PATTERNS OF AGRICULTURAL GROWTH IN INDIA: A STATE - WISE ANALYSIS

Dissertation Submitted in partial fulfilment of the requirements for the award of the Degree of Master of Philosophy in Applied Economics of the Jawaharlal Nehru University, New Delhi

RAMAKRUSHNA PANIGRAHI

CENTRE FOR DEVELOPMENT STUDIES
TRIVANDRUM

1995

July 21, 1995

I hereby affirm that the research for this dissertation titled "Patterns of Agricultural Growth in India: A statewise Analysis" being submitted to the Jawaharlal Nehru University for the award of the Degree of Master of Philosophy, was carried out entirely by me at the Centre for Development Studies, Thiruvananthapuram

Ramakrushna Panigrahi

Certified that this dissertation is the bonafide work of Ramakrushna Panigrahi. This has not been considered for the award of any other degree by any other University.

K. Pushpangadan
Associate Fellow

Supervisor

Chandan Mukherjee
Director
Centre for Development Studies
Thiruvananthapuram

ACKNOWLEDGEMENTS

At the outset I wish to express hearty thanks to Dr. K. Pushpangadan and Dr. K.P. Kannan for their valuable guidance. Dr. K. Pushpangadan took personal interest at every stages of my dissertation and taught me how to be precise and to the point. For the pain he took to see my dissertation work through and the spirit with which he encouraged me throughout, I remain grateful to him. Prof. Kannan has encouraged me a lot and his guidance helped me to learn to be logical and accurate. I owe a lot to him.

I am greatly indebted to Prof. Nilakanth Rath and Prof. Nityananda Sarkar for their valuable suggestions at the initial stages of this work.

During my stay in Bangalore I have greatly benefitted from discussions with Prof. M. V. Nadkarni and my sincere thanks are due to him.

I learnt a lot from Prof. D. Narasimha Reddy and Dr. Pradipta Choudhury in Hyderabad. Their inspiration and affection to me would always be remembered.

Dr. Uday Shankar Mishra and Bhabi went through my work and their comments and suggestions were of much importance. I have benefitted a lot from them and their affection will be remembered for ever.

This work would not have taken the present form without Suresh, Srijit, Sanjith, Kurup and Sudhakar. Their constructive criticisms were very important and the completion of the work was mainly due to the help they extended at the crucial phase. No word can express the feeling I have preserved for them.

Dennis and Saikat made my stay in Trivandrum memorable. I would preserve the moments I shared with them.

Apart from the academic help, Kurup, Sanjith and Suresh were so nice to me during my stay in C.D.S and their presence in the cards session and cricket session made the moments I shared with them cheerful. I would always remember Vinod for his advice and encouragement throughout my stay in Trivandrum.

Sudhakar, as a senior friend was very nice to me that I would be really surprised if I ever come across such a friend in my life.

My friendship with Ram Mohan and Bhaskar will never be forgotten. While Ram gave me company for chess, Bhaskar's jovial personality and enthusiasm added more life to the C.D.S. campus.

Anand Raj, Harilal, Pyarelal and Arvinder Singh as seniors were very nice to me during my stay in C.D.S. and my special thanks are due to them.

My stay at C.D.S. has given me a chance for a great exposure to people with experience and wisdom and I remain grateful to all the faculties. I also thank the library staff especially Joshi, Shobha, Ameer and Gopakumar for their help. Computer staff and all sections of C.D.S.community were helpful to me throughout. I take this opportunity to thank all of them.

I hope to preserve the happy moments with my friends Tomy, Raghu, Sara, Supriya, Piush, Pinaki, Rajib, Tirupati, Sebastain, Nebu and Subramaniam.

My friends Mihir and Venky never allowed me to be alone in Trivandrum. Mihir gave me company for last seven years and tolerated all my arrogance. I would miss him a lot. My stay would not have been enjoyable without the presence of Venky.

I have never come across an innocent boy like Pulak in my life. It will be of great disappointment to me if he fails to achieve that he deserves.

Back in ISEC, Dr. Rajasekhar gave extensive comments on an early draft of this work, his valuable suggestions are highly acknowledged. Dr. Mathiyazhagan has been a constant source of inspiration to me. His friendship, guidance and company will be remembered.

Sushanta Bhai helped and taught me a lot in both academic and non-academic affairs. My stay in Bangalore would have lost its charm without his company.

My friends Shettigar, Puttaswamiah and Kamble gave me nice company in ISEC. Sadabhai, Kashibhai, Gada and Anita apa, took extra care in Bangalore.

Ramakant has been with me at every stage of my work as well as in my life. I shared all my happy and sad moments with him and he helped me a lot to get over the weak moments in my life during last nine years. No word can express the feelings I preserve for him.

My brothers encouraged me a lot on my decision to pursue higher studies. My Bhabis have inspired me a lot and are more concerned about my academic career. The decision of taking another course after two years away from home would not have been possible without the encouragement of my sisters.

My mother was in great trouble due to my prolonged absence from home and it is painful to be away from her. My father took lots of pain to be away from me during the last few years. Their affection and blessings are the assets of my life. I dedicate this work to them with love and respect.

Ramakrushna Panigrahi

CONTENTS

List of Tables

List of Figures

Chapter 1

INTRODUCTION

1.1 The Problem

The crucial importance of agricultural growth in a predominantly agrarian economy has been amply emphasised in development theory. Erratic performance of agricultural sector leads to serious macro economic problems in the form of food crisis and adverse economic situation especially for developing economies. More so because the growth of industrial sector is highly dependent on agriculture for raw materials and its growth is fed in part by agricultural surplus.

The emphasis in the post independence period in the Indian economy has been on industrialisation, yet agriculture constitutes the largest proportion of the national income and remains the main source of livelihood for a large portion of the work force[1]. Agricultural sector remained stagnant throughout the first half of this century because of low levels of investment during the British rule. However, the post independence era witnessed a turning point as evidenced by growth in this sector which increased from 0.37 per cent per annum in the pre-independence period to around 3 per cent per annum in the post-independence period[2]. This acceleration in the growth rate was the result of the inception of new farm technology comprising High Yielding Varieties of seeds and other farm inputs.

---

[1] Dutt and Sundaram (1995)

[2] Bhalla and Alagh (1979)

Despite the growth in agricultural production, the country experienced an acute shortage of food-grains till the late 60's due to higher population growth. This necessitated imports of foodgrains and other agricultural commodities. To overcome the dependence on imports, the prime objective of the earlier five-year plans was to achieve self sufficiency in the foodgrains production, aiming at a growth rate of 4 to 4.5 per cent per annum. Unfortunately, the actual growth rate of agricultural production could not surpass the population growth rate during the period 1950-52 to 1975-76 and this resulted in heavy payments towards the import of foodgrains. However, the trend in the agricultural production in the 1980's reveals a reversal of the earlier situation with the agricultural sector exhibiting high growth rate than that of the population.

India being a large country, exhibits heterogeneous growth pattern in the agricultural sector[3]. The variations in productivity across the states is reflected in the performance of regions. The phenomenon of green revolution with the application of modern farm inputs, improved production technology resulted in remarkable growth of agricultural sector in late 1970s. However, the fruits of green revolution could not reach to many parts of the country and its impact was more pronounced in few states[4]. Thus, the growth of agricultural sector at the national level could not be explained by the green revolution alone. There remains, therefore, a need to look for other factors that are responsible for the differentials

---

[3] Sidhu(1994).

[4] States like Punjab, Harayana and Uttar Pradesh are often cited as examples.

in agricultural productivity across the Indian states to explain this growth phenomenon.

The ongoing globalisation process demands increase in level of yield in order to compete in the world market. Compared to world standards productivity levels in India are low and there exists vast regional disparities across the regions. The low level and disparities in productivity can be attributed mainly to the under-utilisation of resources in agriculturally backward states and the regions which have the necessary potential for achieving a very high level of productivity[5]. This stresses the imperative need to identify the factors responsible for low level of productivity and disparities across the regions.

In this context, it should be mentioned that, one of the important resources available, i.e. human resource, has never been systematically incorporated in the studies on agricultural performance in India[6]. Growth in human resource could be both quantitative as well as qualitative, though for analytical purposes, usually it is the quantitative aspect, represented by population growth that is considered. There are two schools of thought with regard to the population growth and agricultural development; (1) Malthusian; and (2) Boserupean. Malthusian thought attributes a negative role to population growth in the development process. While contradicting this theory, Boserup argues that population growth leads to agricultural development through induced

---

[5] Bhalla and Alagh (1979) and Bhalla and Tyagi (1989) highlights this issue.

[6] The only exception being Boyce (1987) in the case of West Bengal.

innovation and technological change[7]. However, this hypothesis has never been incorporated in the studies on productivity differences across the regions in the Indian context. In the present study we examine, following the Boserupean argument, the impact of population growth on agricultural productivity.

In the context of globalisation and liberalisation, it would be of importance to raise issues concerning the growth pattern and productivity levels in the agricultural sector. As India's tradable items mostly constitute of non foodcrops the performance of this assumes importance. Hence, a detailed study on growth patterns of non foodcrops is taken up in the study. Also, an analysis of foodcrops and non foodcrops to assess the overall performance of the agricultural sector is conspicuous by its absence in available literature. The present study is an attempt to fill this lacunae.

1.2 Objectives of the Study

The main objective of the study is to analyse the growth pattern in the Indian agriculture and to identify the factors affecting the productivity levels across the states. To be more specific the study attempts to :

(i) estimate the growth of area, production and yield of major foodcrops and non foodcrops, at the state level for the period 1967-68 to 1991-92, and for the sub-periods; 1967-68 to 1979-80, and 1979-80 to 1992;

---

[7] Boserup (1965); Boserup(1981); Boyce (1987).

(ii) analyse the growth patterns between the sub-periods at inter-state level and to bring out the extent of regional variations in productivity;

(iii) identify the factors which have contributed to the productivity differences across the states;

(iv) examine the impact of population growth on agricultural productivity.

(v) examine the role of technological innovation and diffusion in determining the productivity growth.

1.3 Coverage

The study covers 17 states that account for nearly 98 percent of the country's total agricultural production. They are Uttar Pradesh, Punjab, Madhya Pradesh, Andhra Pradesh, West Bengal, Orissa, Maharashtra, Bihar, Haryana, Rajasthan, Tamil Nadu, Karnataka, Kerala, Gujarat, Assam, Himachal Pradesh and Jammu & Kashmir. This study confines itself to the crop output which accounts for four fifth of the total agricultural production, on an average. The study covers all the major crops for which the time series data are available.[8] The coverage of time period is from 1967-68 to 1991-92. The rationale behind the selection of this period is discussed in chapter 3.

---

[8] The details on crops included in the analysis and the data sources are discussed in chapter 3.

1.4 Organisation of the Study

The present study is organised into six chapters including the introductory chapter. Chapter 2 briefly reviews the relevant literature on the pattern of agricultural growth in India. The sources of data and the methodology are discussed in Chapter 3. This chapter also explains the rationale behind the choice of the time period and the sub-periods. The trend in agricultural production and the sources of growth during the period of study are also analysed in this chapter. In Chapter 4, state-wise agricultural growth pattern for the period 1967-68 to 1991-92 and for the sub-periods are analysed at both aggregate and dis-aggregated level. Chapter 5, focuses on the factors affecting the productivity at the state level. The factors responsible for inter-regional disparities are identified using multiple regression techniques. The influence of population growth on agricultural development is examined in this chapter. The role of technological change and technology diffusion in determining the productivity growth are also examined in this chapter. Chapter 6 concludes the study, brings together the major findings and highlights the results from empirical exercises.

Chapter 2

AN OVERVIEW OF GROWTH PATTERNS IN INDIAN AGRICULTURE

2.1 Introduction

Empirical investgations show that the agricultural performance of India has been lagging behind that of other predominantly agrarian economies. Despite its potential to raise the productivity to international level, Indian growth experience has not been remarkable, even after four decades of planned development. While comparing Indian performance with the developed countries where the agricultural sector is highly modernised, it can be observed that there exists huge difference in the return and yield per hectare[1]. The growth of output in agricultural sector has been consistently below the expected target, mainly due to low productivity and variations in output across different states. More specifically, certain states have performed extraordinarily well[2] in sustaining not only the high growth in production, but also the growth in productivity. But the poor performance of certain other states[3] offsets these achievements. This regional difference in the growth affects overall growth at the aggregate level. Several studies have attempted to analyse the growth pattern and to identify the main factors responsible for the regional variations in the growth and productivity of Indian agriculture.

---

[1] Bhalla and Tyagi(1989); Dutt and Sundaram(1995).

[2] For example Punjab, Harayana, Uttar Pradesh and Andhra Pradesh.

[3] States like Kerala, Gujarat, Maharashtra, Jammu & Kashmir.

The present study assumes importance for the reasons cited below: (i) this analysis updates the growth patterns by extending the time series data upto 1992, (ii) the crop wise and state wise analysis include the whole of agricultural sector without omitting any crop for which long comparable time series data has been compiled, where as the earlier studies[4] have not included the same in their analysis, (iii) this study attempts to establish the relationship between productivity and its determining factors, (iv) the Boserupean argument is also incorporated in the analysis to understand the extent of the influence of population growth on productivity growth in Indian agricultural sector, and (v) the analysis attempts an indepth study of productivity variations across the states which have not been incorporated in many of the earlier studies, (vi) the study also explains the role of technological development and its diffusion in determining the productivity growth. Rest of this chapter is devoted for a critical review of the existing studies.

2.2 A Brief Survey of the Existing Literature

The major studies on growth performance of the agricultural sector is reviewed in this section. More specifically, these studies are classified as; (i) studies at all India level and (ii) studies at state level. Among them, the important state-wise studies analyzing the all India pattern will be briefly presented in Section 2.2.1. Further, some important studies analyzing the growth pattern in specific states are briefly presented in section 2.2.2.

---

[4] The studies with regard to the agricultural growth and productivity are precisely reviewed in the following section of this chapter.

2.2.1 Studies analysing agricultural growth at all India level

The existence of variations in production and productivity across the states in India has been investigated in number of studies. Among the studies, analysing the agricultural growth pattern in the post green revolution period, the study by Bhalla and Alagh (1979) occupies prominence. In their study they have covered all the districts of the 13 states considering nineteen major crops and have compared the performance of the sector in two time periods, 1962-65 and 1970-73. These two periods were taken as pre and post-green revolution period. The study finds that assured irrigation and high rainfall determine high level of productivity. They also found that the modern inputs are highly concentrated in the high productivity regions as well as high growth areas and there exists large scale variations in the level of productivity across the regions.

Joshi and Haque (1980) examined the relative role of the various inputs like fertiliser, irrigation, HYVs and credit while analyzing agricultural growth patterns and factors determining productivity differentials. Apart from this, they had examined the role of rainfall and technology (using time as a proxy) in determining the level of productivity. They found that fertiliser, irrigation, HYVs and credit are the major determinants of the productivity variations across the states and these factors explain more than 50 per cent of the inter-state disparities across all the 15 states covered in their study.

Parikh (1980) analysed the state specific as well as crop specific growth in agricultural output. The study examined the regional

pattern of growth in the agricultural sector and explains the regional variations in growth performance in terms of growth rates achieved in various sates. However, Parikh's study is silent with regard to the factors affecting the productivity variation.

Mahendradev (1987) studied the growth pattern and the instability in the foodgrains production for the period 1970-71 to 1984-85. The inter-state analysis covering 17 states, emphasises more on the instability in the foodgrain production. The study found that the rainfall and weather explain the growth in the foodgrains production at all India level and state level and points out that, most of the states which recorded high growth rates have shown significant instability in foodgrains production. The study concludes that the states which recorded low growth with increasing instability show high incidence of poverty.

Bhalla and Tyagi (1989) analysed the patterns in the development of Indian agriculture in their district-level study, which covered 17 major states and 19 crops. The study period was 1962-65, 1970-73 and 1980-83 which they named as 60's, 70's and 80's respectively. In their study, they also analysed the state level performances in the growth of production and yield for all these states. The results of the study of Bhalla and Tyagi can be briefly presented as follows.

The large inter-district disparities in productivity level which was already in existence got further accentuated due to introduction of new technology in 60's.

Compared to the first period, there seems to be some positive developments in the spread of new technology during the second period. Thus between these two periods some important changes have taken place in the spatial pattern of agricultural development.

It is evident that there exists a positive correlation between the levels of productivity and use of modern inputs like fertilisers, tractors and tube-wells.

The new seed-fertiliser technology has played a major role in raising yield levels of various crops and thereby augmenting agricultural production in India since mid 60's. They suggested to employ new technology intensively to achieve the targeted growth in agricultural output. To reduce regional inequalities they suggested large infrastructural investments to be directed towards hitherto neglected eastern and central parts of India.

Ahluwalia (1989) studied the sources of growth in rice and wheat output over the period 1970-71 to 1983-84. His analysis included major rice and wheat producing states together with a national scenario. The study analysed the growth patterns for the peak period and also for the trough period. The peak period includes the years 1970-71, 1978-79 and 1983-84. The trough period includes the years 1972-73 and 1979-80. The major conclusions at the aggregate level are :

Output differences between peak and trough years are primarily due to variations in yields on un-irrigated land.

Irrigated yield increases have been substantial, and it has been an increasing source of growth in both rice and wheat output, especially the rice.

In the peak years, changes in area contributed more to growth in wheat than in rice. The better quality of the incentive package available to wheat growers might be behind this development. However, in the trough years the area components accounted for a greater share in the growth of rice than of wheat.

Ahluwalia (1991) has also examined the trends in growth of production in agricultural sector. He analysed the aggregate growth of production at state level and regional level. The study describes the agricultural performance in terms of five regions such as North, East, Central, West and South accounting for 15 major states. His state-wise and crop wise analysis deals with three time periods such as 1949-89, 1949-65, 1967-89. The study has analysed the sources of growth in production and found that for the 2nd period (1967-89), the main source of growth in production is growth in the yield, whereas in case of 1st period the growth in area was the prime contributing factor towards the growth of production. The study found that the high growth in agricultural sector can be achieved by a combination of better technology. According to him this will have to encompass improved drought or flood resistant varieties of HYV seeds, increased fertiliser

application, a strengthened input delivery system and committed extension services along with the provision of better infrastructure which will have to include rural roads, better marketing facilities, government procurement centers, improved water shed management and increased power supply to agriculture.

Sharma (1992) analysed the extent of productivity variations across the states. He has taken fifteen states and analysed the growth pattern and the growth in productivity for certain crops such as Wheat, Rice, Maize, Gram, Rapeseed & Mustard, Cotton and Sugar Cane. The study finds that the productivity ranking of crops in various states have changed noticeably over time. The study advocates for efficient education and training activities for the farmers and efficient supply network of various technological inputs which will reduce the productivity gap and thus can achieve a high growth at aggregate level.

Sen (1992) examined the impact of the economic liberalisation on the Indian agriculture. He pointed out that liberalisation would lead to increasing concentration of growth in output and marketed surplus, in a context in which there were already severe regional inequalities at the beginning of the 80's. He indicates a downward trend in the agricultural investment together with the decline in the public investment in agriculture and rural infrastructure. This has both direct and indirect effects through the concomitant decline in private investment, which has disturbing implications for the future patterns of growth, especially given the long term processes of ecological and soil degradation which are likely to affect agricultural productivity in future. He calls for an

increase in the public investment on infrastructure to augment high growth in the agricultural sector.

Dholakia and Dholakia (1993) had undertaken a study on the growth pattern in the agricultural sector with special reference to the total factor productivity growth. They have estimated the sources of growth of Indian agriculture for three sub-periods during 1950-51 to 1988-89. They have also estimated the contribution of adverse weather conditions and intensity of resource use to total factor productivity growth. They found that Total Factor Productivity Growth (TFPG) has contributed significantly to the acceleration of agricultural growth facilitating release of scarce resources from agriculture to other sectors in the economy. The study concluded that TFPG in agriculture has been the driving force behind the acceleration of overall growth in the Indian economy achieved during the eighties. They also found modern inputs like fertilisers, HYV seeds and irrigation to be the major determinants of the TFPG.

In their study Dholakia and Dholakia have adopted a broad definition of agricultural sector to include not only the crop farming but also animal husbandry, plantations, orchards, fishery, forestry and logging and thus the agricultural sector defined in the study is overestimated and thus the validity of the results could be questioned with particular reference to the agricultural sector which does not include all the above mentioned sectors. The study also lacks analysis for the state-wise performance and only gives an overall macro-picture with a broader definition of the agricultural sector. Finally the study highlights very little

regarding the growth pattern for the states which is major part of our concern.

Sidhu and Sidhu (1994), in their state wise analysis of agricultural productivity, found that public and private investments have tremendously influenced the agricultural productivity. They have covered 20 major crops and 17 major states which include Jammu and Kashmir, and Himachal Pradesh. They have discussed the salient trends of productivity in agricultural sector for the two time periods such as 1949-50 to 1964-65 and 1967-68 to 1988-89. The study mainly analysed three aspects of productivity such as land productivity, labour productivity and capital productivity. They have traced out the factors which are responsible for the agricultural output. They include fertilisers, irrigation, HYVs, credit and Rainfall as the important explanatory variables for the agricultural output. Out of these variables, fertiliser consumption and area under high yielding varieties were found to be the most important determinants of agricultural growth in most states. It was also pointed out that the public and private investments were highly influencing the growth in agricultural productivity. The network of establishment of agricultural universities throughout India was identified responsible for promoting agricultural education and research and thus in the growth in the agricultural sector.

Mishra and Bajpai (1994) analysed the growth performance of the Indian agriculture with special reference to irrigation. The following are the main results:

Yield per hectare in agriculture (particularly of food-grains) is positively correlated with expansion of irrigation facility.

Extent of deficiency in rainfall significantly influences yield in un-irrigated areas whereas it has significant effect in irrigated areas.

Fertiliser accompanied by irrigation facility explains more than 82 per cent of increase in yield.

They have suggested to reduce time and cost overruns in major and medium irrigation projects and to step up irrigation efficiency from its current low levels of around forty per cent. Finally, they have suggested to reduce losses on irrigation projects and to expand the installation of modern irrigation devices such as drip irrigation.

Rao (1994) analysed the trends, perspectives of agricultural growth and rural poverty in India. He explained the experience of the agricultural growth and the emerging perspectives in the context of farm subsidies, bio-technology, dry land development, credit reform, decentralisation and the trade liberalisation. His focus was mainly on the agricultural growth and rural poverty in India in the context of liberalisation and economic reforms. Even though the study could not give a detailed analysis of the Indian agriculture it is helpful to understand the impact of the liberalisation on growth performance.

Dandekar (1994) has updated and put together his writings on Indian agriculture spanning forty years after independence. He has identified the basic problems of Indian agriculture as it has to bear the disproportionately large burden of population which causes net capital consumption rather than capital generation. He has analysed the growth trends of the Indian agriculture which provides an overall idea of the performance of the agricultural sector.

Sawant and Achuthan (1995) analysed the agricultural growth across crops and regions. They have taken post green revolution period 1967-68 to 1992-93 for their analysis and divided the total period into two sub periods as 1967-68 to 1981-82 and 1981-82 to 1992-93. The study covered 15 states excluding two major states Jammu & Kashmir and Himachal Pradesh, where the growth pattern in the above mentioned period is quite impressive. Regarding crops the study did not cover all the major crops, which have significant contributions to the total agricultural production. The methodology in the calculation of growth rates and estimating the index number is not properly explained and justified in this study. The study points out the following observations.

The favourable weather condition is not the determinant of the growth of aggregate production and productivity in Indian agriculture. The role of yield improvement plays a major role in the growth of output and growth has been technologically more dynamic. The study advocated for sustainable development in the agriculture without any theoretical justification. They prescribed higher inter-crop and inter-regional dispersal of

investment and its improved utilisation for achieving high growth in Indian agriculture.

The study also shows some statistical analysis of the agricultural sector at disaggregated level. But the study failed to give theoretical justification of the methodology used and choosing the time period and break point. The study could highlight very little regarding the inter-state variations in the productivity. The present study attempt to clarify the above shortcomings of the earlier studies and makes an indepth analysis regarding the productivity variations.

The above mentioned major studies which are undertaken to assess the growth pattern in the Indian agriculture are precisely presented in Table 2.1. The table explains the period of study, nature of the studies and the major findings at the all India level as well as inter-state level.

Table 2.1: Studies analyzing agricultural growth at all India level

Authors and Year	period of study	Nature of study	Results and Findings
Bhalla and Tyagi (1979)	1962-65 and 1970-73	District wise analysis of growth pattern	productivity is determined by irrigation, rainfall and modern inputs
Joshi and Haque (1980)	1955-56 to 1975-76	Statewise analysis of productivity growth and productivity variations	Fertiliser, rainfall, credit, HYVs, irrigation and time determine productivity and variations
Parikh (1980)	1950-51 to 1977-78	statewise and cropwise study of growth patterns in the sector	Large scale variations across the states in the growth performance and productivity level
Mahendr adev (1987)	1970-71 to 1984-85	statewise growth and instability in agriculture	Low growth with increasing instability have high incidence of poverty
Bhalla and Tyagi (1989)	1962-65 to 1980-83	District level growth pattern and cropwise analysis (All India)	New technology widened inter-district disparity. New seed-fertiliser technology as major determinant of productivity.
Ahluwal ia,1989	1970-71 to 1983-84	Statewise analysis of sources of growth in Wheat and Rice output	Output differences are due to variations in yield in irrigated area and area contributed more to growth of output
Ahluwal ia,1991	1949-50 to 1988-89	Statewise and cropwise analysis of growth pattern	Better technology, flood resistant HYVs, increased fertiliser application, strong input delivery system and infrastructure would increase the productivity level.
Sharma (1992)	1966-67 to 1988-89	state wise analysis of the growth in agricultural sector	Efficient education and training, efficient supply net work of inputs could reduce productivity gap

Sen (1992)	analysis is for 80's and 90's	Impact of liberalisation on agricultural sector	Increase in public investment on infrastructure can augment high growth
Dholkia and Dholkia (1993)	1950-51 to 1988-89	Sources of growth in sector and the role of TFPG in determining growth	Modern inputs (fertilisers, HYVs and Irrigation) determine TFPG which determine the growth in sector
Sidhu and Sidhu (1994)	1964-65 to 1988-89	Sources of growth in productivity and the productivity variations across the states	Farm inputs are determinants of agricultural productivity. Public and Private investment network of agricultural research and extension are responsible for growth
Mishra and Bajpai (1994)	1970-71 to 1988-89	Relative importance of inputs in the agriculture and growth	Irrigation, Rainfall and fertiliser are the major determinants of agricultural growth and productivity
Sawant and Achutan (1995)	1967-68 to 1992-93	State wise and crop wise analysis of growth pattern in agriculture	Yield improvement is the main source of growth. It pleads for sustainable development Inter crop and inter regional dispersal of investment would result in the high growth in the sector.

Table 2.1 briefly presents the studies undertaken to analyse the growth pattern in the Indian agricultural sector. The studies are helpful in understanding the growth patterns in Indian agriculture. However, these studies have certain limitations. Most of the inter-state studies, analyse the growth patterns of only foodcrops and ignore the non foodcrops. The period wise analysis of the growth patterns in these studies are mostly for pre-green revolution period and post green revolution period. The problem of such periodisation is however, discussed in the chapter 3.

Most of the studies only explain the growth of the agricultural output and do not explain, in detail, the factors affecting the productivity level and the regional variations across the states. Except the study of Sawant and Achuthan, all the studies have covered the period till 80's. Since Indian agricultural sector witnessed a turn around in the 80's, the above mentioned studies need to be updated. The present study covers all the crops and states and assesses the growth patterns across the states. However, due to unavailability of data from the authentic sources[5] for certain states and for certain crops, the study presents an update only upto 1992.

After a review of the studies undertaken for the inter-state analysis, a few intra-state analyses are also briefly reviewed in section 2.2.2 which would help us to understand the growth performances and the patterns of productivity growth at the state level. Among intra-state studies only three important studies of Boyce, Kannan & Puspangadan and Saha & Swaminathan are discussed in the following section.

2.2.2 Studies analysing growth patterns at state level

Boyce (1987) analysed the crop-wise and district-wise agricultural growth pattern in Bangladesh and West Bengal for a time period 1901-1981, with emphasis on the period 1949-1981. For the post-independence period he analysed the growth pattern in two time periods such as 1949-64 and 1964-1981. The study found that there was never a very high level of growth in West Bengal. So far as

[5] Data for the present analysis are collected only from the publications of the Ministry of Agriculture, GOI. The data for 1993 and 1994 were not available till the completion of the empirical exercises.

productivity is concerned the performance of Bangladesh is more consistent compares to that of West Bengal. He analysed the agricultural growth vis-a-vis population growth and found a strong positive association between rural population density and land productivity. Contradicting the Malthusian view on population problem being the fundamental economic problem in developing countries, Bengal exhibited a positive impact of population growth via the process of induced innovation, which support the Boserupean argument of population growth and technological change.

Boyce suggests several ways to promote agricultural growth, which would proceed via institutional changes, that is a redistribution of property rights in land so as to remove the barriers posed by the vested interests of the rural elite and the creation of the institutions to achieve collective action in water control, starting with seasonal earth moving activities and moving to more capital-intensive options as required by local conditions.

Kannan and Puspangadan (1990) assessed the growth in Kerala's agricultural sector across crops, seasons and regions while addressing the question of agricultural stagnation in the state. The study analysed the trends in profitability and earnings instability and found that the profitability test does emerge as a proximate reason for the growth performance of most of the crops. They argued that demand played a dominant role in the earning instability of few crops. They also argued that the supply factors were responsible for the earning fluctuations for few crops. The findings suggest that any policy for stabilising income of the

farmers should concentrate on both supply and demand factors. The major findings of the study are the following:

> The most important component of any strategy for agricultural development in Kerala is to make technical change as the main source of growth. Given the intensity of land-use, cropping pattern, abolition of intermediation through land reforms, existence of a network of agricultural research, extension and credit services and above all, the relatively higher level of education among the farming community and their receptiveness to new ideas, Kerala's agriculture seems to have reached a threshold warranting an induced innovation strategy so as to break out of its technological stagnation.

Saha and Swaminathan (1994) analysed the agricultural growth in West Bengal at a disaggregated level in the 1980's and showed that West Bengal is far ahead of the national average and has marked a growth rate of 6.5 per cent in food-grains production. They have examined the performance of food-grains production at district level and estimated the instability coefficients associated with the growth performance for each districts. The study finds that, despite the poor performance in the agricultural sector in 1970's, West Bengal could achieve a very high growth rate in the 1980's in terms of food-grains production. They have pointed out that the adoption of HYV and improved farming practices are the major determinants of growth in West Bengal. They attribute higher growth to the active participation of the Panchayat institutions in production-related activities like water management and irrigation related earthwork of different kinds. Besides, the Panchayats are

involved in ensuring that the cultivators receive electricity for agriculture and the allocation of rural credit.

The above intra-state analysis of West Bengal and Kerala gives us an overall idea with regard to the growth patterns in these two states. The studies on these two particular states are highlighted in this section as both the states have shown peculiar growth patterns. While West Bengal has shown tremendous increase in the productivity in the 80's, Kerala experienced a negative growth in the sector, even though its position with regard to the productivity (yield/hectare) is just next to Punjab and thus ranked as second among the major states.[6] Thus the growth pattern of these two states are discussed in detail in the present analysis.

The present study attempts to test empirically the role of various inputs and other factors in determining the productivity growth over the years and explains the sources of agricultural growth achieved in India during the post green revolution period. It also traces out the major factors responsible for the productivity variations across the states and estimates the extent of regional disparities. Moreover, this study analyses the Boserupean view of population growth and agricultural development in the context of Indian agricultural sector. The empirical exercise and the results for each states are presented in the analysis and the role of population is examined in determining the productivity growth.

Above discussion leads us to conclude that the states which were performing very poor till late 1970's, their growth performance in

[6] For detail see section 8 of chapter 5.

1980's are extremely satisfactory and thus the performance of the agricultural sector had witnessed a turn around in 1980's for certain states. But unfortunately the above mentioned studies could not take into account the growth pattern of non food agricultural crops as well as agricultural sector as a whole for the states at an aggregated level. While most of the studies have highlighted only the food-grains production and not the agricultural sector as a whole the present study attempts to incorporate the non-food agricultural crops as well.

2.3 Conclusion

In this chapter we have briefly reviewed the existing literature with regard to the agricultural growth patterns and productivity variations across the states. The present state wise analysis is important as it not only updates and extends the earlier studies but also analyses the impact of population growth on the agricultural development. By incorporating population as a determinant of growth in productivity, the study goes for an indepth analysis to trace out the factors influencing the productivity in various states. From the literature it is evident that modern farm inputs, credit, assured rainfall, population, profitability, public and private investment are the most plausible factors which influence the level of productivity. This study examines the role of various factors in determining the level of productivity, as a prelude to this in the trend in the agricultural production and the sources of growth are discussed following chapter.

Chapter 3

TRENDS IN AGRICULTURAL PRODUCTION IN INDIA

3.1 Introduction

It is observed that Indian agricultural sector has registered a high growth rate in production and yield in the 80s as compared to the earlier period. This chapter attempts to evaluate the trends in the production and yield and the sources of growth at the all India level. Even though the main purpose of this chapter is to analyse the sources of growth, it also provides data sources and explains methodology adopted for estimation of output growth, its components, growth in area and yield in agricultural sector in India for the period 1967-68 to 1991-92. Before analysing the performance, we provide the rationale behind the selection of time periods and the crops selected.

The organisation of this chapter is as follows. Section 3.2. provides the data sources, their comparability and reliability. It also deals with the periodisation and the coverage of the study. Section 3.3 will explain the method used for the construction of Index numbers and the estimation of growth rates for the foodcrops, non-foodcrops and all crops for the entire period and sub-periods. Section 3.4 examines the trends in the agricultural production and its major features at the national level. Finally, section 3.5 includes an explanation for the sources of growth observed in the agricultural sector during the period.

3.2 Sources of Data

In the present analysis all the crops and the states are included for which time series data are available from the secondary sources. The sources of data for the state wise analysis are from various issues of "Area, Production of Principal Crops in India" published by the Ministry of Agriculture, Government of India. Apart from these sources, data has also been collected from the Directorate of Economics and Statistics (DES) of various state governments. Data published in the volume "Agricultural Situation in India" from time to time are also used. The data with regard to the prices are collected from the "Agricultural prices" published by the Directorate of Statistics and Economics.

3.2.1 Selection of the period and sub-periods

While analyzing the performance of agricultural production, it is customary to divide the entire time period into pre and post green revolution period. But as this study confines the analysis to the post 1967-68 period, it is important to justify the rationale behind the selection of time period. We have taken the base period as 1967-68 for our analysis mainly because of the following reasons:

(i) For most of the states and crops the method of data collection before 1967-68 were not on the basis of crop cutting surveys based on systematic sampling[1]. The methods of data collection were usually based on the reports of the village chowkidars and accountants, and such reports were usually made on the basis of guess work. Thus, data collected are highly unreliable and also not

[1] See "Area and Production of Principal Crops (1989)" published by Ministry of Agriculture, GOI.

comparable with the data collected through crop cutting surveys. It is not that before 1967 the method of crop cutting surveys was not introduced, but for the most of the states and crops the data collection method was on the basis of reports as mentioned above. Thus, data collected through these crop cutting surveys are considered more reliable and superior over the data collected through reports of village accountants and chowkidars. Though this method was not adopted for the entire sector even after 1967, it was used in the case of most of the crops in most of the states. It has been already mentioned those crops, for which crop cutting surveys were not adopted after 1967-68, had a low share in the total production.

(ii) Certain states which are considered for this analysis were formed only in mid fifties. (For instance Kerala was formed in 1956). Therefore separate data for such states are not available and thus the inter-state analysis sounds handicapped with the absence of data for individual states for that time.

(iii) As mentioned earlier, it has been conventional to consider the period 1950-51 to 1964-65 as the pre green revolution period and the period after 1965 as post green revolution period[2]. But such a periodisation could be considered inappropriate due to the non-comparability of data as mentioned in the first point. Secondly, the so-called impact of green revolution was experienced only in very few states and remaining states did not experience any sort of impact of green revolution. Thus in a state-wise analysis it does not look appropriate to consider the periodisation on the basis of the impact of green revolution where most of the states did not experience the impact of green revolution.

---

[2] See Mahendradev(1987), Joshi and Haque (1980) and other studies.

3.2.2 Selection of sub-periods

In the present state wise analysis we have divided the entire period into two sub-periods such as 1967-68 to 1979-80 as first period and 1979-80 to 1991-92 as second period. For the sake of convenience first period is termed as 70's and second period as 80's in the subsequent chapters. The rationale behind the selection of 1979-80 as break point is as follows. For all India Index of area, production and yield and for almost all the states there is a break in the trend of the production and yield figures in the year 1979-80, which is evident from the graph 3.1, 3.2 and 3.3. As far as individual states are concerned, 13 out of 17 states show a break in the trend of agricultural production. At a dis-aggregated level we have found from the graphs (where index of production and yield are plotted against each year) that, for foodgrains except for Andhra Pradesh, Kerala and Punjab the data for all other states justify 1979-80 as the break point in the time trend. With regard to non-foodgrains, except for seven states the index of all other states justify the same year 1979-80 as the break point. For agricultural production as a whole except for five states all other states show 1979-80 as the break point in the trend of area, production and yield of the sector. Thus on the basis of trend in the agricultural production and yield, 1979-80 is taken as the break point in the time that divides two sub-periods as 1967-68 to 1979-80 and 1979-80 to 1991-92 in our analysis.

3.2.3 Coverage

For our analysis we have covered 17 major states which have been already discussed in the section 1.4 of chapter 1. The remaining states account for a very low proportion of output in the aggregate

production and therefore have been excluded from our analysis. Secondly the time series data for these states are not available and thus comparative analysis of these states could not be taken into consideration.

Regarding the coverage of the crops, we have covered 44 crops and divided the agricultural sector into two heads, as total foodgrains and total non foodgrains. The analysis will focus mainly on the growth pattern of foodgrains and non foodgrains separately and on the overall agricultural production which include all the crops. The total foodgrain items include Rice, Jowar, Bajra, Maize, Ragi, Small Millets, Wheat, Barely, Gram, Arhar, and Other Pulses. The non foodgrain items include Groundnut, Sesamum, Rapeseed and Mustard, Linseed, Castor, Safflower, Nigerseed, Coconuts, Soyabeans, Sunflower Seeds, Cotton, Jute, Mesta, Sanhemp, Tea, Coffee, Natural Rubber, Chillies, Ginger, Turmaric, Pepper, Areca nuts, Coriander, Cardamom, Garlic, Potatoes; Sweet Potatoes, Tapioca, Bananas, Onion, Sugar cane, Tobacco and Guarseed. The figures for all crops have been derived by the addition of total foodgrain items and total non foodgrain items. In this state wise analysis we have included almost all the crops in the agricultural sector. But a few non-foodgrain items had to be excluded from the analysis because of the non-availability of adequate time series data for such items.

3.3 Index of Agricultural Production

The data on area and production of crops are available in terms of hectares and physical quantities. This data is available for

individual crops for the time periods required for the analysis. As the analysis will be on total foodgrains, total non-foodgrains and for all crops, we need the aggregate figures for the above mentioned categories of production. The total foodgrain figures were arrived by adding up the physical quantities of individual crops, as all the items were given in same unit of measurement that is in terms of thousand tonnes and the price differences were negligible. But to obtain the aggregate figures for non-foodgrain items,the figures cannot be added up, as the units of measurements of these crops are not same and the differences in the prices are extremely high from crop to crop. Therefore, weights have been assigned to the respective crops on the basis of their value. In this analysis constant prices have been used for of all individual crops to eliminate the effect of inflation. The average price of three years (1981 to 1983) for all the individual crops at the all India level have been taken as the constant price.

The index of the agricultural production for our purpose is constructed in the following way:

X_{ij} represents output production in physical quantities for crop i in year j.

P_{i0} represents constant price of crop i in the year 1981-83.

$P_{i0}\ X_{ij}$ represents the value of production of crop i in year j.

$\Sigma\ P_{0i}\ X_{ij}$ represents the total value of the production in the agricultural sector in the year j.

where i = crop 1,2,.....44th crop.

j = 1967,.....1992.

The values of $\Sigma P_{i0} X_{ij}$ is available for all the years from 1967-68 to 1991-92. The value of production of total foodgrains is $\Sigma P_{i0} X_{ij}$ where i represents only the foodgrains items. In the same way the value of non foodgrain items for different years can be obtained as $\Sigma P_{i0} X_{ij}$ where i represents only non foodgrain items.

In order to analyse the trend and also to estimate the growth rates the values of the aggregate production are indexed. In order to index the area under cultivation we have added up the area under cultivation for individual crops and then obtained the aggregates. Then we have taken the average of the total area under cultivation during three years, i.e., from 1980-81 to 19882-83.

After obtaining an index for the area, production and yield for all India figures, we have followed the same methodology in order to obtain the index number for all the seventeen states. These indices represent the trend in the area, production and yield for total foodgrains, total non foodgrains and the agricultural sector as a whole. The aggregate rates of growth and rate of acceleration in the agricultural sector are obtained by using these indices. The index of the all India data for the value of agricultural production is presented in section 3.8 of this chapter for reference and the index of agricultural production for the states are given in Appendix-I.

3.3.1 Estimation of growth rates

The literature on the issue of estimating growth rates of crop output is wide and vast and it is yet to be agreed unanimously

which functional form fits best[3]. However, in the estimation of the growth of output we have used the following exponential function.

$$\text{Ln } Y_t = a_0 + b_0 T + U_t \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where a is the intercept term;

b is the growth rate over the years.

T is the time trend

and U_t represents the error term.

When the growth rate is changing, then the regression coefficient in (1) is not constant but varying. This varying parameter can be modelled as a function of time[4]. If we postulate a linear relationship between rate of growth and the time T, we have

$$b = \alpha + \tau T$$

By substituting the value of b in (1) we have

$$\text{Ln } Y_t = a + (\alpha + \tau T) T + U_t$$

which implies

$$\text{Ln } Y_t = a + \alpha T + \tau T^2 + U_t \quad \ldots\ldots\ldots\ldots\ldots (2)$$

This equation provides the estimates of acceleration and deceleration in the growth rates. More specifically:

(i) growth rate is accelerating if $\alpha > 0$ and $\tau > 0$;

(ii) growth rate is decelerating if $\alpha < 0$ and $\tau < 0$;

(iii) decelerating from a positive growth if $\alpha > 0$ and $\tau < 0$; and

(iv) accelerating from a negative growth if $\alpha < 0$ and $\tau > 0$.

---

[3] See Dandekar,1980; Rao, 1980; Krishnaji, 1980; Rath, 1980; Srinivasan, 1979; Mukharjee, 1980; Boyce, 1987;Alagh, 1980.

[4] See Maddalla (1978; 380)

The regression coefficients of log-quadratic equation may have low precision due to the high multicollinearity between T and T^2. Therefore, a transformation of T is suggested to overcome this problem. The transformation is in the form [5]

$T' = T - n+1/2$, where;

n is the number of years for which we have the time series data. Now we can use T' instead of T; where T' and T'^2 are orthogonal and the estimates are free from the problem of multicollinearity. In order to estimate the growth rates and the hypothesis about the changes in growth rates at inter-state level, we have used the above log-quadratic function adjusted for multicollinearity between T and T^2.

3.4 Trends in Agricultural Production

The performance of Indian agriculture during the period is examined in this section. In Table 3.1, the index of area production and yield for all India data are presented from which we can draw an overall picture regarding the trend in the output level as well as increase in area and yield in the agricultural sector. The overall performance of Indian agriculture at aggregate level and dis-aggregated level can be seen from the Figures 3.1, 3.2 and 3.3. From Figure 3.2, it is evident that, for all crops the increase in area is very low, while increase in output and yield are high. The gap between production and area is more pronounced in the 80's, which shows that the growth in production is due to increase in the

---

[5] See Dandekar, 1980; Mukharjee and Vaidyanathan, 1980 Reddy, 1978.

yield rate. For foodgrains the same picture emerges which is evident from Figure 3.1.

3.1: Index number of area, production and yield for all India

	FOODGRAINS			NON FOODGRAINS			ALL CROPS		
	AREA	PRODUCTI	YIELD	AREA	PRODUCTI	YIELD	AREA	PRODUCTI	YIELD
67/68	95.60	78.05	81.70	88.31	72.58	82.34	93.92	75.95	80.95
68/69	94.82	77.45	81.74	84.14	71.56	85.20	92.36	75.19	81.50
69/70	97.30	81.70	84.04	88.30	76.73	87.05	95.22	79.80	83.89
70/71	97.88	87.89	89.86	90.71	81.15	89.63	96.23	85.31	88.75
71/72	96.55	85.99	89.13	92.91	81.80	88.20	95.71	84.38	88.26
72/73	93.92	79.22	84.41	87.15	75.21	86.46	92.36	77.68	84.20
73/74	99.63	84.82	85.21	92.96	87.04	93.80	98.10	85.67	87.43
74/75	95.33	81.19	85.24	92.61	87.80	94.98	94.70	83.73	88.51
75/76	100.93	98.89	98.05	94.65	90.24	95.52	99.48	95.57	96.17
76/77	97.92	98.82	101.00	93.47	87.30	93.57	96.89	94.40	97.54
77/78	100.64	103.05	102.48	98.65	98.65	100.18	100.18	101.36	101.29
78/79	101.58	107.07	105.49	96.61	101.15	104.90	100.43	104.80	104.46
79/80	98.58	87.88	89.21	96.41	90.40	93.94	98.08	88.85	90.68
80/81	99.73	104.36	104.73	99.40	97.53	98.30	99.66	101.74	102.20
81/82	101.68	107.76	106.06	104.19	112.07	107.70	102.26	109.41	107.10
82/83	98.50	105.81	107.51	102.43	107.07	104.70	99.40	106.30	107.00
83/84	103.27	122.93	119.13	104.38	111.87	107.30	103.53	118.69	114.70
84/85	99.80	117.68	118.02	103.41	118.47	114.70	100.63	117.98	117.30
85/86	100.81	123.32	122.43	104.12	113.23	108.90	101.57	119.45	117.70
86/87	100.14	116.80	116.73	100.57	112.92	112.40	100.24	115.31	115.10
87/88	94.25	113.77	120.82	101.57	118.77	117.10	95.93	115.69	120.70
88/89	100.53	137.97	137.36	112.71	143.34	127.40	103.34	140.03	135.60
89/90	99.82	138.89	139.25	115.83	150.00	129.70	103.51	143.15	138.40
90/91	100.67	143.45	142.61	119.95	156.42	130.60	105.12	148.43	141.30
91/92	95.75	136.18	142.34	122.94	156.96	127.90	102.02	144.15	141.40

[Source : Estimated]

However, for non-foodgrains, we see from Figure 3.3 that, the growth in area is higher than that of the growth in production and also yield upto early 80's. But after early 80's the growth in area fell short of growth in yield and production, even though the gap is not high as in case of foodgrains and all crops. Thus, it is evident that there was a shift in the area from foodgrains to non foodgrains during the post-green revolution period. It is apparent that in 80's the growth in production and yield at the aggregate

level as well as at dis-aggregated level were higher than that of the 70's. Hence in the following section we shall examine the sources of growth observed during the period 1967-68 to 79-80 and 1979-80 to 91-92.

Figure 3.1

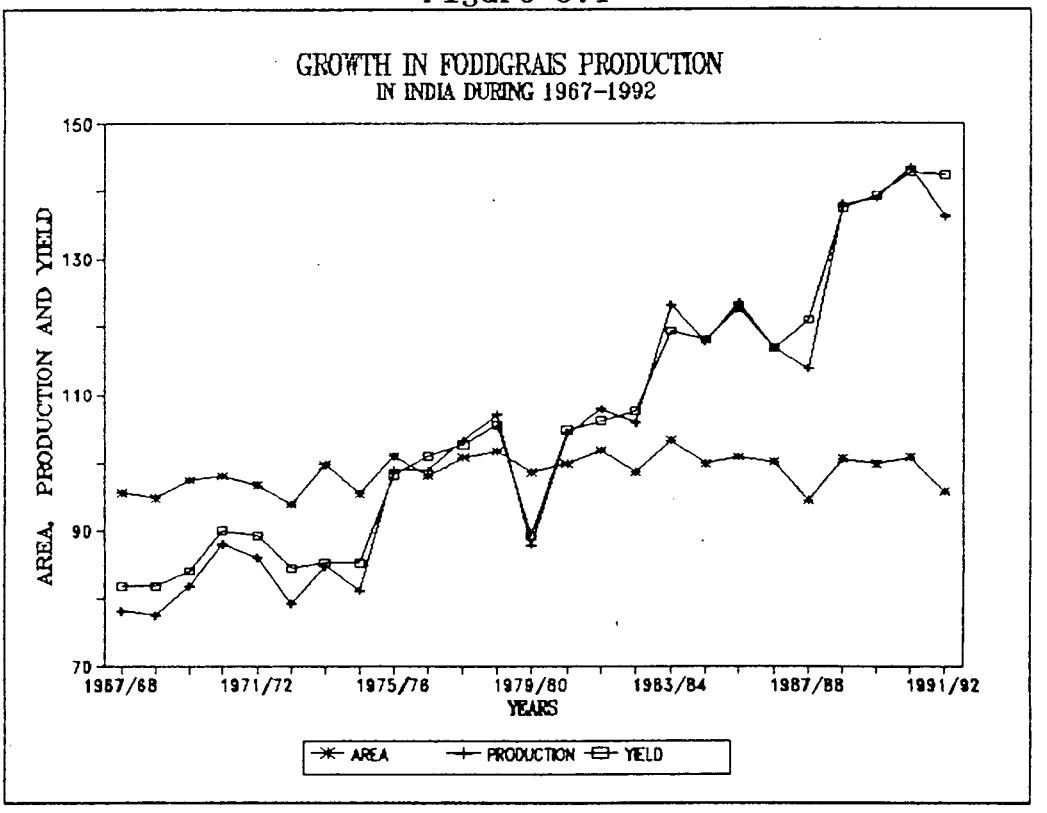


Figure 3.2

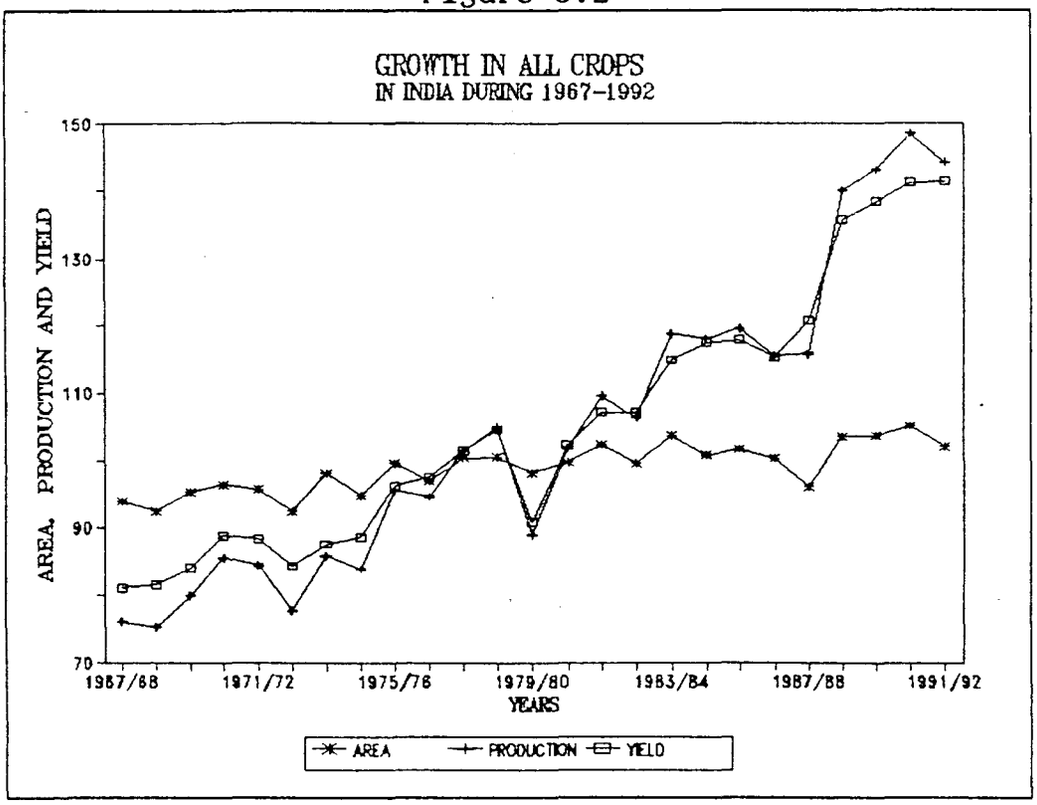
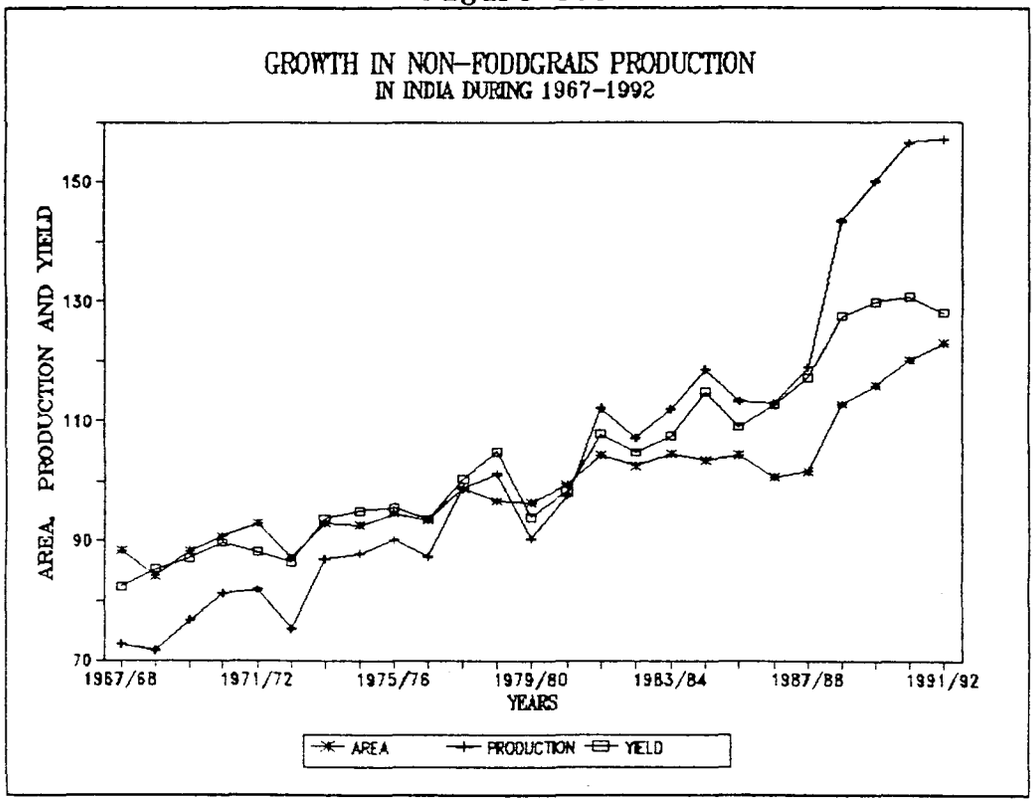


Figure 3.3



3.5 Sources of Growth

The growth in output could be explained either due to the growth in area under cultivation or due to growth in the yield per hectare. It is obvious that neither growth in area alone nor growth in yield has given rise to the growth in production. The growth might be due to area or yield or could be due to both. Here we shall analyse the sources of growth in the output production which India has witnessed since 1967-68. In order to analyse the sources of growth of production we have to examine the overall growth performance of area, production and yield separately.

Table 3.2: All India growth rates foodgrains, non foodgrains and all crops

CROPS		1967/68 TO 1979/80	1979/80 TO 1991/92	1967/68 TO 1991/92
FOODGRAINS	AREA	0.51*	-0.15	0.14 *
	PRODUCTION	2.27*	2.74 *	2.54 *
	YIELD	1.75 *	2.90 *	2.39 *
NON FOODGRAINS	AREA	0.92 *	1.51 *	1.25 *
	PRODUCTION	2.33 *	3.69 *	3.09 *
	YIELD	1.41 *	2.18 *	1.84 *
ALL CROPS	AREA	0.59 *	0.25 *	0.40 *
	PRODUCTION	2.29 *	3.11 *	2.75 *
	YIELD	1.69 *	2.86 *	2.35 *

[Source : Estimated]
* Significant at 5 per cent level.

From Table 3.2, we can discern that, for the period 1967-68 to 1991-92, for foodgrains the growth in area is only 0.14 per cent, while the growth in yield is 2.39 per cent. This clearly shows that the growth in yield mainly explains the growth in the production of output. In case of non-foodgrains, the growth in area is 1.25 per cent, where the growth in yield is 1.84 per cent,

giving a 3.09 per cent growth in production per annum. Here the growth in area is mainly because of the fact that the returns from the non foodcrops are far higher than that of foodcrops. It is also observed that there had been a shift from food to non foodcrops over these years. In the case of All Crops, the growth in area is only 0.4 per cent, where as the growth in yield is 2.35 per cent, which gives a growth rate of 2.75 per cent per annum. This clearly shows that the growth in All Crops is explained due to the growth in yield for the whole time period under the study as the scope for increase in area is very limited due to high population growth and increasing incidence of urbanisation throughout the country.

The growth pattern reveals that the growth in area declined over time. In case of foodgrains it declined from a growth rate of 0.51 per cent in the first period to -0.15 per cent in the second period. In case of non-foodgrains, even though the growth of area increased from 0.92 per cent to 1.51 per cent because of the shift of the cropping pattern in favour of the cash crops which is mainly because of favourable prices and higher yield, the overall growth of area has declined from 0.59 per cent to 0.25 per cent in case of All Crops in the sector.

It is evident from the table that, in case of foodgrains and All crops, the growth in production is mainly due to the growth in yield. It is also evident that there is a shift in the growth of area from foodgrains to non foodgrains over the time and overall growth in area declined over the years considered for this study. From the period 1967-68 to 1992-93, the main source of growth in production has been the growth in the yield. In the second period

the growth in production is more explained by the growth in yield compared to the first period because of the modernisation of agriculture with the support of High Yielding Varieties (HYVs) and irrigation which is explained in detail in chapter 5, as we see that the contribution of area to the total growth of production is almost insignificant in the later period. It is observed from the above results that the growth in area is lower in the second period compared to the first period, but the growth in production is significantly higher than that of the first period which is mainly because of the growth in yield. Thus we can conclude that, in the Indian agriculture, for the period 1967-68 to 1992-93, the major source of the growth in production is the growth in the yield.

It is evident that the growth in the production level is mostly due to the growth in yield. Moreover there has been a shift of area from foodgrains to non-foodgrains in the 80's. Hence, the fluctuations in the production level are mainly because of fluctuations in the yield. A detailed analysis of the state-wise growth patterns in agriculture is taken up in the following chapter.

Chapter 4

AGRICULTURAL GROWTH PATTERN: A STATE WISE ANALYSIS

4.1 Introduction

This chapter examines the growth patterns at the aggregate and disaggregated level in area, production and yield across the states during the period 1967-68 to 1991-92 and the sub-periods; 1967-68 to 1979-80 and 1979-80 to 1991-92. For the sake of convenience, the period 1967-68 to 1979-80 is denoted as first period (70s) and 1979-80 to 1992-93 as second period (80s).

The organisation of this chapter is as follows. Section 4.2 examines the performance of aggregate crop output for foodgrains, non-foodgrains and all crops across the states. The periodwise classification of the states according to their production and yield performance are presented in Section 4.3. Section 4.4 analyses the agricultural performance in terms of yield for both first and second period at a disaggregate level. Section 4.5 examines the agricultural performances across the states in terms of their growth and share in the agricultural production and Section 4.6 presents the summary of the results.

4.2 Growth Patterns in Agricultural Sector

In this section, the pattern of growth in the agricultural sector across the states for All Crops, Foodgrains and Non-Foodgrains discussed separately[1].

---

[1] All the figures of growth rates and other exercises presented in the tables in this chapter and the following chapters are estimated using the data mentioned in chapter III. Therefore here onwards, the sources of the estimates presented in all the tables will not be mentioned.

Table 4.1: Growth of foodgrains across states during 1967/68 TO 1991/92

	1967/68 TO 1979/80			1979/80 TO 1991/92			1967/68 TO 1991/92		
	AR	PROD	YLD	AR	PROD	YLD	AR	PROD	YLD
ANDHRA	0.16	3.33*	3.16	-1.7*	2.24*	3.96*	-0.89*	2.72*	3.61*
ASSAM	0.98*	0.87	0.11	0.88*	2.56*	1.67*	0.93*	1.82*	0.89
BIHAR	-0.01	-0.07	-0.06	-0.69*	2.22*	2.92*	-0.39*	1.21*	1.60*
GUJRAT	-0.73	3.84*	4.58*	-0.72	-0.34	0.38	-0.72*	1.50*	2.23*
HARYAN	0.98*	2.91*	1.92*	-0.67	4.43*	5.10*	0.05	3.76*	3.70*
HIMACH	0.82*	0.52	-0.29	0.07	1.68*	1.60*	0.40*	1.17*	0.77*
J & K	0.58*	2.38*	1.79*	0.67*	1.19*	0.52	0.63*	1.71*	1.08*
KARNAT	-0.14	2.44*	2.58*	0.46	0.37	-0.09	0.19	1.28*	1.08*
KERALA	-0.16	0.59	0.75*	-3.47*	-1.92*	1.54*	-2.01*	-0.81*	1.19*
MADHYA	0.80*	0.78	-0.01	-0.11	3.31*	3.43	0.28*	2.20*	1.91*
MAHARA	1.04*	5.12*	4.08*	-0.02	0.86	0.89	0.44*	2.74*	2.29*
ORISSA	1.58*	0.14	-1.43	0.54*	3.67*	3.13	0.99*	2.12*	1.12*
PUNJAB	2.52*	6.48*	3.95*	1.62*	4.91*	3.29*	2.02*	5.60*	3.58*
RAJSTH	0.42	2.94	2.52	-0.57	-0.22	0.35	-0.13	1.17	1.31*
TAMIL	-0.39	0.73	1.12	-1.58*	1.11	2.69*	-1.05*	0.94*	2.00*
UTTAR	0.22	1.76*	1.54*	0.37*	4.69*	4.31*	0.30*	3.40*	3.09*
WEST B	0.29	0.30	0.01	0.00	3.67*	3.68*	0.12	2.19*	2.06*
ALL IN	0.51*	2.27*	1.75*	-0.15	2.74*	2.90*	0.14*	2.54*	2.39*

Table 4.1 shows that the growth in production and yield of foodgrains, while Table 4.2 and Table 4.3 explain the performances of non-foodgrains and all crops across the states. From the estimates presented in these tables it is evident that there exist large variations in the growth of output and yield across the states. The growth in area is almost stagnant in case of all crops and especially in the case of foodgrains this is more pronounced in the second period. However, the growth in area for non-foodgrains is significant in both the periods at national level. At the state level, nine states in the first period and ten states in the second period show significant increase in growth of area. From the performance in the sub-periods, it is evident that the eastern states like West Bengal, Orissa, Bihar have shown tremendous increase in the growth of production in foodgrains and also non

foodgrains in the second period, though these were lagging behind other states in the first period. While states like Gujrat, Maharashtra and Jammu & Kashmir have registered very poor growth rates in the second period, while their growth in the first period was very high. At dis-aggregated level the main source of the growth and fluctuation in the output in foodgrains as well as non foodgrains has been the growth and fluctuation in the yield, since the contribution of area is insignificant. A detail analysis in regional patterns is presented in section 4.4 of this chapter.

Table 4.2: Growth of non-foodgrains across states during 1967 to 1992

	1967/68 TO 1979/80			1979/80 TO 1991/92			1967/68 TO 1991/92		
	AR	PROD	YLD	AR	PROD	YLD	AR	PROD	YLD
ANDHRA	0.89	1.14	2.03*	4.50*	4.85*	0.33	2.13*	3.22*	1.08*
ASSAM	5.58*	11.04*	5.46*	-1.53*	-4.77*	-3.23*	1.59*	2.19*	0.59
BIHAR	1.18*	-0.21	-1.39*	-0.96*	2.03*	2.99*	-0.01	1.04*	1.06*
GUJRAT	1.21	4.04*	2.83*	-0.10	0.21	1.27	-0.05	1.90*	1.95*
HARYANA	3.42*	2.25*	-1.17	3.69*	5.58*	1.88*	3.57*	4.11*	0.54
HIMACHAL	1.63*	-1.90	-0.27	0.22	1.93	1.71	-0.59*	0.24	0.84
J & K	2.91*	7.06*	4.15*	2.93*	-1.30	-4.23*	2.92*	2.37*	-0.54
KARNATAKA	2.78*	4.65*	1.86*	2.01*	3.81*	1.80*	2.35*	4.18*	1.83*
KERALA	0.91	0.16	-0.75*	-2.97*	-2.72	0.24	-1.26	-1.45	-0.19
MADHYA P	0.22	-1.60	-1.83*	4.38*	4.11*	-0.27	2.55*	1.59*	-0.96*
MAHARASTR	0.28	3.52*	3.23*	1.61*	2.90*	1.28*	1.02*	3.17*	2.14*
ORISSA	6.27*	5.97*	-0.30	4.51*	6.14*	1.62*	5.28*	6.06*	0.78*
PUNJAB	1.06*	1.40	0.34	-0.81	2.57*	3.39*	0.00	2.06*	2.05*
RAJSTHAN	4.58*	5.55*	0.97*	2.62*	7.45*	4.83*	3.48*	6.62*	3.13*
TAMIL NA	1.00	2.87*	1.87*	-0.18	1.31*	1.49*	0.34	2.00*	1.65*
UTTAR PRA	0.70	1.93*	1.22*	-3.59*	2.50*	6.09*	-1.70*	2.25*	3.95*
WEST BENG	3.72*	8.24*	4.52*	2.30*	5.13*	2.83*	2.93*	6.50*	3.57*
ALL INDIA	0.92*	2.33*	1.41*	1.51*	3.69*	2.18*	1.25*	3.09*	1.84*

Table 4.3: Growth of agricultural production (all crops) during 1967 to 1992

	1967/68 TO 1979/80			1979/80 TO 1991/92			1967/68 TO 1991/92		
	AR	PROD	YLD	AR	PROD	YLD	AR	PROD	YLD
ANDHRA	0.17	2.44*	2.62 *	0.21	3.32*	3.10*	0.04	2.93*	2.89*
ASSAM	1.83*	4.59*	2.75 *	0.41*	-0.14	-0.56	1.04*	1.94*	0.90*
BIHAR	0.07	-0.10	-0.17	-0.71*	2.18*	2.90*	-0.37*	1.17*	1.54*
GUJRAT	0.17	3.98*	3.80*	-0.87	0.04	0.91	-0.41	1.77*	2.19*
HARYANA	1.33*	2.70*	1.36*	0.25	4.79*	4.53*	0.73*	3.87*	3.14*
HIMACHAL	0.75*	0.41	-0.33	0.07	1.73*	1.65*	0.37*	1.15*	0.77*
J & K	0.69*	2.75*	2.05*	0.79*	0.99	0.20	0.75*	1.77*	1.02*
KARNATAK	0.57	3.40*	2.82*	1.01*	2.14*	1.13*	0.82*	2.69*	1.87*
KERALA	0.34	0.07	-0.26	-2.76*	-2.01*	0.75*	-1.39*	-1.09*	0.30
MADHYA P	0.65*	-0.12	-0.78	0.86*	3.61*	2.74*	0.77*	1.96*	1.19*
MAHARAST	0.83*	4.38*	3.54*	0.42	1.79	1.37	0.60*	2.93*	2.33*
ORISSA	2.05*	1.20	-0.84	1.08*	4.28*	3.19*	1.51*	2.93*	1.41*
PUNJAB	2.25*	5.24*	2.98*	1.22*	4.40*	3.18*	1.67*	4.77*	3.09*
RAJSTHAN	1.16*	3.23*	2.06*	0.28	3.03*	2.74*	0.67*	3.12*	2.44*
TAMIL NA	0.00	1.78*	1.78*	-1.12*	1.23	2.36*	-0.63*	1.47*	2.11*
UTTAR PR	0.32*	1.83*	1.50*	-0.39*	3.87*	4.26*	-0.07	2.97*	3.05*
WEST BEN	0.74*	1.80*	1.05*	0.31	4.05*	3.68*	0.50*	3.03*	2.53*
ALL INDI	0.59*	2.29*	1.69*	0.25*	3.11*	2.86*	0.40*	2.75*	2.35*

It can be seen from these tables that at all India level, the growth rate in the second period is higher than that of the first period for all the crops mainly because of the growth in yield. The growth in yield can be attributed to the growth of farm inputs and large scale investments in the agricultural sector. Hence a detailed analysis of the growth in productivity is undertaken in chapter 5.

Having noted the inconsistency in the growth performance in production and yield all the states and there exists a gap between sub-periods which is evident from the performances of certain states. Thus, to understand the relative performance, the states are classified according to their performances in the production

and yields in the agricultural output for the entire period and sub-periods.

4.3 Classification of States on the Basis of Production Performance

Table 4.4 arranges the states in descending order of their performance (growth rates in production) for foodgrains, non foodgrains and for all crops for the entire time period.

Table 4.4: Classification of states according to the performance in production

ALL CROPS		FOODGRAINS		NON FOODGRAINS	
PUNJAB	4.77	PUNJAB	5.60	RAJSTHAN	6.62
HARYANA	3.87	HARYANA	3.76	WEST BENGAL	6.50
RAJSTHAN	3.12	UTTAR PRA	3.40	ORISSA	6.06
WEST BENGAL	3.03			KARNATAKA	4.18
		MAHARASTRA	2.74	HARYANA	4.11
UTTAR PRA	2.97	ANDHRA PRA	2.72	ANDHRA	3.22
ORISSA	2.97	MADHYA PR	2.20	MAHARASTRA	3.17
MAHARASTRA	2.97	WEST BENGAL	2.19		
ANDHRA PRA	2.97	ORISSA	2.12	J & K	2.37
KARNATAK	2.69	ASSAM	1.82	UTTAR PR	2.25
MADHYA PRA	1.96	J & K	1.71	ASSAM	2.19
ASSAM	1.94	GUJRAT	1.50	PUNJAB	2.06
GUJRAT	1.77			TAMIL NADU	2.00
J & K	1.77	KARNATAK	1.28	GUJRAT	1.90
		BIHAR	1.21	MADHYA PR	1.59
TAMIL NADU	1.47	RAJSTHAN	1.17		
BIHAR	1.17	HIMACHAL PR	1.17	BIHAR	1.04
HIMACHAL	1.15	TAMIL NADU	0.94	HIMACHAL	0.24
KERALA	-1.09	KERALA	-0.81	KERALA	-1.45
ALL INDIA	2.75	ALL INDIA	2.54	ALL INDIA	3.09

With regard to the performance of foodgrains production, It can be seen from Table 4.4 that only three states Punjab, Haryana and Uttar Pradesh are on the top and could achieve a growth rate of more than 3 per cent. Only five states have registered growth rates above the All India growth rate of 2.54 per cent per annum.

This was mainly due to the widespread use of modern farm inputs and irrigation facilities. Seven States, Kerala, Himachal Pradesh, Bihar, Tamil Nadu, Jammu & Kashmir, Gujrat and Assam registered low growth rate in production. Kerala is the only state which has a negative growth rate of 0.85 per cent per annum might be due to high yield level at base period. Due to this variations, at the aggregate level, agricultural sector could not achieve its target of foodgrains production over the years.

In Table 4.5 the states are arranged in descending order on the basis of their yield performance.

Table 4.5: Classification of states according to the yield performance

ALL CROPS		FOODGRAINS		NON FOODGRAINS	
HARYANA	3.14	HARYANA	3.70	UTTAR PRA	3.95
PUNJAB	3.09	ANDHRA PRA	3.61	WEST BENGAL	3.57
UTTAR PRA	3.05	PUNJAB	3.58	RAJSTHAN	3.13
ANDHRA PRA	2.89	UTTAR PRA	3.09	MAHARASTRA	2.14
WEST BENGAL	2.53	MAHARASTRA	2.29	PUNJAB	2.05
RAJSTHAN	2.44	GUJRAT	2.23	GUJRAT	1.95
MAHARASTRA	2.33	WEST BENGAL	2.06	KARNATAK	1.83
GUJRAT	2.19	TAMIL NADU	2.00	TAMIL NADU	1.65
TAMIL NADU	2.11	MADHYA PRA	1.91	ANDHRA	1.08
KARNATAK	1.87	BIHAR	1.60	BIHAR	1.06
BIHAR	1.54	RAJSTHAN	1.31	HIMACHAL	0.84
ORISSA	1.41	KERALA	1.19	ORISSA	0.78
MADHYA PRA	1.19	ORISSA	1.12	ASSAM	0.59
J & K	1.02	J & K	1.08	HARYANA	0.54
ASSAM	0.90	KARNATAK	1.08	KERALA	-0.19
HIMACHAL	0.77	ASSAM	0.89	J & K	-0.54
KERALA	0.30	HIMACHAL	0.77	MADHYA PRA	-0.96
ALL INDIA	2.35	ALL INDIA	2.39	ALL INDIA	1.84

It is evident that with regard to foodgrains production, only four states Haryana, Andhra Pradesh, Punjab and Uttar Pradesh have achieved growth rates above 3 per cent per annum due to extensive use of modern farm inputs and the existence of infrastructural facilities and are regarded as the leading states. Certain other states are lagging far behind the national average. For all crops the above mentioned states are having higher growth in yield. However, in case non foodgrains Rajasthan and West Bengal have shown very high growth rate of 3.57 and 3.13 per cent. Punjab and Uttar Pradesh are the two states which have been performing consistently well both in the case of foodgrains as well as non foodgrains. In the following section, comparative picture of the performance of the states between the sub-periods is given. The yield performance being our main concern we skip the analysis of production performance in this section. However, the analysis of production performance with regard to the sub-periods are presented in Appendix I.

4.4 Comparison of Yield Performance Between the Sub-periods

It is observed that performance in the growth of yield is not consistent for most of the states between the sub-periods. To assess the performances of the states, the states which have shown high growth in the second period and those states which did well in the first period but could not sustain their performance in the second period have also been examined. From the Tables 4.6, 4.7 and 4.8 the performance of various states could be seen between the sub-periods.

Table 4.6: Yield performance of foodgrains production in 1970's and 1980's

(i) performance was better in 1970's

STATES	1967/68 TO 1979/80	1979/80 TO 1991/92
RAJSTHAN	2.52	0.35
MAHARASTRA	4.08	0.89
KARNATAK	2.58	-0.09
GUJRAT	4.58	0.38
J & K	1.79	0.52

(ii) performing better in 1980's

STATES	1967/68 TO 1979/80	1979/80 TO 1991/92
ORISSA	-1.43	3.13
WEST BENGAL	0.01	3.68
MADHYA PRADESH	-0.01	3.43
UTTAR PRADESH	1.54	4.31
HIMACHAL PRADESH	-0.29	1.60
BIHAR	-0.06	2.92
ASSAM	0.11	1.67
KERALA	0.75	1.54
HARYANA	1.92	5.10

Table 4.7 Yield performance of non foodgrains production

(i) performance was better in 1970's

STATES	1967/68 TO 1979/80	1979/80 TO 1991/92
ANDHRA PRADESH	2.03	0.33
ASSAM	5.46	-3.23
GUJRAT	2.83	1.27
JAMMU & KASHMIR	4.15	-4.23
MAHARASTRA	3.23	1.28
WEST BENGAL	4.52	2.83

(cont...)

(ii) Performing better in 1980's

STATES	1967/68 TO 1979/80	1979/80 TO 1991/92
BIHAR	-1.39	2.99
HARYANA	-1.17	1.88
HIMACHAL PR	-0.27	1.71
ORISSA	-0.30	1.62
PUNJAB	0.34	3.39
RAJSTHAN	0.97	4.83
UTTAR PRADESH	1.22	6.09

Table 4.8: Yield performance of agricultural sector (all crops) during 1970' & 1980's

(i) performance was better in 1970's

STATES	1967/68 TO 1979/80	1979/80 TO 1991/92
ASSAM	2.75	-0.56
GUJRAT	3.80	0.91
JAMMU & KASHMIR	2.05	0.20
MAHARASTRA	3.54	1.37

(ii) Performing better in 1980's

STATES	1967/68 TO 1979/80	1979/80 TO 1991/92
ORISSA	-0.84	3.19
WEST BENGAL	1.05	3.68
BIHAR	-0.17	2.90
HIMACHAL PRADESH	-0.33	1.65
MADHYA PRADESH	-0.78	2.74
UTTAR PRADESH	1.50	4.26
HARYANA	1.36	4.53
KERALA	-0.26	0.75

From Table 4.6, 4.7 and 4.8, it is evident that, certain states like West Bengal , Orissa, Bihar and Madhya Pradesh could achieve high growth in the second period, while the growth was stagnant in those states in the first period. At the same time, states like

Maharashtra, Gujurat, Jammu & Kashmir and Assam could not keep up their pace in the second period though they were the leading states in the first period. This differential assumes crucial importance as it affects the performance at national level. This necessitates a detailed analysis of the factors that influence the productivity variations across the states. This aspect is analysed in Chapter 5.

Even though the growth rates indicate the performance of the states during the period 1967-68 to 1991-92, it is important to see the relative position of the states in the yield performance and also their share in the total agricultural production. Because it is found that although state like Kerala, has registered a very low growth rate over the years, its rank is just next to Punjab so far as the value of output per hectare is concerned. Therefore, in the following section 4.5 the relative positions of the states are presented on the basis of their productivity and share in the total agricultural production.

4.5 Classification of States on the Basis of their Share and Performance in Agricultural Production

In this section the states have been classified on the basis of their share in the agricultural production as well as their growth in the production. It is observed that certain states which have registered very low growth rates have large shares in the agricultural production and their yield rates are also high. For instance Kerala has experienced very low growth rate in the production over the years but still it is ranked next to Punjab with regard to the yield per hectare. Thus in this section the share of the states in the agricultural production as well as their

performance in the growth of production and yield are presented in order to assess their position in agricultural production.

Table 4.9: Share and growth of agricultural production (all crops) during 1967 to 1992

	1967/68 TO 1979/80			1979/80 TO 1991/92			1967/68 TO 1991/92		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ANDHRA	8.16	2.44*	2.62*	8.77	3.32*	3.10*	8.56	2.93*	2.89*
ASSAM	2.09	4.59*	2.75*	2.55	-0.14	-0.56	1.75	1.94*	0.90*
BIHAR	7.07	-0.10	-0.17	5.27	2.18*	2.90*	4.86	1.17*	1.54*
GUJRAT	5.03	3.98*	3.80*	6.26	0.04	0.91	4.53	1.77*	2.19*
HARYANA	3.51	2.70*	1.36*	3.57	4.79*	4.53*	4.41	3.87*	3.14*
HIMACHAL	0.55	0.41	-0.33	0.46	1.73*	1.65*	0.43	1.15*	0.77*
J & K	0.65	2.75*	2.05*	0.66	0.99	0.20	0.47	1.77*	1.02*
KARNATAK	5.56	3.40*	2.82*	6.26	2.14*	1.13*	5.32	2.69*	1.87*
KERALA	3.80	0.07	-0.26	2.83	-2.01*	0.75*	1.69	-1.09*	0.30
MADHYA P	8.17	-0.12	-0.78	8.97	3.61*	2.74*	7.40	1.96*	1.19*
MAHARAST	10.94	4.38*	3.54*	8.88	1.79	1.37	9.48	2.93*	2.33*
ORISSA	4.18	1.20	-0.84	3.80	4.28*	3.19*	4.13	2.93*	1.41*
PUNJAB	5.15	5.24*	2.98*	7.18	4.40*	3.18*	7.74	4.77*	3.09*
RAJSTHAN	3.90	3.23*	2.06*	4.05	3.03*	2.74*	5.03	3.12*	2.44*
TAMIL NA	7.33	1.78*	1.78*	7.25	1.23	2.36*	5.69	1.47*	2.11*
UTTAR PR	18.07	1.83*	1.50*	17.02	3.87*	4.26*	17.88	2.97*	3.05*
WEST BEN	5.69	1.80*	1.05*	5.41	4.05*	3.68*	5.99	3.03*	2.53*
ALL INDI	100	2.29*	1.69*	100	3.11*	2.86*	100	2.75*	2.35*

* Significant at 5 per cent level of significance.
Column 1, 4 and 7 : Share of production in percentages for the period 67-68 to 69-70, 79-80 to 81-82 and 89-90 to 91-92.
Column 2, 5 and 8 : Growth rate of production in three periods.
Column 3, 6 and 9 : Growth rate of Yield in three periods.

The share of certain states in the agricultural production has reduced despite the high growth rate in the agricultural production (See Table 4.9). For instance Uttar Pradesh, Tamil Nadu, Orissa and Maharashtra show a decline in their share of the total agricultural production even though the growth rates are high. On the otherhand, the share of Gujrat in the production has increased from 5.03 per cent in the first period to 6.26 per cent in the second period,

even though the growth rate in the second period is very low as compared to first period. But for the remaining states it is found that the share in the production declined with the decline in growth rates and vice versa. Table 4.9 gives an overall idea with regard to the growth performance of the states and their share in the agricultural production over the years and this would help to understand the productivity variations across the states.

4.6 Conclusion

This analysis indicates that certain states which had poor performances in first period could overcome the crisis and give a boost to the agricultural sector in the second period. On the other hand, the states which had performed very well in the first period could not sustain their position in the second period. As the overall performance of the agricultural sector depends on the performance of the states to achieve the targeted growth rate in the sector, it is very important to know the causes behind such inconsistency in the production. From this analysis, it is evident that only few states have performed well and their share in the agricultural production is large and because of the poor performance of most of the states, the total production in the agricultural sector at national level is lagging far behind the targeted growth rate. It is observed that the main source of the inconsistency is the erratic performance in the yield, and thus, it is important to see the main factors responsible for the productivity variations across the states. This chapter gives an overall idea with regard to the growth pattern across the states during sub-period at dis-aggregated level. This stresses an analysis of the determinants of productivity growth. The succeeding

chapter analyses the influence of these factors on agricultural productivity and the extent of regional variations and their causes across the states. Apart from this, the impact of population growth on agricultural productivity is analysed. The role of technological change and the diffusion of technology in determining the productivity growth is also examined.

Chapter 5

DETERMINANTS OF INTER-STATE PRODUCTIVITY GROWTH

5.1 Introduction

Indian agriculture in the late 70s witnessed the phenomenon of green revolution in which modern farm inputs were intensively used for increasing the productivity of land. However, as this was limited to only three to four states in India, the growth in agricultural output can not be explained by green revolution at a disaggregated level. This stresses the need to understand and analyse the factors responsible for intertemporal fluctuations and inter regional disparities across the states in India. However, few empirical studies were undertaken in the past on this crucial aspect. In this chapter we analyse and identify the factors behind the inter temporal and inter regional variation in agricultural growth.

Joshi and Haque (1980) analysed the inter regional disparities and found that the inputs like HYVs, credit, fertilizer and irrigation were responsible for the regional disparities. Also they found HYVs and fertilizer were relatively important factors affecting the level of productivity in almost all the states.

But the growth pattern shows that during 80s the growth in yield is high compared to 70s as the growth rates are 2.86 and 1.69 per cent respectively[1]. From chapter 4 it is evident that there has been a change in the growth pattern in 80s. Another feature of the inter-state growth pattern was that, some states which had high growth in

---

[1] See Table 4.5 of Chapter IV.

70s are almost stagnating in 80s and some other which were stagnating in 70s have experienced very high growth in 80s. This would mean that these states were not able to sustain the growth between the two periods. In other words, some states were able to accelarate their growth while certain states failed to keep the momentum of the growth.

Thus it is important to trace out the main factors responsible for the inter-state variations in productivity. This chapter aims at estimating the relative role of various technological, institutional and climatic factors in determining the inter temporal and inter regional growth disparities in India. Apart from this, the Boserupean hypothesis[2] of population growth affecting agricultural productivity via technological change is also examined in this chapter.

The organisation of this chapter is as follows. Section 5.2 explains the sources of data used and section 5.3 provides the the specification of yield equations. Section 5.4 presents the major findings from the empirical results. Section 5.5 examines the relative roles of selected factors in determining productivity variations across states. Section 5.6 explains the role of development and diffusion of technology in determining the productivity growth. Section 5.7 examines the possible factors that are not explicitly included in the model but are affecting

[2] Boserupean Argument: The high rate of population growth put pressure on the existing technology and as a result technological change takes place which raise the level of productivity in agricultural sector. For details see Boserup Ester (1982)

productivity and regional disparities. Section 5.8 presents summary of the main findings.

5.2 Sources of Data

The data on fertilisers, area under HYVs, area under irrigation, credit, rainfall and population are collected from the following sources. The data on irrigation are collected from "Agricultural Situation in India" and various issues of "Economic Survey" of states published by respective state governments. The data for rainfall is collected from various issues of Economic Surveys and also from the "Fertilizer Statistics" published by Fertilizer Association of India. The data for credit are collected from various issues of RBI publications (Basic Statistical Returns, Report on Currency and Finance). The data for area under HYVs are collected from the "Agricultural Statistics Compendium" and are compared with the data published by the Directorate of Economics and Statistics. The data on fertilizer consumption are collected from various issues of 'Fertilizer Statistics' published by Fertilizer Association of India. The population figures are obtained from the census publications. Data on productivity are estimated figures.

5.3 Specification of Yield Equations

The method of estimation of aggregate output and yield is mentioned in chapter 3[3]. In order to estimate the relative role of various

---

[3] Agricultural output is estimated from the following eqation.
$Y = \Sigma P_i y_i$; where Y is value of aggregate agricultural output;
P_i is the price of ith crop; y_i is the total production of ith crop; i = 1, 2, 3..., n ; where n is the number of crops grown in the state. Here constant prices at all India level are taken to eliminate the effect of inflation and regional fluctuations due to price differences.

factors in determining the productivity growth at the state level, the following yield equation is specified.

$$Y = f(F, I, H, C, R, T) \quad \ldots\ldots\ldots\ldots (1)$$

$\delta Y/\delta F > 0$, $\delta Y/\delta I > 0$, $\delta Y/\delta H > 0$, $\delta Y/\delta C > 0$,

$\delta Y/\delta R > 0$, $\delta Y/\delta T > 0$,

Where,

Y is agricultural output per hectare;

F is fertilizer consumption per hectare;

C is credit per hectare (in constant prices);

H is proportion of area under HYVs to Gross cropped area;

I is proportion of area under irrigation to Gross Cropped area;

R is actual rainfall as percent of normal rainfall;

T is proxy for all other factors affecting yield.

5.3.1 Estimation of yield equations

In this section two versions of yield equation, given in (1), are estimated; one with time trend (T) and other with population growth (P). For estimation of the yield equation(1), we have specified Double Log function of the form,

$$\text{Ln } Y = \alpha + \beta_1 \text{ Ln } F + \beta_2 \text{ Ln } I + \beta_3 \text{ Ln } H + \beta_4 \text{ Ln } C + \beta_5 \text{ Ln } R + \beta_6 T + U_t \quad \ldots\ldots\ldots\ldots (2)$$

The population growth is replaced for (T) in equation (2) so that second version of equation (1) yield equation is specified as:

$$\text{Ln } Y = \alpha + \beta_1 \text{ Ln } F + \beta_2 \text{ Ln } I + \beta_3 \text{ Ln } H + \beta_4 \text{ Ln } C + \beta_5 \text{ Ln } R + \beta_6 P + U_t \quad \ldots\ldots\ldots\ldots\ldots (3)$$

The estimated equations for each state for the period 1967-68 to 1991-92 are given in Table 5.1 and 5.2. However, both the equations are plagued by the problems of autocorrelation and multicollinearity. To eliminate the possibility of obtaining biased and inefficient estimators, due to autocorrelation, we have used first order and second order auto regressive models[4]. The variables like fertiliser, HYVs and irrigation are found to be highly correlated. To eliminate the problem of multicollinearity, procedures like ridge regression, principal component analysis and dropping variables, suggested for the purpose, are tried out. But due to their inadequacy and inefficiency[5], the results obtained using these procedures are not presented here. Hence, to eliminate the effect of multicollinearity from the model the following method is used. We have taken an input index comprising of variables which are highly correlated. The input index is obtained by taking linear combination of these three variables. The new variable is termed as FHI (Fertiliser, HYVs and Irrigation) could be interpreted as 'one unit of FHI explains a certain amount of variation in the yield'. Thus in the new 'yield equation' the variables are FHI (which represent input index), credit, rainfall and the population growth.

The new yield function becomes

$$\text{Ln } Y = \alpha + \beta_1 \text{ Ln FHI} + \beta_2 \text{ Ln C} + \beta_3 \text{ Ln R} + \beta_6 \text{ P} + U_t \ldots\ldots (4)$$

The results of from equation (4) are presented in Table 5.3.

---

[4] See Maddala (1993), Johnston (1992) and Gujurati (1994) for the detailed method.

[5] While applying such techniques to solve multicollinearity problem the pre-requisites to be satisfied to get effecient estimates could not be met in this context. For details regarding pre-requisites see Maddala (1993); Johnston(1993); Gujurati (1994).

5.4 Empirical Findings

In section 5.4.1 the results from the yield equation (2) where time is taken as determinant of productivity along with other variables are presented. Section 5.4.2 deals with equation (3) where population is considered as determinant of productivity along with other variables. Section 5.4.3 presents the results after adjusting for multicollinearity in the yield equation.

5.4.1 Time as determinant of productivity

From table 5.1 it is evident that fertilizer consumption is significant in two states viz. Karnataka and Tamil Nadu and the coefficients are 0.16 per cent and 0.31 per cent, while the same was significant in 13 out of 15 states in the study of Joshi & Haque (1980) during 1955-56 to 1975-76. It shows that the explanatory power of fertiliser to determine the productivity has reduced in the later period[6]. In case of HYVs, it is significant for six states which include Assam, Bihar, Haryana, Jammu and Kashmir, Uttar Pradesh and West Bengal. The role of irrigation in explaining the productivity growth is found to be positive and significant in five states.

[6] For comparison the coefficients estimated for different factors by Joshi and Haque is presented in Table 1.1 of Appendix I.

Table 5.1: Factors affecting agricultural productivity

STATES	FERT	IRRI	HYVS	CREDIT	RAINFALL	TIME	AdjR2
AP	0.080 0.268	0.191 0.282	0.033 0.066	-0.108 0.102	-0.003 0.085	0.038* 0.013	0.890
ASSAM	-0.005 0.050	-0.295 0.593	0.152* 0.047	-0.099 0.082	-0.123 0.108	-0.001 0.014	0.590
BIHAR	0.080 0.080	0.425* 0.260	-0.135* 0.047	-0.252 0.608	-0.033 0.093	0.066* 0.017	0.790
GUJRAT	0.261 0.306	0.018 0.357	0.065 0.120	-0.579 0.327	0.228* 0.118	0.099* 0.044	0.520
HARYANA	0.004 0.158	-0.023 0.144	0.112* 0.049	-0.106 0.406	0.150* 0.086	0.067* 0.017	0.880
HP	-0.129 0.355	0.370 0.328	0.064 0.089	-0.001 0.129	-0.094 0.149	0.003 0.005	0.130
J&K	-0.053 0.070	0.330 0.440	0.271* 0.095	0.050* 0.020	-0.220* 0.070	-0.020* 0.011	0.570
KARNATAK	0.168* 0.101	-0.159 0.184	0.043 0.041	-0.010 0.080	-0.005 0.107	0.007 0.019	0.860
KERALA	0.181 0.138	0.204* 0.106	0.060 0.060	0.166 0.108	-0.086 0.078	-0.060* 0.030	0.170
MP	-0.001 0.119	-0.113 0.504	0.087 0.122	-0.311 0.202	-0.005 0.184	0.040* 0.030	0.440
MAHARASTRA	-0.018 0.198	-0.532* 0.184	-0.015 0.180	-0.400 0.226	-0.607* 0.190	0.122* 0.083	0.310
ORISSA	-0.038 0.204	0.173 0.229	-0.113 0.182	-0.097 0.070	0.290* 0.220	0.051* 0.026	0.510
PUNJAB	0.031 0.029	0.409* 0.140	-0.002 0.030	0.022* 0.012	-0.033 0.028	0.013* 0.006	0.970
RAJSTAN	-0.131 0.286	-0.548 0.374	-0.052 0.143	-0.060 0.120	0.184* 0.080	0.070* 0.030	0.690
TAMIL	0.313 * 0.184	0.166 0.266	-0.090 0.119	-0.055 0.144	0.065 0.071	0.010 0.030	0.760
UP	0.131 0.160	-0.155 0.470	-0.203* 0.106	-0.165 0.112	-0.220* 0.130	0.070* 0.021	0.850
WB	0.043 0.080	-0.500* 0.300	-0.220* 0.130	0.068 0.089	0.117 0.207	0.030* 0.010	0.830

* Significant at 5 per cent level of significance.
Figures in second row indicates standard errors.

However, for most of the states coefficient of credit was found to be negative and insignificant. This could be due to the high degree of correlation among the independent variables. The role of rainfall in explaining productivity was found to be very poor. It is observed that for 13 out of 17 states the coefficient of time is positive and significant in explaining productivity.

5.4.2 Impact of population growth on agricultural productivity

In this section the relative role of population growth is discussed along with other agricultural inputs and institutional variables in explaining the growth in productivity. In our regression model we have replaced time (T) by population (P) to test the Boserupean argument. The results are presented in Table 5.2.

Table 5.2: Impact of population on agricultural productivity

STATE	FERT	IRRI	HYVS	CREDIT	RAIN	POPLN	Adj R2
AP	0.124 0.162	0.171 0.280	0.058 0.060	-0.130 0.100	-0.204 0.080	0.004* 0.001	0.880
ASSAM	-0.017 0.058	-0.140 0.480	0.147* 0.048	-0.109 0.060	-0.100 0.110	0.001 0.002	0.590
BIHAR	0.083 0.099	0.439* 0.280	-0.087* 0.050	-0.215 0.170	-0.010 0.100	0.003* 0.001	0.770
GUJRAT	0.280 0.290	-0.270 0.300	0.033 0.110	-0.570 0.370	0.220* 0.110	0.015* 0.005	0.560
HARYANA	0.018 0.189	-0.027 0.154	-0.184 0.180	-0.063 0.064	0.109 0.090	0.018* 0.005	0.860
HP	-0.023 0.309	0.482* 0.230	0.086 0.075	0.051 0.103	-0.120 0.140	0.030 0.040	0.190
J&K	-0.050 0.070	0.380 0.420	0.250* 0.090	0.048 0.044	-0.210* 0.070	0.004* 0.002	0.570
KARNATAK	0.182* 0.090	-0.260 0.210	-0.001 0.056	0.090 0.060	0.098 0.103	-0.001 0.001	0.840
KERALA	0.086 0.093	0.026 0.073	0.032 0.039	-0.129 0.086	-0.060 0.050	0.006* 0.003	0.380
MP	0.062 0.116	-0.133 0.540	0.031 0.120	-0.173 0.18	0.022 0.192	0.004* 0.002	0.380
MAHARASTR	-0.018 0.197	-0.530* 0.180	-0.010 0.170	-0.390 0.275	-0.06* 0.194	0.009* 0.004	0.300
ORISSA	-0.014 0.212	0.172 0.247	-0.079 0.190	-0.090 0.070	0.258 0.229	0.009* 0.005	0.480
PUNJAB	0.190 0.031	0.431* 0.018	0.004 0.030	0.109* 0.018	-0.027 0.029	0.004* 0.002	0.983
RAJSTAN	-0.109 0.288	-0.538 0.386	-0.023 0.148	-0.059 0.127	0.205* 0.090	0.007* 0.003	0.680
TAMIL	0.311* 0.183	0.160 0.260	-0.084 0.117	-0.052 0.137	0.067 0.069	0.001 0.003	0.760
UP	0.150 0.152	-0.150 0.446	-0.106 0.100	0.173* 0.096	-0.207* 0.126	0.003* 0.001	0.860
WB	0.087 0.085	-0.720* 0.200	-0.280* 0.060	0.113* 0.070	0.090 0.170	0.003* 0.001	0.880

* Significant at 5 per cent level of significance.
Figures in second row indicates standard errors.

A comparison of Tables 5.2 and 5.1 reveals that population has become significant in as many as 13 states for which time was significant and the coefficients are positive for all the states. Even though the estimates do not differ largely in these two regressions, the explanatory power of the second model is higher than that of the first one which is evident from the Adj R^2 of different states and in case of Kerala the difference is high.

From the analysis, it can be concluded that population is a determinant of the productivity growth via technological change and thus the Boserupean argument holds good in 13 out of 17 states. However, like the model where time was one of the explanatory variable, this model is also not free from the problem of multicollinearity even though the problem of autocorrelation is taken care off. Due to the presence of multicollinearity, estimates for most of the states are insignificant and are of negative signs and thus can not be interpreted appropriately. In order to overcome the problem of the multicollinearity, the procedures suggested for the purpose are also tried out here as in case of equation (2).

Both the findings are based on unprecious estimates due to multicollinearity. We have re-estimated the model by taking an input index for the fertilizer, HYVs and irrigation and included the other variables. Here the effect of FHI on productivity growth is examined along with the variables like credit, rainfall and population. The results are discussed below.

5.4.3 Re-estimation of the model using input index

Apart from the input index (FHI), other variables like credit, rainfall and population are taken in the new yield equation. However, the exercise with regard to time is not undertaken with the new input index as it is found that population is a better proxy for the technological change. The model used for the purpose is specified in equation (4).

This regression model, however, is free from the problem of autocorrelation as in such cases where it exists, auto regressive of order 1 and 2 are estimated. The problem of multicollinearity is reduced to a large extent as the input index is taken as one variable instead of those three variables which were highly correlated.

Table 5.3 reveals that FHI plays an important role in determining the productivity growth as the coefficients from this regression is found to be positive and significant in 10 out of 17 states. This means in seven states the impact of modern inputs is not significant in the determining yield. Therefore, this can be a source of growth for these states in future. The yield equation has the maximum explanatory power in Punjab followed by Harayana, Karnataka, Uttar Pradesh and West Bengal.

Table 5.3: Input index (FHI) in agricultural productivity

STATES	FHI	CREDIT	RAIN	POPLN	Adj R2	DW stat	Fstat
AP	0.410*	-0.120	-0.020	0.002*		1.960	43.190
AR(1)	0.240	0.70	0.060	0.001	0.900		0.000
ASSAM	0.083*	-0.030	-0.080	0.002		1.970	4.990
AR(1)	0.042	0.100	0.080	0.002	0.460		0.000
BIHAR	0.040	-0.150	-0.010	0.002*		2.110	17.630
	0.170	0.91	0.100	0.001	0.730		0.000
GUJRAT	0.190	-0.480	0.330*	0.008*		2.040	6.580
AR(1)	0.320	0.320	0.100	0.003	0.540		0.000
HARYANA	0.250*	-0.080	0.110	0.020*		2.000	33.210
AR(1)	0.110	0.050	0.080	0.004	0.870		0.000
HP	0.670*	-0.050	-0.080	-0.020		1.990	2.940
	0.360	0.060	0.130	0.030	0.240		0.040
J&K	0.170*	0.081*	-0.130*	-0.003		1.830	5.460
	0.090	0.040	0.070	0.003	0.420		0.000
KARNATAK	0.400*	-0.048	-0.040	0.001		2.290	33.210
AR(1)	0.060	0.040	0.070	0.001	0.870		0.000
KERALA	0.100	-0.090	-0.002	0.003		1.630	2.400
AR(1)	0.070	0.060	0.066	0.002	0.230		0.070
MAHARASTR	0.430*	-0.120	-0.060	0.002*		1.420	9.940
AR(1)	0.210	0.180	0.080	0.001	0.660		0.000
MP	0.330*	-0.250	0.090	0.002*		2.060	5.640
AR(2)	0.140	0.170	0.170	0.001	0.500		0.000
ORISSA	0.093	-0.130	0.310*	0.009*		2.130	6.270
AR(1)	0.290	0.230	0.160	0.004	0.530		0.000
PUNJAB	0.180*	-0.010	0.010	0.010*		2.090	174.950
AR(1)	0.070	0.012	0.030	0.001	0.970		0.000
RAJSTAN	-0.390	-0.160	0.260*	0.008*		1.700	12.040
AR(1)	0.410	0.090	0.070	0.002	0.700		0.000
TAMIL	0.160*	0.020	0.001	0.001		1.900	15.020
AR(1)	0.070	0.120	0.070	0.002	0.750		0.000
UP	-0.100	-0.090	-0.110	0.002*		2.050	42.520
	0.170	0.080	0.110	0.001	0.870		0.000
WB	0.050	0.130*	0.270	0.001*		2.060	23.76
AR(1)	0.220	0.060	0.200	0.000	0.830		0.000

* Significant at 5 per cent level of significance. Figures in second row represent standard errors.

The coefficients of credit was found negative and insignificant in most of the states. However, credit is positive and significant only in two states, West Bengal and Jammu & Kashmir. The result can be explained by the argument that the credit sanctioned for the agricultural purposes are used for non-agricultural activities.

Rainfall has positively and significantly explained the productivity in three states which include Gujrat, Orissa and Rajasthan. The growth in yield in these states are explained by the favourable climatic conditions. Here it is observed that only in Jammu and Kashmir rainfall has adversely affected the productivity growth.

It is observed that in 11 out of 17 states the coefficient of population is positive and significant. However, in the earlier models where we used different inputs instead of input index, population was significant in 13 out of 17 states. Only in few states both modern inputs and population growth are significant. The states with highest explanatory power, Punjab and Andhra Pradesh have both coefficients significant. At the same time, the states with low explanatory power, Kerala and Himachal Pradesh, have insignificant coefficients for population growth. This findings suggest that Boserupean hypothesis of population growth and agricultural development is valid in case of Indian agriculture.

The effect of component factors such as HYVs, irrigation, fertliser, credit could not be separated due to severe multicollinearity problem. In order to overcome this difficulty we

have used the following method suggested by Joshi and Haque (1980) for decomposition of the effects.

5.5 Decomposition of Determinants of Productivity Variations

The following yield equation is estimated for the decompostion in order to assess the individual impact of diffrent inputs on productivity. The cross section data on 17 states using the .... averages, of the variables corresponding to the period, 1989-90 to 1991-92.

$$Y = \alpha F^{\beta 1} I^{\beta 2} H^{\beta 3} C^{\beta 4} U_t \quad \ldots\ldots\ldots(5)$$

Where

Y is output per hectare in value terms;

F is fertiliser used per heactare;

I is area under irrigation;

H is area under HYVs;

C is credit per hectare at constant prices.

Since Punjab has achieved the highest level of productivity among all the states it is taken as the base for estimating the differences in land productivity among states. The differences are calculated and interpreted as per cent of Punjab land productivity.

The estimated version of equation (5) is,

Ln Y = 12.783 + 0.02 LnF + 0.20 LnI + 0.17 LnH + 0.35 LnC

T-stat = (0.12) (2.22)* (2.09)* (2.91)*

Adj R^2 = 0.664,

F-Stat = 8.937, Sig of F = 0.0014

* significant t-values.

It can be observed, variables like irrigation, HYVs and credit are significant in the cross section estimates with high Adjusted R^2 of 0.664. Using the estimated coefficients, the impact of each input on difference in the yield is assessed across the states using the following accounting formula[7].

$$(Yp - Yo) / Yp = 0.02 (Fp - Fo)/Fp + 0.20 (Ip - Io)/Ip + 0.17 (Hp - Ho)/Hp + 0.35 (Cp - Co)/Cp$$

Where, the lower case letter `p' denotes Punjab `o' denotes state other than Punjab;

Y represents Yield per hectare in respective states,

F, C, I, H represent consumption of fertilizer and credit per hectare, area under irrigation and HYVs in different states.

The results are presented in Table 5.4.

From Table 5.4 it is evident that position of Kerala is just next to Punjab so far as the value of output per hectare is concerned even though it has registered a very low growth rate of 0.30 per cent over the years. Kerala's productivity level is very high because of the very high yield rate in the non food-crops production even though the growth in production is stagnant over these years. Due to the prevalence of high wage rate and climatic conditions, there had been a shift in the cropping pattern in Kerala from foodcrops to cash crops. This shift mainly contributed to a large extent in the high level of yield for Kerala (Kannan and Pushpangadan, 1990) .

---

[7] For detailed methodology see Joshi and Haque (1980).

Table 5.4: Decomposition of the factors affecting productivity variations

States	TD	ED	H	I	F	C
AP	43.18	21.67 (50.19)	7.92 (18.34)	10.78 (24.97)	0.59 (1.36)	2.38 (5.52)
ASSAM	55.20	46.36 (83.99)	8.24 (14.92)	6.33 (29.59)	1.89 (3.43)	19.90 (36.05)
BIHAR	58.50	30.54 (52.21)	0.74 (1.27)	0.79 (18.45)	1.36 (2.32)	17.65 (30.18)
GUJRAT	55.76	38.06 (68.25)	10.10 (18.11)	13.96 (25.03)	1.12 (2.01)	12.88 (23.10)
HARYNA	27.72	15.22 (54.91)	4.83 (17.41)	3.48 (12.54)	0.77 (2.76)	6.15 (22.20)
HP	59.30	38.33 (64.64)	6.10 (10.28)	15.38 (25.94)	1.60 (2.69)	15.25 (25.72)
J&K	58.03	32.11 (55.33)	2.98 (5.14)	10.21 (17.59)	1.46 (2.51)	17.46 (30.09)
KARNA	59.52	33.90 (56.95)	12.41 (20.85)	15.06 (25.30)	1.19 (2.00)	5.24 (8.80)
KERALA	14.25	-54.37 (-381.52)	10.55 (74.03)	15.58 (109.32)	0.74 (5.18)	-81.24 -570.05)
MAHARA	68.31	46.42 (67.96)	8.65 (12.67)	17.33 (25.37)	1.30 (1.90)	19.14 (28.02)
MP	65.56	54.58 (83.25)	11.04 (16.83)	16.61 (25.33)	1.65 (2.51)	25.29 (38.57)
ORISSA	58.16	50.00 (85.97)	9.55 (16.41)	13.98 (24.05)	1.75 (3.00)	24.72 (42.51)
RAJSTH	75.25	53.11 (70.58)	11.71 (15.56)	14.64 (19.46)	1.77 (2.35)	25.00 (33.22)
TAMIL	21.26	-12.17 (-57.23)	5.31 (24.97)	10.17 (47.86)	0.59 (2.77)	-28.2 (-132.83)
UP	37.52	31.97 (85.22)	5.16 (13.76)	7.64 (20.35)	1.03 (2.74)	18.15 (48.36)
WB	33.13	29.66 (89.51)	7.78 (23.47)	8.35 (25.20)	1.19 (3.60)	12.34 (37.24)

Figures in parentheses are the percentage of explained difference.
TD = Total Difference in the productivity from Punjab.
ED = Explained difference in the productivity by all factors.

In case of other states variations in yield are mostly explained by credit, HYVs and irrigation. The amount of variation contributed by various inputs are given in both absolute and percentage terms in Table 5.4. In case of Kerala and Tamil Nadu the variations are explained by the factors other than the variables which are taken into consideration. From the above results it is observed that the variations in most of the states are explained in terms of HYVs, irrigation and credit. Except for Kerala and Tamil Nadu, in all the states more than 50 per cent of the variations are explained by the chosen variables. The impact of fertliser in determining the difference in the productivity is reduced to a large extent. While in 70s, fertiliser was the major determinant of the yield differentials[8], HYVs has become the major source of variations during late 80s. From this it can be concluded that HYVs play an important role in the productivity differntials. Hence, in the following section an attempt is made to asses the impact of technology diffusion and technological development in determining productivity.

5.6 Development and Diffusion of Technology and Productivity

The productivity growth is explained in terms of new knowledge and diffusion of knowledge with the help of Diffusion model developed by Hayami (1991). The model facilitates us to assess the role of new technolgy and the technolgy diffusion in determining the productivity growth across the states. The model is specified as follows:

---

[8] For comparision the results of the study of Joshi and Haque (1980) are presented in Table A2 in Appendix.

$$GR\ YI_T = \beta_1\ GR\ YAHPU_T + \beta_2\ GR\ CV_T + U_T; \quad \ldots\ldots (7)$$

$$\beta_1 > 0\ ,\ \beta_2 < 0.$$

Where

GRYI is growth in yield of India,

GRYAHPU is growth in yield of Andhra Pradesh, Haryana, Punjab and Uttar Pradesh which are the leading states,

GRCV is growth in coefficient of variation in yield across states,

U is the error term,

T is the subscript which denotes the time from 1967 to 1992.

Here the coefficient of GRYAHPU represents the role of new technological knowledge and the coefficient of GRCV represents the role of technolgy diffusion. The regression results at aggregate and disaggregated levels are presented as follows.

For All Crops the estimated function is

$GRYI_T$ = 0.596 $GRYAHPU_T$ - 0.239 $GRCV_T$
SE = (0.095) (0.054)
T-value= (6.23) (-4.42)

R^2 = 0.76, Adj R^2 = 0.75
DW = 2.34, F-stat = 71.99

For Foodgrains the estimated function is

$GRYI_T$ = 0.619 $GRYAHPU_T$ - 0.221 $GRCV_T$
SE = (0.097) (0.052)
t-value= (6.33) (-4.22)

R^2 = 0.77, Adj R^2 = 0.76
DW = 2.27, F-stat = 74.01

For Non-foodgrains the estimated function is

$GRYI_T$ = 0.485 $GRYAHPU_T$ - 0.224 $GRCV_T$
SE = (0.083) (0.06)
T-value= (5.78) (-3.60)

R^2 = 0.61, Adj R^2 = 0.59
DW = 2.60, F-stat = 35.21

It can be seen that at aggregate level, the growth in yield is explained more by the new knowledge and less by the diffusion of technology (as β_1 = 0.59 and β_2 = -0.22). However, at disaggregate level, the same story is repeated for foodgrains where β_1 = 0.61 and β_2 = -0.22. But in case of non-foodgrains the coefficient of β_1 is far less than that of foodgrains which is 0.48 while the coefficient of β_2 remains the same. From Graphs 5.1, 5.2 and 5.3 it is evident that in the first period growth in productivity is explained mainly by the introduction of new technology, while in the second period the growth is explained by the diffusion of technology in addition to the new knowledge.

Figure 5.1

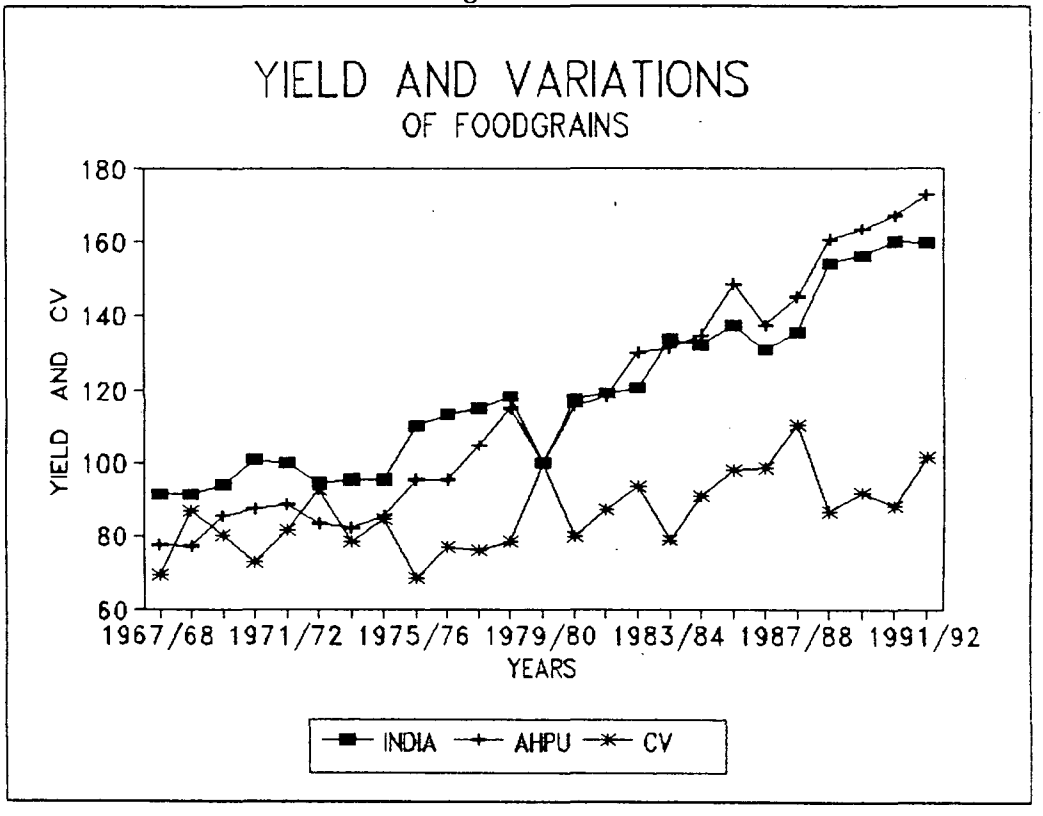


Figure 5.2

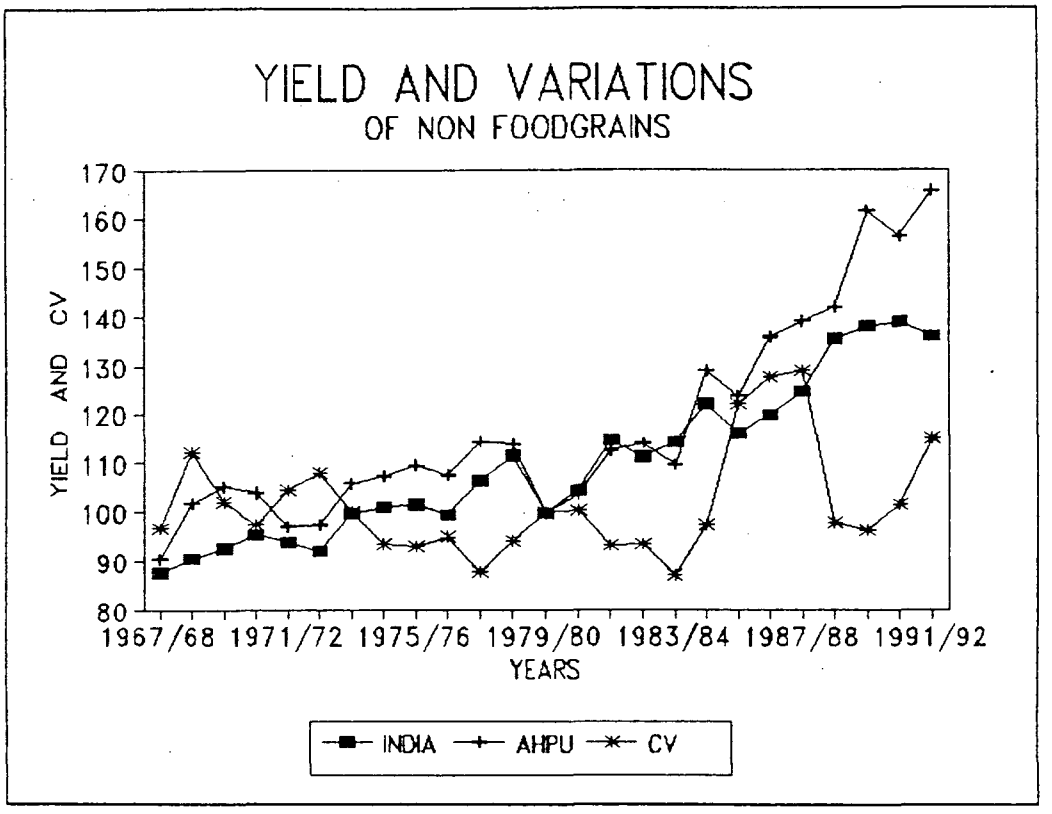
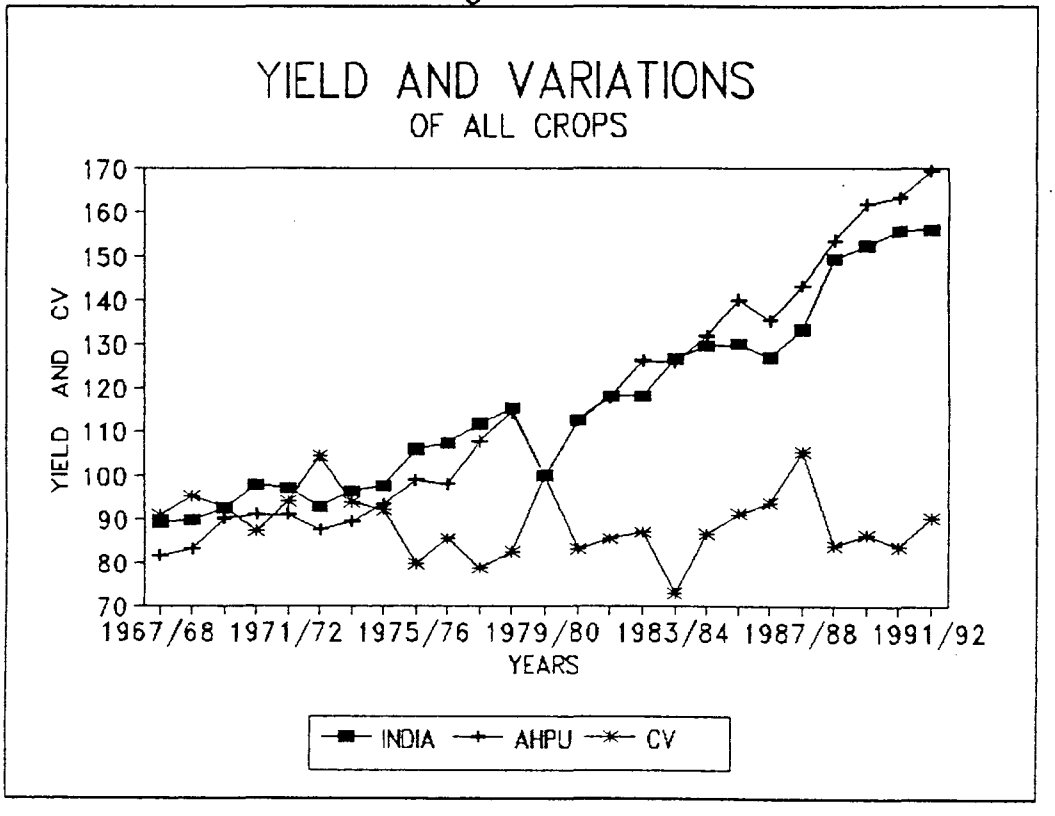


Figure 5.3



From results of diffusion model and graphs it could be concluded that in case of foodgrains, non-foodgrains and all crops, the growth in productivity is explained more by the expansion of new knowledge and less by diffusion of technology. But in case of non-foodgrains the impact of new technology is less as compared to food crops and all crops. But if we look at sub-periods, it is evident that the contribution of diffusion of technology in second period is more than that of the first period in explaining productivity growth.

5.7 Role of Political and Institutional Factors in Determining Agricultural Productivity.

Till now we included in the analysis the variables like fertiliser, irrigation, rainfall, HYVs, credit, population and time. However, there are some other factors which were not included in the model but were important in explaining the productivity differentials. These include public and private investment[9], profitability, role of pancayats, land reforms and the network of agricultural research.

Barring the factors included in the model, the role of private and public investments are the other possible reasons for this phenomenal growth. In the agricultural sector both central and state governments played crucial role in fostering agricultural development. Profitability is also an important factor which contribute to the productivity growth across the states[10].

---

[9] For details see Sidhu and Sidhu (1994).

[10] Kannan and Pushpangadan(1990) hughlights this issue in the context of Kerala.

Even though the positive impact of land reforms on agricultural productivity is still debatable, in certain states its impact can not be ruled out[11]. The example of Kerala is important in this context where land reforms are considered highly successful. In spite of the observed stagnation in the growth of production the state occupies second position with regard to value of yield per hectare.

Another major landmark was the establishment of a network of agricultural universities and research Institutes throughout India to promote agricultural education, research and extension in an integrated manner. The departments of the state governments has also been strengthened. The government stepped up its expenditure on agricultural research from Rs 2.27 crores in the first plan to Rs 540 crores in the in the sixth plan.

At state level, it is observed that the eastern states have performed very well in the 80's. For example, Orissa registered a growth rate of 3.19 per cent in the 80's from a negative growth rate of -0.84 per cent in 1970's. Apart from the factors included in our model, the network of agricultural research extension could be attributed to this growth. In Orissa, a research station for rice was established in Cuttack which has already released 65 high yielding varieties of rice for different types of lands that played a crucial role in the output growth in Orissa in the 80's. Apart from that the role of land reforms could be attributed to the productivity growth.

---

[11] Shah and Swaminathan (1994) highlights this issue in the context of West Bengal

In West Bengal, the productivity of growth was very high in 1980's that is 3.68 per cent as compared to a low growth rate of 1.05 per cent in 70's. The reasons for this phenomenal growth could be attributed to the active participation by panchayats in production related activities.[12] Apart from that the role of land reforms in 80's in West Bengal could also be responsible for such increase in productivity level. Also the role of Panchayats in distributing input packages to small cultivators and the role of 'Operation Barga' could also be associated with the growth in agricultural sector that has been observed in 1980s.

In case of Kerala, the yield per hectare is very high as, the cropping pattern has shifted in favour of cash crops due to high wage rates in agricultural sector. Thus, Kerala even with a very low growth rate could be ranked as second so far as the value of productivity is concerned.

The role of favourable climatic conditions can not be ignored as most of the Indian states do not have assured irrigation facilities. Since the climatic conditions are exogeneously determined, the analysis of productivity variations is confined only to these above mentioned technological, institutional and political factors.

5.8 Conclusion

The following conclusions can be drawn from the above analysis. The packages of FHI along with favourable monsoon and infrastructural facilities backed by supportive political and institutional factors

---

[12] See Saha and Swaminathan (1994).

are the main determinants of productivity growth and the extent of productivity variations across the states in agricultural sector. In this exercise the role of population growth in determining agricultural growth via technological change found to be significant in most of the states. Thus the Boserupean argument of population pressure and agricultural development is valid in the case of Indian agriculture.

From the analysis it is evident that there exists large scale variations in productivity across the states. The major factors which contribute to such variations are HYVs, irrigation, credit and fertiliser. However, the contribution of fertiliser found to be negligible. At disaggregated level we observed that these factors determine the variations to a large extent. Even though the impact of credit on productivity level found to be insignificant in most of the states in the state level analysis, its contribution to productivity variation across the states is highly significant from decomposition analysis.

With the help of diffusion model, we have estimated the impact of technology diffusion on agricultural productivity. It was found that, while in 70's the impact of new technological knowledge on productivity is more pronounced, it is the diffusion of technolgy which is more prominent in determining the growth in 80's.

The following chapter summarises the major findings of the study and presents an over view of the growth pattern in Indian agriculture observed in the post-green revolution period.

Chapter 6

SUMMARY AND CONCLUSIONS

This study aimed to bring out the performance of the agricultural sector in India and to assess the factors determining the productivity growth and productivity variations across the states. In the process we have analysed the trends and variations in the agricultural production and the sources of growth. The study has also examined the role of population growth and the diffusion of technology in determining the productivity growth.

Analysis of the trends in agricultural production over the last three decades have shown that the output has increased in the 80's, However, this is mostly explained by the growth in yield. As the growth in area is not significant, the fluctuations in the production level are largely due to the fluctuations in yield.

An analysis of the growth pattern reveals that there exists large scale variations in the growth of production across the states. Some states which were stagnant in the first period could register very high growth in the second period. The example of West Bengal and Orissa assumes importance in this regard as both the states could register very high growth rates in the second period. At the same time, states like Maharashtra, Gujurat and Jammu & Kashmir which were performing well in the first period could not sustain their growth in the second period. However, states like Punjab, Haryana and Uttar Pradesh are performing consistently well over the years.

The review of growth pattern in Indian agriculture indicates that variables like fertiliser, HYVs, irrigation, credit, rainfall, profitability, public and private investment and population influence the productivity growth. However, due to non-availability of data on profitability and investment, these two variables were excluded from the empirical exercise.

The role of various farm inputs were examined at disaggregated level. But due to multicollinearity problem the relative importance of modern inputs - HYVs, fertiliser, irrigation could not be separated using the regression analysis. Therefore, an Input Index comprising of Fertiliser, HYVs and Irrigation (FHI) was taken in order to assess its impact on productivity. We have observed that higher doses of (FHI) is positively associated with higher levels of productivity.

Analysis also shows that credit plays an important role in determining the agricultural productivity. However, credit is negatively associated with productivity in most of the states. This is mainly because of the reason that credit meant for the use of agricultural development are not properly utilised. Rainfall is found to be an important determinant of agricultural productivity across the states. We also found that assured level of irrigation and normal rainfall are positively and significantly associated with higher level of productivity.

In this study the role of population growth was incorporated and it was found that population is significantly determining the productivity growth in 13 out of 17 states. The explanatory power

of the yield equations are very high where the coefficient of population is significant. Thus the Boserupean argument of population growth and agrarian development is valid in the case of Indian agriculture.

We also examined the role of new technological knowledge and the technology diffusion in determining the productivity growth. It was found that the new knowledge explains more of the productivity growth than that of diffusion of technology in the earlier period. However, the impact of diffusion of technology is higher in the later period which contributed to the increased growth in the late 80s.

The major findings of this inter-state study could be summed up as follows:

India shows a heterogenous growth pattern across the states in the period 1967-68 to 1992. Between the sub-periods, the growth in productivity is not consistent for all the states and there exist large scale variations across the states. However, the extent of variation is reduced due to the diffusion of technology in the later period.

The growth and fluctuations in agricultural production over the years are mainly explained by the growth and fluctuations in the yield. This is more pronounced in the second period.

Certain states could not sustain their growth and productivity in the second period which were leading states in the first period.

The impact of fertiliser use on productivity has been reduced to a large extent in 80s which was the major determinant of the productivity growth during 60s and 70s.

The role of Input Package comprising of Fertiliser, HYVs and Irrigation (FHI), Credit and Rainfall is significant in determining the productivity growth across the states.

Population growth and its density determine the productivity growth significantly and positively.

The role of new technology plays crucial role in determining the level of productivity. However, diffusion of technology explains the productivity growth in the 80s. Thus in the present context, new technological development is required for further expansion of the productivity at the aggregate and disaggregate level.

Policy Implications

On the basis of the above findings of the study the following policy measures could be prescribed.

(1) The extensive use of modern inputs are required for the future source of growth in the states where the growth in productivity is very low.

(2) The distribution of agricultural credit should be properly channelised and precautions should be taken as to see that the sanctioned resources for the purpose of agricultural development are not invested elsewhere.

(3) The technology diffusion model clearly indicates that faster growth can be achieved by new technological development in the agricultural production.

(4) Government should formulate the policy to ensure that modern technology is transferred to the low growth regions of the country, where the agricultural growth is stagnating over the years.

Areas for Further Research

Profitability assumes importance in Indian agriculture in the context of liberalisation especially when input subsidies are withdrawn to a large extent. We found that there has been a shift from traditional crops to cash crops in the recent years due to differences in profitability and the emergence of high wage rate in the agricultural sector. A systematic empirical exercise analysing the impact of profitability on productivity would be of importance.

The diffusion model can be estimated at various state level using further disaggregated data to assess the impact of technology diffusion in the individual states.

The impact of private and public investment can be traced out incorporating in the yield equations mentioned in this study.

A grass root level study would be of great importance to trace out other plausible factors determining the level of productivity.

Appendix

Table A.1

Coefficients of Factors Influencing Agricultural Output

State	Fert.	Irrig.	HYVs	Credit	Rainfall	Time	R^2
Andhra	0.0927	0.347	0.0319	-0.082	-0.6572	0.1361	0.58
	(0.0470)	(1.4241)	(0.0131)	(0.0748)	(0.2625)	(0.170	
Assam	-0.0816	1.1816	0.0457	0.0166	0.11	0.1768	0.48
	(0.0668)	(0.6553)	(0.0232)	(0.0200)	(0.2388)	(0.0802)	
Bihar	0.1239	-0.5888	0.0393	-0.035	0.0506	0.0638	0.48
	(0.0339)	(1.1091)	(0.0110)	(0.0483)	(0.2362)	(0.1737)	
Gujrat	0.2608	0.0763	0.0716	-0.0259	-0.0619	-0.0043	0.59
	(0.0339)	(0.8276)	(0.0203)	(0.1056)	(0.1431)	(0.3023)	
H.Pradesh	0.4867	-0.1935	0.03	-0.0684	-0.2266	-0.0768	0.89
	(0.1616)	(0.404)	(0.0508)	(0.0604)	(0.1927)	(0.1674)	
Karnatak	0.0952	0.7852	0.0362	-0.0473	0.0768	-0.001	0.52
	(0.0335)	(1.2335)	(0.0162)	(0.1043)	(0.4518)	(0.3306)	
Kerala	-0.1681	0.4909	0.0402	0.0178	-0.445	0.5604	0.5
	(0.8954)	(0.5932)	(0.0452)	(0.0704)	(0.4327)	(0.247	
M.P	0.0013	0.5687	0.0309	0.0044	0.3092	0.0108	0.46
	(0.1829)	(0.1856)	(0.0390)	(0.0738)	(0.1958)	(0.1557)	
Maharastr	0.535	- 0.7603	0.0397	-0.0928	0.4329	-0.322	0.79
	(2104)	(0.8086)	(0.0270)	0.0785	(0.1111)	(0.1)	
Orissa	0.2213	-0.5553	0.0305	-0.0788	0.0643	0.0804	0.84
	(0.1256)	(0.3798)	(0.0426)	(0.0735)	(0.1658)	(0.1276)	
Punjab	0.1723	0.3847	0.1397	-0.0058	0.1832	0.1455	0.95
	(0.0298)	(0.2746)	(0.0276)	(0.0385)	(0.0928)	(0.0805)	
Rajsthan	0.071	0.8585	0.0267	0.0493	0.0436	-0.0351	0.49
	(0.0502)	(0.3570)	(0.0567)	(0.0645)	(0.07460	(0.5761)	
TamilNadu	0.2316	2.3916	0.0045	-0.1182	-0.1697	0.0904	0.52
	(0.4177)	(1.8247)	(0.0654)	(0.1430)	(0.3680)	(0.3059	
U.P	0.192	0.1393	0.0178	0.0642	0.0883	0.1526	0.76
	(0.8843)	(0.5846)	(0.0205)	(0.0429)	(0.1271)	(0.1092)	
W.B.	0.1749	-0.7861	0.0033	0.0194	0.3605	0.345	0.67
	(0.1804)	(1.3617)	(0.0359)	(0.0397)	(0.4123)	(0.2469)	

Source: Joshi and Haque (1980)

Table A.2

Accounting For Land Productivity Differences In Agriculture in Selected States From Punjab As Percent of Punjab Land Productivity

State	Difference in output per hect. as percent of Punjab	Percentage of difference explained by				
		Total	Fertilizer	Irrigation	HYVs	Credit
Andhra	24.49	21.49	6.92	6.87	5.9	1.8
	(100.00)	(88.11)	(25.79)	(28.16)	(24.19)	(7.30)
Assam	37.77	31.02	11.81	8.16	9.16	1.89
	(100.00)	(82.12)	(31.26)	(21.60)	(24.25)	(5.00)
Bihar	33.29	26.48	9.92	7.46	7.25	1.8
	(100.00)	(79.54)	(29.79)	(22.40)	(21.77)	(5.56)
Gujrat	40.27	24.46	7.75	8.57	8.15	-0.01
	(100.00)	(60.74)	(19.29)	(21.28)	(20.23)	(0.002)
Haryana	12.2	11.4	7.68	3.74	-0.01	-0.01
	(100.00)	(93.44)	(62.95)	(30.65)	(-0.08)	(-0.08)
H.Pradesh	25.2	20.83	10.13	7.35	1.94	1.41
	(100.00)	(82.65)	(40.19)	(21.16)	(7.69)	(5.59)
Karnataka	49.28	28.65	7.61	8.99	10.95	1.1
	(100.00)	(58.13)	(15.44)	(18.24)	(22.22)	(2.23)
Kerala	45.62	24.31	5.33	7.4	11.42	0.16
	(100.00)	(53.25)	(11.68)	(16.22)	(25.03)	(0.35)
M.P.	54.39	33.31	11.06	9.66	10.99	1.6
	(100.00)	(61.24)	(20.33)	(17.76)	(20.20)	(2.94)
Orissa	34.9	33.22	10.52	8.54	12.6	1.56
	(100.00)	(95.13)	(30.14)	(24.46)	(36.10)	(4.46)
Maharastra	48.07	30.24	8.88	9.6	10.53	1.23
	(100.00)	(62.90)	(18.47)	(19.97)	(21.90)	(2.55)
Rajasthan	65.62	34.25	11.35	8.64	12.38	1.88
	(100.00)	(52.19)	(17.29)	(13.16)	(18.86)	(2.86)
Tamil Nadu	21.62	9.6	2.68	4.1	2.68	0.14
	(100.00)	(44.40)	(12.39)	(9.05)	(12.39)	(0.64)
U.P.	24.17	22.15	8.13	6.44	5.75	1.83
	(100.00)	(91.64)	(33.63)	(26.64)	(23.78)	(7.53)
W.B.	35.65	27.69	8.7	8.14	9.03	1.82
	(100.00)	(77.67)	(24.40)	(22.83)	(25.32)	(5.10)

Source: Joshi and Haque (1980)

Table A.3

Performance of Foodgrains Production in 1970's and 1980's

Performing better in 1980's

STATES	1967/68 TO 1979/80	1979/80 TO 1991/92
ORISSA	0.14	3.67
WEST BENGAL	0.30	3.67
MADHYAPRADESH	0.78	3.31
UTTAR PRADESH	1.76	4.69
HIMACHAL PRADESH	0.52	1.68
BIHAR	-0.07	2.22
ASSAM	0.87	2.56

Performance was better in 1970's

STATES	1967/68 TO 1979/80	1979/80 TO 1991/92
RAJSTHAN	2.94	-0.22
MAHARASTRA	5.12	0.86
KARNATAK	2.44	0.37
GUJRAT	3.84	-0.34
KERALA	0.59	-1.92

Table A.4

Performance of Non Foodgrains Production

performing better in 1980's

STATES	1967/68 TO 1979/80	1979/80 TO 1991/92
BIHAR	-0.21	2.03
ANDHRA	1.14	4.85
HIMACHAL PR	-1.90	1.93
MADHYA PR	-1.60	4.11

(contd)

Performance was better in 1970's

STATES	1967/68 TO 1979/80	1979/80 TO 1991/92
ASSAM	11.04	-4.77
GUJRAT	4.04	0.21
JAMMU & KASMIR	7.06	-1.30
KERALA	0.16	-2.72

Table A.5

Performance of Agricultural Sector (all crops) during 1970'& 1980's

performing better in 1980's

STATES	1967/68 TO 1979/80	1979/80 TO 1991/92
ORISSA	1.20	4.28
WEST BENGAL	1.80	4.05
BIHAR	-0.10	2.18
HIMACHAL PRADESH	0.41	1.73
MADHYA PRADESH	-0.12	3.61

Performance was better in 1970's

STATES	1967/68 TO 1979/80	1979/80 TO 1991/92
ASSAM	4.59	-0.14
GUJRAT	3.98	0.04
JAMMU & KASMIR	2.75	0.99
KERALA	0.07	-2.01

BIBLIOGRAPHY

Ahluwalia, D (1989): "Sources of recent growth in rice and wheat output", *Economic and Political Weekly*, Vol.24, pp.A137-A144, September 30.

Ahluwalia, D (1991): "Growth performance in Indian agriculture", *Journal of Indian School of Political Economy*, Vol.3, No.4.

Alagh, Y K and Sharma, P S (1980): "Growth of crop production 1960-61 to 1978-79: Is it decelerating?", *Indian Journal of Agricultural Economics*, Vol.35, No.2, pp.104-18.

Berry, R A and Cline, W R (1979): Agrarian Structure and Productivity in Developing Countries, The John Hopkins University Press, London.

Bhalla, G S (1979): *"Farm size, productivity and technical change in Indian agriculture"* in appendix of R.A. Berry and W.R. Cline (1979), Agrarian Structure and Productivity in Developing Countries, The John Hopkins University Press, London.

Bhalla, G S and Alagh, Y K (1979): *Performance of Indian agriculture: A District-Wise Analysis*, Sterling Publishers Pvt. Ltd. New Delhi.

Bhalla, G S and Tyagi, D S (1989): *Patterns in Indian Agricultural Development: A District-level Study*, Institute for Studies in Industrial Development, New Delhi.

Boserup, E (1965): *The Conditions of Agricutural Growth*, Aldine, Chicago.

Boserup, E (1981): *Population and Technological Change: A Study of Long Term Trends*, University of Chicago Press, Chicago.

Boyce, James K (1987): *Agrarian Impasse in Bengal: Institutional Constraints to Technological change (Agricultural Growth in Bangladesh and West Bengal, 1947-80)*, Oxford University Press, New Delhi.

CMIE (1993): *Performance of Agriculture in Major States, 1967-68 to 1991-1992*, Bombay.

Dandekar, V M (1980): "Introduction to seminar on database and methodology for the study of growth rates in Indian agriculture", *Indian Journal of Agricultural Economics*, Vol. XXXV, No.2.

Dandekar, V M (1994): *The Indian Economy, 1947-92*, Vol-1, Sage Publications, New Delhi.

Datt, Ruddar and Sundaram, K P M (1995): *Indian Economy*, 32nd Edition, Sultan Chand & Company Ltd. New Delhi.

Dhawan, B D (1991): "Role of irrigation in raising intensity in cropping", *Journal of Indian School of Political Economy*, Vol.3, No.4.

Dholakia, Ravindra R and Dholakia, Bakul H (1993): "Growth of total factor productivity in Indian agriculture", *The Indian Economic Review*, Vol.XXVIII, No.1.

Gujurati, Damodar N (1994): *Basic Econometrics*, International Edition, McGraw Hill Book Company, New York.

Hazzel, P (1982): "Instability in Indian foodgrains production". *IFPRI, Research Report No.30*, Washington D.C.

Johnston, J (1993): *Econometric Metthods*, Tokyo, Kogalkosha.

Joshi, P K and Haque, T (1980): "An enquiry in to the long term prospects of balanced agricultural growth in India", *Indian Journal of Agricultural Economics*, Vol.XXXV, No.4.

Kannan, K P and Puspangadan, K (1990): "Dissecting agricultural stagnation in Kerala: An analysis across crops, seasons and regions",*Economic and Political Weekly*, Sept 1-8.

Kannan, K P and Puspangadan, K (1988): "Agricultural stagnation in Kerala: An exploratory analysis", *Economic and Political Weekly*, September, Review of Agriculture.

Krishnaji, N (1980): "Measuring agricultural growth", *Indian Journal of Agricultural Economics*, Vol.35, No.2, pp.31-41.

Maddala, G S (1993): *Introduction to Econometrics*, Macmillan, London.

Mahendradev, S (1987): "Growth and instability in foodgrains production: An inter-state analysis", *Economic and Political Weekly*, Sept.26.

Mahendradev, S (1991): "Constraint on agricultural productivity: A district level analysis", *Economic and Political Weekly*, Vol.26, No. , pp.126-134.

Mehra, Sakuntala (1981), "Instability in Indian agriculture in the context of new technology", *IFPRI Research Report No. 25*, Washington D.C.

Michael R Moore, Neol R Gollehon and Donald H Negri (1994): "Alternative forms of production function of irrigated crops", *The Journal of Agricultural Economics Research*, Vol.44, No.3.

Mishra, Baidyanath (1990): *Agricultural Development*: Problems and Prospects, Ashish Publishing House, New Delhi.

Mishra, S K and Bajpai, A D N (1991): *Economics of Irrigation and Performances of Agriculture in India*, New Economic Policy of India.

Mukharjee, Chandan and Vaidyanathan A (1980): "Growth and fluctuations in foodgrains yield per hectare: A state wise analysis", *Indian Journal of Agricultural Economics*, Vol.XXXV, No.2.

Nadkarni, M V (1993): "Sustainable development: concept and issues with special reference to agriculture", *Indian Journal of Agricultural Economics*, Vol. XLVIII, pp. 516-526.

Narayan, Dharam (1988): "Growth of productivity in Indian agriculture", in K N Raj, A K Sen and C H Hanumanth Rao (eds), *Studies in Indian Agriculture*, Oxford University Press, New Delhi.

Narayan, Dharam (1975): "Growth and ibalances in Indian agriculture", in K N Raj, A K Sen and C H Hanumanth Rao(eds), *Studies in Indian Agriculture*, Oxford University Press, New Delhi.

Parikh, A (1980): "State wise growth rate in agricultural output: An econometric analysis", *Arthavijnana*, Vol.8, No.1, pp.1-52.

Puspangadan, K and Kanan, K P (1990): "Agricultural stagnation and economic growth in Kerala: An explanatory analysis", *CDS Working Paper No. 227*, Trivandrum.

Puspangadan, K (1991): "Agricultural stagnation in Kerala: An econometric study of tapioca", *CDS Working Paper No. 226*, Trivandrum.

Rao, V M (1980): "Methodological issues in recent Indian researchers", *Indian Journal of Agricultural Economics*, Vol. XXXV, No.2.

Rao, Hanumanth C H and Gulati, Ashok (1994): "Indian agriculture: emerging perspectives and policy issues", Economic and Political Weekly, Vol.XXIX, No.53.

Rao, Hanumanth C H (1994): "Agricultural growth and rural poverty in India: Emerging trends and perspectives", *Indian Economic Review*, Vol.XXVIII, No.2, pp. 129-40.

Rao, V M, Nadkarni, M V and Deshpande, R S (1980): "Measurement of growth and fluctuations in crop-output: An approach based on the concept of non-systematic component", *Indian Journal of Agricultural Economics*, Vol-XXXV, No-2, pp.21-30.

Rao, Hanumanth C H (1965): "Agricultural growth and stagnation in India", *The Economic Weekly*, Vol.17, pp.407-411.

Rath, Nilakanth (1989): "Agricultural growth and investment in India", *Journal of Indian School of Political Economy*, Vol.I, No.1.

Rath, Nilakantha (1980): "A note on agricultural production in India during 1955-78", *Indian Journal of Agricultural Economics*, Vol. XXXV, No.2.

Ray, S K and Sharma, H L (1985): "Contributions of fertiliser and cropping intensity to differential agricultural growth in India: A district-wise approach", *Agricultural Situation in India*, Vol. , No. , April, pp.3-6.

Robert E Evaenson, Carmen M Fernandez and Casiniro A Herruzo (1993): "Measurement of the total factor productivity growth of Spanish agriculture: 1962-69", *Economic Growth Centre Discusion Paper No-708*, Yale University.

Sawant, S D and Achuthan, C V (1995): "Agricultural growth across crops and regions: Emerging trends and patterns", *Economic and Political Weekly*, Vol. XXX, No.12.

Sen, Abhijit (1992): "Economic liberalisation and agriculture in India", *Social Scientist*, Vol.20, No.11.

Sen, S R (1967): "Growth and instability in Indian agriculture", *Journal of Indian Society of Agricultural Statistics*, Vol. 19, No. 1.

Sharma, J L (1992): "Productivity variation in Indian agriculture", *Agricultural Situation in India*, Vol.XLVII, No.2.

Sidhu, D S and Sidhu, R S (1994): *Agricultural productivity in Asia: A comparative analysis*, Oxford and IBH Publishing Company, Pvt. Ltd, New Delhi.

Singh, Karan and Kaur, Kulwinder (1992): "Growth in agricultural productivity and nature of agricultural change in Punjab agriculture", *Agricultural Situation in India*.

Srinivasan, T N (1979): "Trends in agriculture in India", *Economic and Political Weekly*, Vol.14 No. 30-2, Special Number.

Swaminathan, Madhura and Saha Anamitra (1994), "Agricultural growth in West Bengal in 1980's", *Economic and Political Weekly*, Vol.29, March 29.

Vaidyananthan, A (1980): "On analyzing agricultural growth", *Journal of Indian Society of Agricultural Statistics*, Vol.32, No.1, pp.1-24.

Vaidyanathan, A (1992): "Instability in agriculture: Extent, causes and consequences. A review article", *Indian Economic Review*, Vol XXVII, No 2, pp.211-222.

Vaidyanathan, A (1987): "Agricultural development in Eastern India", *Economic and Political Weekly*, Review Article, Dec. 26, pp.2259-2263.

Vaidyanathan, A. (1977), "Performance and prospects of crop production in India", *Economic and Political Weekly*, August, Special Number, pp.1355-1368.