in area in comparison to period II. Since C.V.s of all the three periods are more than that of C.I.I. implied that there was an acceleration in mean areas in all the periods.

YIELD

The mean yield of groundnut was highest in period III exhibiting 1299.20 kg/ha followed by 1280.30 kg/ha in period I and 1273.30 kg/ha in period II. This illustrates that even through mean area under the crop had increased but the mean yield was reduced during period II in comparison to period I. Fortunately, along with increase in mean area, there was an increase in mean yield in period III.

Considering the coefficient of variations and C.I.I., the yield did not follow the same pattern of instability as in case of area. Even through the mean yield was lowest (1273.30 kg/ha) in period II but there was highest fluctuation in yield and also around the yield trend. In period I, the mean yield was 1280.30 kg/ha with minimum variation in yield rate as well as around the yield trend.

The lower instability index than the coefficient of variation in period I implies that there was an acceleration in yield in this period. But the coefficients of variation in period II, III and entire post-technology periods were lower than the instability indices which implied that the yield remained more or less stagnant during technology periods.

This concludes that there was an acceleration with less instability in yield rate of groundnut in traditional system in comparison to two techno-periods. In case of area, fluctuation was more during the period I in comparison to other two periods even if there was maximum increase in mean area in period III.

4.7 DECOMPOSITION ANALYSIS OF AVERAGE CHANGE IN GROUNDNUT PRODUCTION

Area and yield are two prime components for crop production. Therefore, it is important to assess the contribution of area and yield and also their interaction to the average change in production between any two periods. This type of analysis was first studied by Minhas (1984) and is popularly known as Minhas' Additive Decomposition scheme or simply Decomposition Analysis.

Following Minhas' additive decomposition model, the effects of two elementary component (area and yield) and their interaction on groundnut production for different periods have been estimated and presented in terms of percentage in Table 4.7.

TABLE 4.7 EFFECT OF COMPONENTS (AREA, YIELD AND THEIR INTERACTION) DURING THE TRIENNIUM -ENDING PERIODS I, II AND III TO THE AVERAGE CHANGE IN GROUNDNUT PRODUCTION

	Area effect	Yield effect	Interaction effect	Total
Period I	100.367	-0.841	0.474	100.000
Period II	75.305	11.446	13.249	100.000
Period III	79.018	27.825	-6.843	100.000
Period (II +III)	85.607	8.166	6.227	100.000

The main effect of area component was higher in period I accounting 100.367 percent while yield effect was negative accounting only 0.841 percent. At the same period interaction effect was 0.474 percent. This explains that change in average production in period I was due to area effect only. For period II the distribution of area, yield and their interaction effect was different in comparison to period I and period III. All three components have positive contributions to the average change in production, maximum contribution was by area effect accounting 75.305 per cent followed by interaction effect and yield respectively. Similarly in period III the contribution of area effect was maximum exhibiting 79.018 per cent while yield contribution was 27.825 per cent and interaction effect was negative. This indicates that area and yield had contributed more than hundred percent contribution. During period III contribution of yield increased to about 17 per cent in comparison to period II. But in periods I, II and III contribution of area supersede the contribution of yield and interaction effects. Again this decomposition analysis proves that average change in production was mainly due to coverage of more area in period II and III. It is clear that adequate measures have not been taken to enhance yield rate. Some yield augmenting steps are to be taken by the groundnut growers to bring the contribution of yield effect upto a desirable level say thirty to forty percent. Only area augmentation is not a suitable measure for change in average production as there is a limitation in coverage of groundnut crop. At this present situation it is desirable to increase yield rate to bring the balance between contribution of area yield and their interaction effect.

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Chapter - V

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

This chapter contains the summary and conclusion of the present study.

5.1 MAJOR FOCUS OF THE STUDY

The present study has been analysed the impact of modern technology on groundnut production of Orissa. The specific objectives of the study were as follows :

1. To examine the changes in mean of area, yield and production of groundnut of Orissa during pre- and post technology periods.
2. To examine the reliability of the fitted equation.
3. To estimate compound growth rates of area, yield and production of groundnut during pre- and post-technology periods.
4. To examine the acceleration and deceleration in the above growth rates during the above two periods.
5. To estimate the effect of technological change on groundnut production.
6. To evaluate the magnitude of instability in the production of groundnut during pre- and post-technology periods.
7. To examine the relative contribution of effects of basic components, area, yield and their interaction to the change in average production of groundnut during pre- and post-technology periods.

The above objectives have been tested by using appropriate null hypotheses against their alternative hypotheses.

5.2 SUMMARY

✷ Change in groundnut production

The percentage change in area during post-technology period (period II + period III) over pre-technology period (period I) was more (226.69 per cent) in comparison to change in yield was only 0.46 per cent. This revealed that increase in production was due to increase only in area under groundnut rather than increase in yield.

✷ Reliability of fitted equation

On the basis of higher values of $R^2, \overline{R}^2$, minimum Standard Error and Residual Mean Square commonly used exponential curve was used for the present study to estimate compound growth rates.

✷ Estimation of compound growth rates

Though there was a drastic reduction in growth rate of area in period III in comparison to period II but there was a significant growth rate of area during post-technology period in comparison to pre-technology period. This positive and significant growth was due to significant growth rate of area during the first-techno period (period II). Non-significant growth rate of yield indicated that yield rate was more or less stable in all the three periods. The higher growth rate in production during period II over period I was due to the significant increase in area during this period. Subsequently, the growth rate of production reduced in period III as a result of decrease in growth rate of area. But in overall post-technology period, the significant growth rate of production was due to the significant growth rate of area during this period.

* **Acceleration and deceleration in rate of growth**

The change in rate of growth of area was not prominent in period III, while the same for post-technology period was found to be significantly decelerated due to increase in rate of deceleration during period II.

There was no distinct acceleration/deceleration in rate of growth of yield during post-technology period (period II + III) indicating more or less stableness in yield during post-technology period.

Deceleration in rate of growth of production had started from period I and continued till the end of period II. But there was a significant deceleration in rate of growth of production in post-technology period which was due to the significant deceleration in area during the same period.

* **Effect of modern technology in groundnut production**

There was no significant impact of both area and technological change over time in period I, II and III. But in post-technology period there was a significant change in production process over pre-technology period which was due to the significant increase in area only. Over time, there was no technological effect on groundnut production.

In kharif season, area had a significant effect on production in post-technology period while there was no significant technological change over time during this period. There was significant difference between the two production processes and the average incremental value in annual production had not been associated with technological change as indicated by the coefficient of dummy variable.

During rabi season, area had a significant impact on rabi groundnut production during post-technology period. But no technological change over time was observed.

Moreover, district level analysis also revealed that only area had a significant effect on production and no technological change was observed during post-technology period.

This clearly illustrated that, the modern technology adopted in the state has no overall impact on kharif, rabi as well as total groundnut production, in the state during post-technology period. Thus modern technology may be renamed as area-augmenting technology instead of yield augmenting technology.

* **Instability in groundnut production**

There was more coverage of area under the crop after advancement of modern technology and subsequently more fluctuation in area was observed in period II and period III. But there was an acceleration in mean area during all the periods.

During pre-technology period there was an acceleration in yield with less variation in comparison to period III. As the coefficients of variation in period II, III and entire post-technology periods were lower than the instability indices, it indicated that there was more or less stagnation in mean yield.

* **Decomposition analysis of average change in groundnut production**

During pre-technology period area had more than hundred per cent contribution on average change in production. Negative contribution of yield had compensated the excess contribution of area. Subsequently the area effect decreased in period II and period III in comparison to period I while yield effect increased during both period II and III. But during post-technology period, the yield effect decreased in comparison to that of in period II and III. During all the periods area had contributed more to the average change in production. So it is clear that adequate measures have not been taken to enhance the yield rate.

5.3 CONCLUSION

The study on impact of modern technology on groundnut production of Orissa concludes that modern technology, i.e. seed-fertilizer technology adopted in the state has no overall impact on kharif, rabi as well as total groundnut production, it has failed to boost up the rabi as well as total groundnut production in the state during post-technology period. The increased production was mainly due to significant growth in area under the crop and the yield rate had no role in enhancing the production. Hence the modern technology may be simply renamed as area-augmenting technology. This statement is also supported by the decomposition analysis indicating more than eighty five per cent contribution of area towards the change in average production during post-technology period.

This clearly points to the fact that the potentiality of the viable technology developed for groundnut have not yet made a significant impact in increasing the productivity in the state during the post-technology period i.e. from 1978-79 to 1997-98.

Suggestions

The following suggestions may broadly be recommended to improve the growth performance of groundnut.

1. To increase production and the productivity, efforts are needed to raise productivity level through adoption of improved technology with an effective extension education system at regional level.
2. Efforts be accelerated to develop stable high yielding, pest and disease resistant and quick maturing varieties of groundnut to enhance the yield rate and to counteract the weather effect.
3. In view of possibility of realisation of better yields under irrigated condition as compared to rainfed conditions, measures to bring more area under irrigation are recommended.

However, further in depth study is necessary to identify (i) the factors contributing to increase the productivity of groundnut and (ii) the different constraints to the productivity of this crop.

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