CROP SHIFTS IN COASTAL REGION OF ANDHRA PRADESH – AN ECONOMIC ANALYSIS

BY

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B.Sc. (Ag.)

THESIS SUBMITTED TO THE ACHARYA N.G. RANGA AGRICULTURAL UNIVERSITY IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF

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DECLARATION

I, **Ms. S.B. RAMYA LAKSHMI,** hereby declare that the thesis entitled **"CROP SHIFTS IN COASTAL REGION OF ANDHRA PRADESH – AN ECONOMIC ANALYSIS"** submitted to **Acharya N.G.Ranga Agricultural University**, for the degree of **Master of Science in Agriculture** is the result of original research work done by me. I also declare that no material contained in this thesis has been published earlier in any manner.

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CERTIFICATE

Ms. S.B. Ramya Lakshmi has satisfactorily prosecuted the course of research and that the thesis entitled **"Crop Shifts in Coastal Region of Andhra Pradesh – An Economic Analysis"** submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that neither the thesis nor its part thereof has been previously submitted by her for a degree of any university.

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This is to certify that the thesis entitled **"Crop Shifts in Coastal Region of Andhra Pradesh – An Economic Analysis"** submitted in partial fulfilment of the requirements for the degree of "Master of Science in Agriculture" of the Acharya N.G.Ranga Agricultural University, Hyderabad is a record of the bonafide original research work carried out by **Ms. S.B. Ramya Lakshmi** under our guidance and supervision.

No part of the thesis has been submitted by the student for any other degree or diploma. The published part and all assistance received during the course of the investigations have been duly acknowledged by the author of the thesis.

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(S.B. Ramya Lakshmi)

List of Contents

List of tables

List of Figures

List of Symbols and Abbreviations

@	:	At the rate of
%	:	Per cent
CGR	:	Compound Growth Rate
et al.	:	and other people
etc.	:	and so on
FHP	:	Farm Harvest Price
Fig.	:	Figure
GDP	:	Gross Domestic Product
g	:	Gram
ha	:	Hectare
HYV	:	High Yielding Variety
i.e.	:	That is
Kg	:	Kilogram
mm	:	Millimeter
No.	:	Number
Qtl	:	Quintal
Rs	:	Rupees
Sq.km	:	Square kilometer
T.E.	:	Triennium Ending
Viz.,	:	namely

ABSTRACT

Author	:	S.B. Ramya Lakshmi
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The present study entitled "Crop Shifts in Coastal Region of Andhra Pradesh – An Economic Analysis," was undertaken to study the growth rates of area, production and productivity of major crops, direction of cropping pattern changes, factors influencing the cropping pattern changes in the selected districts of Coastal Andhra region.

The study was conducted in two districts of Coastal Andhra region namely Vizianagaram and Prakasam. Data required for the study was collected from various published and unpublished sources. The data covered a period of 28 years commencing from 1981-82 to 2008-09.

In Vizianagaram district, jowar, bajra, ragi, small millets, bengalgram, recorded significant negative area growth. On the other hand, crops like maize, redgram, blackgram, greengram, sugarcane and sesamum were found associated with positive significant growth of area. Area under paddy declined at an annual rate of 0.20 per cent but it was non-significant. Among the foodgrains, bengalgram recorded the highest growth rate of productivity (3.80 per cent). In Prakasam district, area growth rate was the highest for bengalgram followed by maize and sunflower. Productivity growth rate was the highest in bengalgram (3.10 per cent) followed by chillies (2.04 per cent).

In Vizianagaram district, groundnut which retained a relatively higher proportion of its area in period I was highly unstable in period II. Greengram was the next crop to groundnut in period I which exhibited retention levels of

its own area, but in period II it had a zero degree of retention. In the case of mesta, the retention probability of its own area has increased to a little extent to 0.3288 in period II from 0.3154 in period I. Paddy one of the major crops in the district did not retain much of its area in the second period as observed in the period I. Horsegram and sesamum remained as the most unstable crops in both the periods. Other crops ability to retain their own area was very less in period I but was moderate in period II. In Prakasam district in period I, bengalgram and cotton were the only unstable crops, but in period II, Jowar, cotton, redgram and tobacco remained as unstable crops. Cotton in both the periods was unstable.

In Vizianagaram district area under paddy, greengram, groundnut, mesta, sugarcane and sesamum were significantly influenced by their own lagged prices. Rainfall significantly influenced the area under blackgram and groundnut only. Gross irrigated area exerted non-significant influence on paddy and sugarcane acreage. In Prakasam district area under paddy, redgram, bengalgram, chilly and tobacco were positively influenced by their own lagged prices. Increase in gross irrigated area had a significant positive influence on the area under paddy.

Chapter I

INTRODUCTION

Agriculture is the most important sector of the Indian economy, since it contributes the largest share of National Income (NI) and provides a source of livelihood to 70 per cent of the people. Agriculture accounted for 14.2 per cent of the Gross Domestic Product (GDP-at constant prices) in 2010-11 as compared to 21.7 per cent in 2003-04. Recent technological break-through in Indian agriculture, resulting from the introduction of High Yielding Varieties has resulted in more than four times increase in the foodgrains production in the country of 229.85 million tonnes in 2008-09 as compared to the level in 1950-51 i.e. 50.87 million tonnes. Annual agricultural growth rose to 3.7 per cent during 2003-04 to 2007-08. The foodgrains production recorded an increase of 10 million tonnes each year during this period and touched an all-time high of 230 million tonnes in 2007-08.

Economic growth in the countries of Asia and Pacific region including India, Bangladesh, Myanmar, Thailand etc. is substantially influenced by growth of agricultural sector. A high level of growth of agriculture is essential both for achieving the objective of food security at macro and micro levels and also to alleviate poverty in India. The efforts towards the holistic development of agriculture encompassing planning, promoting, conducting and coordinating research, education and extension and training on all aspects of agriculture for ensuring optimal utilization of land, water, plant and animal resources have yielded significant results. Application of science to generate cost-effective technologies and well-developed system to transfer technologies to the farmers ensured significant levels of growth of this sector and enabled the country to become free from food import.

The development experience in the country over the past five decades indicate that policy makers and planners are increasingly showing their concern towards agricultural diversification to promote agricultural growth and improve productivity by extending appropriate policy support and fiscal incentive. Diversification in agriculture refers to adoption of farming system, involving shift in cropping pattern from traditionally grown less remunerative crops to more remunerative crops like oilseeds, pulses, fodder cops, horticulture, medicinal and aromatic plants, floriculture etc. including land-based activities like livestock and fishery enterprises. This shift in area under different crops takes place due to changing demand position and prices of agricultural commodities. Diversification within agriculture is of two types: (i) Crop diversification and (ii) Enterprise diversification involving inter-crop and inter-enterprise shifts of resources respectively (Sawant, 1993). Diversification emerges from the farmers' response to a slack in the system, leading to an addition of complementary crop activities or enterprises for exploiting the unemployed or under-employed resources, whenever the opportunity to do so arises (Vyas, 1996). The trend towards crop and enterprise diversification has emerged in Indian agriculture since 1967-68.

1.1 CROP DIVERSIFICATION

In the developing context, crop diversification has become an important option to attain several objectives of agriculture sector viz., natural resource sustainability, ecological balance, output growth, buffer stocks, employment generation, risk coverage etc. The process of crop diversification in Indian agriculture commenced after the objective of agricultural development strategy was changed from maximizing the production of foodgrains to evolving a production pattern in line with the demand pattern in early eighties.

Crop diversification takes into account the economic returns from different value-added crops. It is different from the concept of multiple cropping or succession planting in which multiple crops are planted in succession over the course of a growing season. Moreover, it implies the use of environmental and human resources to grow a mix of crops with complementary marketing opportunities, and it implies a shifting of resources from low value crops to high value crops, usually intended for human consumption such as fresh market fruits and vegetables. With globalization of the market, crop diversification in agriculture means to increase the total crop productivity in terms of quality, quantity and monetary value under specific, diverse agro-climatic

situations world-wide. There are two approaches to crop diversification in agriculture. First is horizontal diversification, which is the primary approach to crop diversification in production agriculture. Here, diversification takes place through crop intensification by adding new high-value crops to existing cropping systems as a way to improve the overall productivity of a farm or region's farming economy. The second is the vertical diversification approach in which farmers and others add value to products through processing, regional branding, packaging, merchandising, or other efforts to enhance the product. The ability of the country to diversify the cropping pattern for attaining various goals depends on the opportunities available for diversification, the need for diversification and responsiveness of farmers to those needs and opportunities and these opportunities vary depending on risks, opportunities and the feasibility of proposed changes within a socio-economic and agro-economic context.

Analysis on crop diversification in Indian agriculture during three distinct post-independence time periods i.e. pre-green revolution (up to 1964-65), green revolution period (mid sixties) and post-green revolution period (early eighties) revealed that, within foodgrains, during pre-green revolution period, there was substantial increase in absolute area under cereals and pulses. However, proportionate area under cereals marginally declined, with corresponding increase in proportionate area under pulses. But, during the green revolution period, there was considerable increase in proportionate area under cereals and corresponding decrease under pulses. The proportionate area under cereals increased from 79.5 per cent of total area under foodgrains in Triennium Ending (T.E.) 1964-65 to 82 per cent in T.E. 1980-81. During this period there was considerable decline in even absolute area under pulses by as much as 1.3 million hectares. This trend was reversed during the post-green revolution period. Between T.E. 1980-81 and T.E. 1998-99, absolute area under cereals declined by 3.0 million hectares which was accompanied by marginal increase in area under pulses. Also it was revealed that during the last 20 years (post-green revolution period) there has been diversification of crop area away from cereals as a group to non-food crops. During the pre-green revolution period, the area under oilseeds, cotton, jute and sugarcane increased considerably. During the green revolution period, increase in area under these non-foodgrain crops slowed down. However, after 1980-81, there was again a considerable increase in area under almost all non-foodgrain crops. The most significant increase was in the case of oilseeds. The area under oilseeds, which had increased from 11.20 million hectares in T.E. 1952-53 to 15.14 million hectares in T.E.

1964-65 and 17.42 million hectares in T.E. 1980-81, went up sharply to 26.23 million hectares in T.E. 1998-99. The area under cotton, sugarcane, spices, vegetables and fruits also increased sharply during the post-green revolution period.

Crop diversification is the outcome of several interactive effects of many factors:

1. Environmental factors including irrigation, rainfall, temperature, and soil fertility.
2. Technology-related factors including seeds, fertilizers and water technologies, but also those related to marketing, harvest, storage, agro-processing, distribution, logistics etc.
3. Household-related factors including regional food traditions, fodder and fuel as well as the labour and investment capacity of farm people and their communities.
4. Price-related factors including output and input prices as well as national and international trade policies and other economic policies that affect the prices either directly or indirectly.
5. Institutional and infrastructure-related factors including farm size, location and tenancy arrangements, research, in-field technical support, marketing systems and government regulating policies etc.

All these five factors are interrelated. The adoption of crop technologies is commonly assumed to be influenced primarily by resource-related factors when institutional and infrastructure factors can play as much or more of a role in their adoption.

1.1.1 Benefits of Crop Diversification

The crop diversification may results in the following anticipated benefits.

(i) Alternative crops may enhance profitability.

(ii) Reduce risks arising out of crop failures, yield losses and market failures.

(iii) Labour may be spread out more uniformly.

(iv) Different planting and harvesting times can reduce risks from weather.

(v) New crops can be renewable resources of high value products.

(vi) Efficient utilization of available land, labour, water and other resources.

(vii) Realizing quicker or regular returns to the farmers.

However, these advantages of diversification are not without costs to an individual farmer. Crop diversification demands higher level of managerial input from the farmer. More number of small surpluses creates difficulties in efficient handling and marketing of the produce. Further it becomes prohibitive to acquire specialized and more efficient tools and equipment under diversified farming situations. Despite these difficulties, the advantages of crop diversification on Indian farms outweigh the disadvantages (Dhondhyal, 1990).

1.2 JUSTIFICATION

Agriculture is the bedrock of Andhra Pradesh state's economy. Out of the total population, over 72.7 per cent live in rural areas seeking their livelihood from agriculture and allied sectors. Around 13.4 per cent contribution of advance estimates at constant prices of the state GDP is from agriculture during 2008-09 and 15.4 per cent during 2007-08, whereas at current prices 14 per cent during 2008-09 and 15.5 per cent in 2007-08. Agriculture in Andhra Pradesh provides employment to 65 per cent of the population.

Agriculture in Andhra Pradesh is mostly dependent on rainfall. Agricultural production depends upon the seasonal distribution of rainfall. The influence of south-west monsoon is predominant in Telangana region (716 mm) followed by Coastal Andhra (620 mm) and Rayalaseema regions (407 mm), whereas the north-east monsoon provides high amount of rainfall in Coastal Andhra area (324 mm) followed by Rayalaseema (238 mm) and Telangana (129 mm) regions.

Among the various states of the country, Andhra Pradesh is an agriculturally important state in India. It is the third largest producer of rice and groundnut, while it is second in cotton and sunflower. It has been one of the front-runners in reaping the benefits of green revolution. However, its vast dryland tracts could not keep pace with the better-endowed regions resulting in wide inter-regional disparities. In order to address the problems of agriculture, the state has been implementing various schemes from time to time. Despite this, agriculture in the state has been exhibiting stagnation in growth and is seeking innovative policy and technology interventions. Andhra Pradesh is also an important producer of horticultural crops. The National Horticulture Mission (NHM) has identified the state as having potential to enhance exports of mango,

banana, grapes, papaya, guava, brinjal and cabbage. Diversification has been identified as one of the potential ways of enhancing growth and ensuring stability in agriculture. Therefore an attempt is made in this study entitled "Crop Shifts in Coastal region of Andhra Pradesh-An Economic Analysis" to critically analyse growth rates of area, production and productivity, crop shifts during post-liberalization and post-WTO period and factors influencing cropping pattern changes over time at district level so as to arrive at appropriate policy measures towards booting agricultural production, productivity and profitability. Keeping in view of the study the following objectives were taken.

1.2.1 Objectives

1. To estimate the compound growth rates of area, production and productivity of major crops in coastal region.
2. To study the direction of cropping pattern changes and to find out the nature of substitution of crops.
3. To analyze the factors influencing changes in the area under different crops.

1.3 HYPOTHESIS

In order to attain the set objectives, the following hypothesis have been formulated.

1. There is a positive growth in the area, production and productivity of major crops in coastal region.
2. There is a shift from low value to high value crops.
3. Both price and non-price factors influence the changes in the area under different crops.

1.4 PLAN OF THESIS

The thesis is divided into five sections. After the introduction in section I which sets out the main objectives of the study along with the hypotheses, section II includes a brief review of the studies conducted on the topic. Section III deals with materials and methods. Section IV is meant for presentation of results along with discussion. Finally section V contains summary and conclusions arrived at in the study along with suggestions relevant to the study.

Chapter II

REVIEW OF LITERATURE

This chapter attempts a brief review of the relevant literature that has been accumulated on the areas related to the present study. Keeping in view of the objectives of the study the review is presented under the following sub- headings.

2.1. Studies on growth rates of area, production and productivity.

2.2. Studies on the direction of cropping pattern changes, and

2.3. Studies on the factors influencing changes in the area under different crops.

2.1. STUDIES ON GROWTH RATES OF AREA, PRODUCTION AND PRODUCTIVITY

Venkataramana and Prahladhachari (1980) analysed the growth rates in area, output and yield of major crops in six states in India during the period 1950-51 to 1974-75 and examined the impact of disparities in growth rates of crops on cropping pattern in these states. The results showed that the growth rate in crop output was the highest in Punjab (5.5 per cent) followed by Rajasthan (4.7 per cent), Bihar (3 per cent), Uttar Pradesh (2.7 per cent) and lowest was noticed in Maharashtra.

Singh *et al.* (1981) examined growth behaviour of rice in different states of India during the period 1954-55 to 1978-79 and found that the area, production and productivity of rice grew at an annual rate of 1.03 per cent, 2.53 per cent and 1.48 per cent respectively in Andhra Pradesh. A marked acceleration in growth was observed after the introduction of HYVs in the mid sixties.

Jawahar *et al*. (1988) while analyzing growth trends of oilseeds in Bihar observed that the area under rapeseed and mustard and linseed declined during the period 1961-62 to 1983-84. But the area of sesamum increased by 22 per cent up to 1969-70 and thereafter declined till 1983-84. The production of rapeseed and mustard decreased till 1967-68 and from there it had shown an increasing trend and that of linseed showed declining trend up to 1969-70 and thereafter increased. In the case of sesamum, production showed an increasing trend up to 1968-69, thereafter it showed a decline. Productivity of all these crops increased during the study period.

Sidhu and Sidhu (1988) examined the changes in the growth of commercial crops in Punjab during 1965-66 to 1984-85 and observed that the compound growth rates per annum of area under groundnut (-8.12 per cent), desi cotton (-4.71 per cent) and sugarcane (-3.21 per cent) were found to be significantly negative but for rapeseed and mustard it was insignificantly negative (-0.21 per cent). The growth rates of American cotton (5.93 per cent) and potato (5.73 per cent) were positively significant. The growth rates of productivity of rapeseed and mustard (3.24 per cent), sugarcane (3.40 per cent) and potato (2.631 per cent) were positive and significant whereas that of desi cotton was negative and significant (-2.47 per cent) but groundnut and American cotton did not show any change. The production of rapeseed and mustard, American cotton and potato increased at the rate of 3.00, 5.02, 8.48 per cent per annum respectively and a significant decline in the production of groundnut and desi cotton was witnessed. There was no significant improvement in the production of sugarcane over time.

Moorti *et al*. (1991) found that the area, production and productivity of groundnut in Himachal Pradesh decreased by 5.03, 13.42 and 7.91 per cent per annum, respectively during the period 1970-71 to 1987-88. There had been significant increase in the area under rapeseed and mustard but this increase was offset by very high negative growth in productivity, which resulted in the decrease in production. The area, production and productivity of all oilseeds showed negative growth rates of 0.10, 2.96 and 2.87 per cent per annum respectively.

Singh (1998) in his study on growth and supply response of oilseeds in Uttar Pradesh, analysed growth rates for mustard for the period 1966-67 to 1989-90. The results revealed that, mustard area increased with a positive compound growth rate of

4.39 per cent per annum, while the total production showed a positive compound growth rate of 7.72 per cent per annum and the per hectare yield of mustard increased with a positive compound growth rate of 3.18 per cent per annum.

Rangi and Sidhu (1999) computed compound growth rates in respect of area, production and yield of important crops in Punjab for the period 1966-67 to 1993-94. The results showed that rice production recorded the highest growth of 12.36 per cent per annum. The contribution of area and yield was 8.52 and 3.54 per cent respectively. Among cereals, wheat was the next crop to record a high production growth rate of 5.20 per cent, area and production contributed 2.26 and 2.88 per cent respectively. Sugarcane witnessed a negligible growth rate of 0.74 per cent. In the case of potatoes, the growth rates of area and yield were 2.15 and 1.57 per cent respectively. The other crops maize, desi cotton, bajra, pulses and oilseeds had negative growth rates of production and yield.

Gyanendra and Hukum (2001) stated that in Madhya Pradesh the growth rates in area under foodgrains (1.20 to 1.29 per cent), production (2.3 to 4.27 per cent) and productivity (1.1 to 2.95 per cent) had gone up during pre-green revolution period to green revolution period. Further growth rates for area and production were significant, while that of productivity was non-significant during these periods.

Dhillon and Jabir (2002) studied the productivity growth in the agriculture sector of Punjab during 1970-71 to 1995-96 and observed a sharp growth in the area under rice (7.2 per cent per annum), American cotton (3.7 per cent), and wheat (1.6 per cent). The area under other crops like chickpea, pearl millet, groundnut, maize and desi cotton declined. Output registered an annual increase of 9.4 per cent for rice, 4.3 per cent for wheat, 5.1 per cent for American cotton. The compound growth rates for production were negative only for chickpea (-13.45 per cent), pearl millet (-13.95 per cent), groundnut (-14.37 per cent), maize (-4.53 per cent) and desi cotton (-6.54 per cent).

Samui *et al.* (2002) studied the trends in area, production and productivity of sugarcane in relation to weather in Maharashtra and Uttar Pradesh for the period 1970-71 to 1990-91. They employed exponential form of compound growth rates. The results revealed that the average growth rate of Uttar Pradesh in respect of area, production and

productivity were 1.75, 1.78, 1.78 per cent and for Maharashtra 1.85, 1.79, 1.88 per cent respectively. They concluded that significant rise in productivity along with significant rise in area clearly indicated that there was a dependable worker support for sugarcane cultivation in both the states even under extreme climatic conditions.

Bharti *et al.* (2003) analysed the growth of pulses in India during the last five decades and also compared them with that of foodgrains. The compound growth rates of pulses and foodgrains both showed a declining trend. The overall compound growth rates of area, production and yield of pulses during 1951-2000 were 0.10, 0.62 and 0.52 per cent respectively, whereas for foodgrains compound growth rates of area, production and yield during the same period were 0.36 per cent, 2.7 per cent and 2.33 per cent respectively.

Chahal *et al.* (2003) for analyzing the growth of cotton in Punjab during 1950-51 to 2000-01, computed compound growth rates for area, production and productivity and revealed that area under cotton increased at 0.25 per cent per annum which was statistically significant. The production and productivity grew at 2.43 and 2.18 per cent per annum respectively and were statistically significant.

Manyatha and Gajja (2004) while analyzing the growth of pulses in arid zone of Rajasthan during 1974-75 to 2000-01 observed an increase in area and production of guar and moong bean in most of the selected districts during the second period (1988-89 to 2000-01) of the study in comparison of first period (1974-75 to 1987-88). In the case of moth bean, area in all the districts except Barner has witnessed decline in second period while production and productivity were higher in second period.

Lakshmanan *et al.* (2005) reported that in India during the period 1970-71 to 2000-01, the area and production of redgram and other pulses were increasing marginally, while that of gram was shrinking at 5.45 per cent per annum during the overall period. However the production of gram was constant because of slight increase in productivity during the last two decades. A stagnation in the yield of pulses was observed because of low input use and growing them under unirrigated conditions.

Malik (2005) while analyzing the dynamics of wheat production in India reported that the growth rate for area under wheat crop in the world showed a moderate

decrease at the rate of 0.43 per cent per annum during 1992-2001. The production of wheat for the world as a whole increased at a compound growth rate of 0.99 per cent whereas the compound growth rate of wheat yield indicated moderate increase for all major wheat producing countries and the world as a whole.

Rama Rao *et al.* (2005) observed growth patterns in area, production and productivity of redgram during 1981-82 to 2000-01 in Andhra Pradesh and revealed that the lowest and highest growth rates were observed during the overall period in area and they were -3.1841 per cent in East Godavari and 3.1366 per cent in Nellore, in production they were -1.9022 per cent in East Godavari and 5.9820 per cent in Kadapa and in productivity they were -0.3068 per cent in Visakhapatnam and 3.4901 per cent in kadapa respectively. Thus they concluded that East Godavari had lowest area and production growth rates and Kadapa with highest production and productivity growth rates. And among the regions Coastal Andhra had shown significant growth rates in area (1.9582 per cent) and in production (3.1065 per cent) in the overall study period.

Ashwani and Yadav (2006) stated that sugarcane cultivation saw a spurt in acreage up to mid-sixties particularly in Assam, Nagaland and Manipur as the area under sugarcane increased at an annual compound growth rate of 3.06 per cent for the whole north-eastern region.

Borah and Chakraborty's (2006) studies indicated that rice productivity had recorded an increase of 1.2 per cent per annum in the north- east region of India, whereas in maize, wheat and rapeseed and mustard the annual compound growth rates in productivity were 1.03, 1.02 and 1.02 respectively during 1990-91 to 1997-98.

Devraj *et al.* (2006) analysed the growth and instability of chickpea (gram) production in Madhya Pradesh and pointed out that during the overall period of study (1980-81 to 2000-01) the state as a whole showed a significant growth rate in area (0.98 per cent), also registered positive growth rate of 3.50 per cent and 2.49 per cent in the case of production and yield respectively.

Moloy *et al.* (2006) observed a significant change in the cropping pattern of Tripura during 1985-88 to 2004-05. The area under paddy which was 2.68 lakh hectares

during triennium ending 1985-88 had declined by 12.5 thousand hectares during 2004-05. The area under oilseeds, fibres and sugarcane also declined during the same period and these areas were covered by vegetables, fruits, spices, tea, rubber and other plantation crops. The area under these crops increased from 27.13 per cent to 42.80 per cent of gross cropped area during the period of study.

Pravat (2006) observed a relative growth of area under foodgrain crops and the relative decline in area under some minor crops, viz., gram, jute and tobacco during 1951-52 to 1999-2000. The overall performance of agriculture in the state did not show any significant trend of prosperity and also the increase in yield rates were low and negative for many crops during the same period.

Thangaraja *et al*. (2006) analysed the productivity of selected dry land crops in Dindigul district of Tamil Nadu using compound growth rates and observed that there was decline in the growth rate of crops, namely, sorghum (-0.04 per cent), maize (-0.82 per cent), cumbu (-1.28 per cent), minor millets (-1.79 per cent), cowpea (-0.19 per cent), redgram (-0.55 per cent), moong (-1.09 per cent), groundnut (-0.43 per cent), sunflower (-0.19 per cent), soybean (-0.30 per cent), and cotton (-0.09 per cent). Increasing growth rate was observed in the crops like blackgram (0.98 per cent), horsegram (1.11 per cent), sesame (1.00 per cent) and castor (0.12 per cent).

Kshirsagar *et al*. (2007) observed an increasing trend in growth rates of area, production,productivity of sugarcane crop during the period 2000-05 over the decade of 1990-99. Per annum growth rates were 8.94, 13.13 and 11.36 per cent for area, production and productivity respectively during 2000-05.

Swain (2007) while studying the growth and variability of oilseeds production in Rajasthan observed that in sesamum around fifty six per cent of the districts in Rajasthan showed declining trends in area, production, and yield during 1980-81 to 1989-1990 and Ganganagar was the only district where area, production and yield increased substantially at the rate of 9.52, 26.79 and 17.26 per cent per annum respectively in the same period. Rapeseed and mustard was found to have better progress in its production during the observation period i.e. from 1980-81 to 1999-2000.

Linseed area as well as production had shown declining trend, while yield had reflected a marginal positive growth. With regard to the variability in the growth of area, production and yield of oilseeds in different districts as well as state, it was concluded that there existed very high degree of variability or very low degree of consistency in the growth of almost all the oilseeds studied during the observation period.

Aparna *et al*. (2008) in their study, examined the trends in growth rates of major vegetables in Visakhapatnam district of Andhra Pradesh during 1996-2005 and revealed that the compound growth rate of area for tomato and onion were negative i.e. -0.697 per cent and -3.113 per cent respectively. Bhendi exhibited the highest growth rate in area and production (13.231 per cent and 15.733 per cent respectively), whereas productivity registered highest in the case of onion (4.84 per cent). It was also inferred that area was the main guiding force directing the production of brinjal.

Dhakre and Amod (2009) in their analysis on ginger crop during 1992-93 to 2004-05 in the north-eastern states of India observed that, in Mizoram there was non-significant growth rate in area but significant in production with negative significant growth rate in productivity (-7.48 per cent). Arunachal Pradesh registered the highest growth rate in area (96.74 per cent) and production (131.34 per cent) as well as a significant growth rate in productivity (17.59 per cent) during the period. All the states except Mizoram showed negative growth rate in productivity (-7.48 per cent) but was significant. Nagaland achieved the highest significant growth rate (45.82 per cent) in productivity.

Hemant *et al*. (2009) in their study on lentil crop revealed that during the overall period (i.e. from 1970-71 to 2006-07) India had shown 0.934 per cent growth in area and 3.32 per cent growth in production. During eighties, the country experienced the highest growth rate of 5.41 per cent in production. Compound growth rate for lentil area in India was highest (2.35 per cent) for the period of 1990-91 to 1999-2000.

Prema and Patil (2009) observed that in Vidarbha region of Maharashtra state during 1980-81 to 2004-05 oilseed crops registered high positive significant growth trend (9.68603 per cent), while the reverse trend (-1.96 per cent) was observed in the irrigated area. Pulses recorded positive growth trend (2.49236) in cultivated area but it lacked in irrigated area. Commercial crops registered negative trend in both cultivated

area as well as irrigated area (-0.78625 and -0.0401 per cent respectively). In cereals, cultivated area registered negative growth trend (-2.53858 per cent) in their acreage, while the reverse trend (0.52058 per cent) was observed in the irrigated areas.

Singh and Grover (2009), while analyzing the performance of sesamum in India during 1970-71 to 2003-04 observed positive and significant growth in area in the States of Gujarat (5.05 per cent), West Bengal (5.39 per cent) and Uttar Pradesh (4.06 per cent), while negative growth was witnessed in Rajasthan (-1.22 per cent), Madhya Pradesh (-2.16 per cent) and Andhra Pradesh (-0.47 per cent). The growth in yield was positive and significant in Madhya Pradesh (2.38 per cent), Tamil Nadu (2.16 per cent), Gujarat (2.00 per cent), Uttar Pradesh (1.83 per cent), West Bengal (1.66 per cent), Rajasthan (1.65 per cent), Karnataka (1.12 per cent), Andhra Pradesh (0.82 per cent), Maharastra (0.75 per cent) while in Punjab State it was negative and non-significant (-0.14 per cent).

Surabhi Mittal (2009) examined the economic feasibility of diversifying towards horticultural crops over the period 1990-2004 and concluded that, for fruits, the area growth was 3.28 per cent in 1990-95, which increased to 6.67 per cent during 2000-04, whereas, their production grew at a rate of 9.43 per cent in the initial period, but later started delining. The area under vegetables increased at the rate of 3.15 per cent during 1995-2000, which later declined. During the same period, high production growth was also observed. The overall area growth was 3.38 per cent for fruits and 2.10 per cent for vegetables during the study period. The production growth was 3.06 per cent and 3.95 per cent for fruits and vegetables respectively.

Chaudhari and Pawar (2010) examined growth in area, production and productivity of chickpea in Marathwada region of Maharashtra State and concluded that there was a significant growth in area, production and productivity during the period 1985-86 to 2004-05. They stated that both at regional and state level, the annual growth in area and production recorded 2.51 per cent and 2.51 per cent respectively during the study period, which was due to the shift in area from cereals to pulses as the latter gave more remunerative price than cereals. The significant increase in productivity was due to the use of improved technology and introduction of irrigation facilities.

Prema *et al*. (2010) in their study on growth rates of area, production, productivity of soybean in Vidarbha region of Maharastra State during 1990-91 to 2004-06 had observed that the area under the crop recorded positive significant growth rate in all districts except Bhandara district (-11.68 per cent). The highest positive significant growth rate in area and production was observed in Buldhana district i.e. 54.50 per cent and 44.08 per cent respectively, whereas the lowest positive significant growth rate for the same was recorded in Nagpur i.e. 5.34 per cent and 5.69 per cent respectively. With respect to productivity Vidarbha region observed a non-significant growth rate in all districts except Akola and Bhandara (5.39 per cent and 6.92 per cent respectively) districts.

2.2 STUDIES ON THE DIRECTION OF CROPPING PATTERN CHANGES

Garg *et al*. (1978) observed a shift in cropping pattern in Uttar Pradesh in favour of remunerative and cash crops like wheat, rice, maize, sugarcane, and potato, particularly during the period after 1966-67, which happened because of development of irrigational resources and increased use of fertilizers. The area under irrigation and fertilizer responsive crops increased while that of less remunerative crops like barley, arhar etc., declined considerably. The area under less remunerative crops were replaced by wheat, sugarcane, potato and rice.

Mellor (1984) made an attempt to introduce the Markov chain model as a mechanistic model of behaviour in agricultural setting. The concept of time varying transitional probabilities was introduced as a feasible alternative to the standard stationary assumptions. The results supported the view that the basic model was simple and benefited from the introduction of explanatory variables influencing the transitional probabilities. He also cautioned that neglect of important variables would lead to undesirable consequences as the model was used for forecasting purpose.

Johl and Sidhu (1988) observed shifts in cropping pattern in different states of India during triennium ending 1984-85 over that in triennium 1972-73. The results revealed that for the country as a whole, per cent area under coarse cereals decreased by 3.85 per cent, under rabi pulses by 0.78 per cent and cotton by 0.33 per cent over this period. As against this, the area under wheat increased by 2.03 per cent and rice by 0.04

per cent. Thus, coarse cereals were replaced by finer cereals, i.e. wheat and rice. The area under total cereals declined by 1.78 per cent. This area has shifted from coarse cereals to kharif pulses, sugarcane and oilseeds.

Rajagopal (1988) studied the structural relationship between the various components of price spread, their impact on the producers' share and the substitutional effect on cropping pattern due to price spread with reference to the tobacco and cotton crops in Guntur district of Andhra Pradesh during 1984-86. The study revealed that there was a shift in the cropping pattern from tobacco to cotton in the region due to factors attributable to the marketing costs such as transportation, weighing, grading, labour etc., and middlemen's margin. Since the price spread in tobacco crop was higher, the cotton crop was preferred by the farmers.

Joseph and Gowda (1996) used Markov chain analysis to project the cropping pattern of Kerala state during 1970-71 to 1994-95 and found that there had had been a large scale area substitution in Kerala away from food crops in favour of commercial crops. The transition probability matrix for cropping pattern changes in the state showed that rubber to be the most stable crop, which retained over 75 per cent of the period's acreage in the current period. Other relatively stable crops were rice and coconut while tapioca was found to be highly unstable. The projections of cropping pattern indicated that acreage share of food crops was less than half of what it was in the base year 1970-71. The area under coconut, the main crop of the state's economy, exhibited a modest increase.

Tripathy and Gowda (1999) applied Markov chain analysis to study the structural changes in the cropping pattern in Orissa by using macro data of crop production from 1975-76 to 1989-90. Farmers of Orissa retained 71.05 per cent of the previous year's share of rice during current year. They shifted 20.46 per cent of the previous year's share of rice to oilseeds, 7.59 per cent to vegetables and about one per cent to pulses. However, rice gained 99 per cent of previous year's share of coarse cereals (ragi, maize, millets, etc.,) and 38.63 per cent share of oilseeds during current year. Farmers could not retain all the previous year's share of coarse cereals. They diverted 99 per cent of previous year's share of coarse cereals to rice and only one per cent to pulses. During the year under study, oilseeds gained more than 20 per cent of the previous year's share of rice. The previous year's share of vegetables was shifted to fruit and other crops,

while it gained 35.45 per cent of the previous year's share of oilseeds and 75.9 per cent share of rice during the year under reference. The authors concluded that price incentive played an important role for diversion of land from rice to groundnut and vegetables.

Reddy and Lalith (2000) applied Markov chain approach and the results showed that from 1980s, the Indian agriculture sector witnessed considerable transformation in terms of cropping pattern, technological advancements and market demands at domestic and international levels. In this regard, an attempt was made to analyse the structural change in Karnataka's agriculture during the period 1980-81 to 1989-90 and 1990-91 to 1993-94 using Markov chain analysis. The study had revealed that, though most of the crops had shown stability in the study period, the proportion of area under oilseeds and other commercial crops had increased in the 1980s at the cost of foodgrains. This may be due to government's deliberate policy to increase the production of edible oils to reduce the demand-supply imbalances.

Rao and Shahid (2005) in their studies on dynamics of cropping pattern in sorghum growing states of India used Markov chain analysis to study the shifts in cropping pattern and revealed that the area under rainy sorghum crop declined significantly in all the states and districts and was highly unstable losing to other competing crops during the 1970s and 1980s like cotton and groundnut in Andhra Pradesh at state level. Cotton in Maharashtra appeared to compete both at the state and district level while other pulses and pearl millet were other crops competing at state level.

Sharma (2005) analysed that agriculture in Himachal Pradesh recorded a fairly high growth rate especially after 1987-88. The process of crop diversification was, however, more pronounced in the districts/areas enjoying favourable (temperate) agro-climatic conditions. The study showed that the process of crop diversification in low hill districts (Bilaspur, Hamirpur and Una) was, however, among the cereal crops only; in these three districts, there had significant shift of area from paddy to maize. The sate's agriculture over the years, especially since the late eighties, had diversified towards fruits and off-season vegetables like peas, potato, cabbage, cauliflower, etc.

Birthal *et al*. (2006) made a study on agricultural diversification in North Eastern region of India and presented that high-value crops together contributed 62 per

cent to agricultural growth during 1980-81 to 1991-92 and 75 per cent during 1992-93 to 2002-03. As these crops generated quick and higher returns and also the agro-climatic conditions in this region were favourable for their growth, the smallholders did participate in high-value agriculture and allocated a larger proportion of area to these crops especially vegetables.

Goswami and Challa (2006) while studying land use scenario in Meghalaya observed that the area under food crops declined with progressive area shift towards non-food crops. The proportion of area under total food crops to total cropped area was reduced from 60.0 per cent in 1987-88 to 50.6 per cent in 1998-99. Proportion of area under non-food crops to total cropped area increased from 40.0 per cent in 1987-88 to 49.4 per cent in 1998-99. It was observed that there was a highly significant increase in area under arecanut, sweet potato, ginger, potato and citrus and also yield in most of the crops increased significantly except other cereals and small millets, tapioca, and citrus.

Seema (2008) reported that inter crop area shifted in favour of high yielding crops viz. wheat, paddy, sugarcane, fruits, vegetables, fibres, spices etc., during the nineties and early twenties, while area under wheat and paddy expanded solely at the cost of low yield growth crops viz. coarse cereals and pulses due to price support and HYV programme.

Singh and Mathur (2008), while analyzing the structural changes in horticulture sector in India used first order finite Markov chain model to predict the changes in shares of horticulture sub-sectors for the period 2000-01 to 2011-12. The results indicated that the share of fruits, vegetables, plantation and spice crops would continuously increase, while the share of field crops would decline and the share of nuts and flowers would be constant during eleventh Five Year Plan period.

Mahendra (2010) for estimating structural changes in cropping pattern in eastern Uttar Pradesh during 1997-2005 applied Markov chain model and reported that sugarcane ranked first with a probability of 0.3235, followed by wheat (0.2903), rice (0.2096), potato (0.199) and oilseeds (0.145). Millets, other crops, barley and total pulses had shown zero stability.

2.3 STUDIES ON THE FACTORS INFLUENCING CHANGES IN THE AREA UNDER DIFFERENT CROPS

Sharma *et al.* (1978) in their studies on area allocation of wheat and maize during 1951-52 to 1973-74 in Himachal Pradesh found that, in the case of wheat only lagged area and lagged absolute price variables were found to be significant, ranging from 0.4470 to 0.5678 and 0.064 to 0.0980 respectively. In the case of maize, lagged area, lagged absolute price and lagged relative price variables were found to be significant and their magnitudes ranged from 0.6588 to 0.8997, 0.0492 to 0.0580 and 0.0606 to 0.0705 respectively. Thus, it was concluded that lagged area influence was quite high as compared to lagged price variables on area allocation decision of the farmers.

Gupta and Tewari (1985) by using regression analysis studied empirical relationship between crop diversification and selected socio-economic variables in the year 1981-82 and revealed that farm size, distance of farm from the market had a significant negative effect (-22.64 and -42.278 respectively), whereas irrigation intensity had a significant positive effect on crop diversification indicating that with the availability of irrigation all-round the year diversification would increase.

Singh *et al.* (1985) while examining the factors affecting agricultural diversification in Punjab during 1971-72 and 1981-82, concluded that diversification was inversely related to farm size, distance from the market and assets per hectare and directly related to family size and dairy income.

Deole and Waghmare (1986) measured the impact of price policy relating to cotton monopoly procurement on area, production and yield for the districts of Marathwada and the Maharashtra state for the period 1964-65 to 1980-81 using multiple regression analysis. The results of the study revealed that for the Marathwada region as a whole, the functional shift in area was significant. The positive changes in production and yield were non-significant for pre-monopoly and monopoly purchase years. The changes in the intercept of the line of the regression were significant in Maharashtra

state. No shift in production and yield was noticed during the monopoly purchase period.

Ram *et al.* (1986) in their study to examine the relationship between the procurement/support price and the area under foodgrain crops, found that there existed a positive significant (0.394) relationship between procurement/support price and the area under wheat crop, but in the case of paddy this relationship was not found significant (0.047) in Uttar Pradesh state from 1975-76 to 1984-85.

Raju *et al*. (1988) estimated the acreage response of the selected commercial crops to the price and non-price factors in Andhra Pradesh during 1968-69 to 1985-86 and observed that lagged area was an important factor influencing sugarcane area allocation in the state. Lagged price was the prime-mover of the cultivators' response in significantly influencing the acreage allocation in cotton, tobacco and groundnut. Overall rainfall during the sowing period had a positive impact though not significant in the area allocation of all the selected crops except cotton. The possibility of acreage adjustment to price was observed for cotton, tobacco, and sugarcane in the long run over short run.

Bhatia and Tewari (1990) used regression analysis to examine the empirical relationship between crop diversification and selected agro-economic variables in Uttar Pradesh during 1970-71 to 1980-81 and observed that irrigation intensity had a positive (69.43) and significant effect on acreage diversification suggesting that availability of irrigation water all round the year in a district was expected to promote crop acreage diversification. Rainfall showed a significant negative (-0.05) effect on crop acreage thereby indicating that good rainfall was expected to discourage the diversification.

Khunt and Antani (1991) while studying the impact of weather and economic factors on acreage and production fluctuations in cotton in Gujarat state during 1950-51 to 1987-88 observed that price and non-price factors *viz.*, yield and irrigation were found to have strategic role in acreage allocation decision, while rainfall had not exerted any significant influence on the acreage in all the cases barring the Rajkot district. In spite of the improvements in the price over time the area under cotton had not responded positively in Baroda and Broach districts. This happened due to higher profitability of low input crop like tur as a competitive crop. Production behaviour

found sensitive to various factors *viz.*, acreage, fertilizer, rainfall, irrigation, etc., but their impact on production was not uniform across the districts.

Louise and Loren (1992) applied multiple regression analysis to determine the effect of different household characteristics on crop diversity in Malawi. The results suggested that an increase in labour availability over the production period was associated with a more diverse cropping pattern. Landholding size also influenced diversity, which rose to a maximum and then fell as the area cultivated per capita increased. Farmers who grew a non-food cash crop (tobacco) had more diverse cropping patterns than those who did not.

Radhakrishnan *et al.* (1992) made a study to know the influence of rainfall on production and productivity of coffee in Kodagu zones during 1956-87. The multiple regression models developed for this analysis revealed that, depending upon the period, March or April rainfall in the case arabica species and previous season's december rainfall in the case of robusta species, significantly influenced the production and productivity. Irrespective of the species, the effect of previous year's crop level was a significant factor which negatively affected the current crop year's production of yield.

Gauraha (1996) made an attempt to study the impact of technological change on the cropping pattern in Raipur district of Madhya Pradesh in 1995-96. The study revealed that the cropped area in the kharif season on the whole had declined, while the area under the rabi and summer crops had increased as a result of some assured irrigation and higher yield and income from rabi and summer crops. In the kharif season the HYVs of paddy occupied the entire paddy area due to higher yield and income.

Khatkar *et al.* (1996) examined the empirical relationship between crop diversification and selected economic variables in Hisar district of Haryana in the year 1994-95 and it was observed that farm size, distance from the market, number of family members, engaged in agriculture and irrigation intensity were the major factors contributing positively and significantly to crop diversification.

Raman and Sharda (1996) revealed that the agriculture had diversified in favour of fruits and vegetables in Himachal Pradesh during 1973-74 to 1992-93 and stated that among the factors responsible for diversification, the most important happened to be the

policy of the State Government which was evolved primarily to promote horticultural crops. This was supported by the fact that a large amount of money was spent every year to improve the infrastructure, production technology and post-harvest management of the horticulture produce.

Saraswat (1996) observed that the diversification in agriculture in Himachal Pradesh during 1959-60 to 1989-90 took place due to increasing trend of agricultural productivity because of the technical changes i.e. use of HYV seeds, fertilizers, pesticides, and improved methods of cultivation in agriculture.

Sharma *et al*. (1996) identified the factors affecting crop diversification in major states of India during 1980-81 to 1991-92 using regression analysis. The results had shown that the size of holding had a positive relationship with diversification whereas the percentage of leased-in area, Gini index, fertilizer consumption in nutrient value (kg ha^{-1}) had no effect on crop diversification.

Vyas (1996) stated that price response was one aspect of the impact of the market on the cropping pattern. The agronomic conditions in a given region and the technology available for various crops, geographical features and climatic factors were other important forces which conditioned diversification. The most significant technological change which had remarkable impact on the cropping pattern was irrigation.

Arora *et al.* (1997) identified that the irrigation facilities and use of chemical fertilizers particularly nitrogenous fertilizers contributed to the variation in crop productivity in the state of Uttar Pradesh during the period 1970-71 to 1993-94.

Harish and Ajay (1997) observed that rainfall and per cent irrigated area by canal were the major factors affecting crop diversification in positive direction in Madhya Pradesh during 1979-80 to 1993-94. The percentage of gross irrigated cropped area was reported to be another positive significant factor of crop diversification.

Mani and Jose (1997) while studying shifts in cropping pattern in Kerala between 1975-76 and 1995-96 revealed that the free trade in India during the study period had necessitated significant changes in the cropping pattern away from cereals,

pulses, oilseeds and sugarcane and in favour of superior cereals, horticultural crops, vegetables and livestock products. As a result of these measures the area under food crops substantially declined in India in recent years.

Parveen *et al.* (1997) carried out multiple regression analysis to assess the important factors determining agricultural performance of different districts in Haryana during 1975-76 to 1995-96 and reported that the percentage area under HYVs and level of fertilizer consumption were the significant factors governing agricultural performance. During the periods under the study, the declining values of regression co-efficients for HYVs (from 16.56 to 3.39) and fertilizer consumption (from 13.28 to 3.39) indicated that the increase in the value of the agricultural produce per hectare due to these factors showed a declining trend.

Singh *et al*. (1997) used multiple regression analysis to examine the factors responsible for determining yield and acreage of important food grain crops in India during 1972-73 to 1992-93. Their studies concluded that irrigated area, fertilizer consumption and area under HYVs emerged as the important factors in determining yield variations. Amongst these three variables, fertilizer use was the most important factor exercising maximum influence on crop yields. And with regard to the determinants of growth rates of irrigated area, total cropped area, yield per hectare, number of regulated markets and the road length per 100 sq. kms of area in a region exercised positive and significant influence on acreage of rice, wheat, coarse cereals and food grains among different states in India during the study period.

Amit *et al*. (2003) in their work on linkages between crop diversification and poverty in Indian states reported that the consumption of fertilizer and village electrification had a positive and significant impact on the crop diversification. The study also revealed that adoption of HYV of pulses, oilseeds, and vegetables played an important role for diversification and also the development of hard and soft infrastructures such as road, irrigation facility and literacy among rural people negatively influenced the crop diversification.

Shukla *et al.* (2003) studied the inter-state disparities in rice productivity in India during 1995-2000 and concluded that aberrant weather conditions and socio-economic factors apparently deteriorated the rice productivity creating inter-state

disparities. In both the conditions of drought and flood, the rice plant did not get congenial conditions for plant growth. Apart from this, the socio-economic factors also played a vital role for bringing down the rice productivity in various states particularly in rainfed areas. In addition to these, lack of mechanization, low purchasing power, lack of technical knowledge, low efficiency of farm labours and conservative thinking also helped for bringing down the rice yield and regional imbalance in rice production.

Nampoothiry (2003) stated that the expected price for the output was one of the most significant factors influencing crop production and the change in consumption pattern induced by dietary diversification was often cited as an important factor for the decline in area under coarse cereals. Also the decline in the area of rabi crops in 2000-01 reflected the impact of unfavourable weather while the decline in 2002-03 reflected the impact of severe drought that affected both kharif and rabi crops.

Utpal Kumar (2005) studied the impact of major factors on the acreage change of the boro rice, potato and mustard in West Bengal by employing multiple linear regression model and observed that irrigation and chemical fertilizers had substantial positive impact on acreage growth of boro rice. Chemical fertilizer and yield growth has led to acceleration in acreage of potato and mustard. In the case of boro rice, yield and dummy variable (that represents the influence of land reforms measures) coefficients were also found to be positive and significant but not to the extent as that of irrigation and chemical fertilizer. But the effect of irrigation was not seen to be much stronger in the case of potato and even negative in the case of mustard. The actual situation was however not like so. The reason was that potato and mustard are winter crops and during winter one could not depend on rainfall. Thus irrigation was essential. He also revealed that the farmers were highly influenced by last year's price of the crop which was chosen for cultivation. The corresponding regression coefficients were 0.68 in boro rice, 0.003 in potato and 0.668 in mustard.

Pravat Kumar Kuri (2006) while studying the cropping pattern changes in Assam during 1951-52 to 1999-2000 stated that the expansion of gross cropped area had led mostly to the expansion of area under foodgrain crops. The expansion effect of gross cropped area could explain 97 per cent of the total changes in area allocation under crops during the last five decades since 1951-52.

Makar and Ghosh (2007) used regression equation to study the impact of institutional credit on cropping pattern in Nagaland in the year 2003-04 and observed that agricultural credit was one of the most important determinants of agricultural production and they were directly related. Hence it was inferred that there existed an impact of agricultural credit on cropping pattern in Nagaland.

Gajja *et al*. (2008) explained the impact of selected variables on the area allocation of sesamum crop in arid Rajasthan during 1960-2003. He stated that own harvest price lagged by one year had a positive and significant impact in Bikaner (0.35) and Jodhpur (0.30) districts and it had no influence in Barmer and Sikar districts. Rainfall during the crop growth period had a positive and significant impact in all the districts except Jodhpur district.

Sushila and Ghasi (2009) using multiple regression analysis examined the impact of fertilizer and labour inputs, rainfall and temperature on productivity of jowar crop in Karnataka state for the year 2000-01. The results indicated that the use of fertilizer, deviation from the normal rainfall had a negative impact, whereas the human labour had a positive and statistically significant impact on jowar productivity. The mean maximum and minimum temperatures during the growing season of the crop had negative and positive implications for the crop respectively.

Suresh and Palanisami (2010) studied the impact of drip irrigation on farming system in Southern India and revealed that adoption of drip method of irrigation technology had increased the net sown area, net irrigated area and thereby helped in achieving higher cropping intensity and irrigation intensity and it was found to have a significant impact on yield of crops in southern India.

Chapter III

MATERIALS AND METHODS

In this chapter, the general description of the study area, sampling design, data base and analytical tools employed in the present study to analyze the objectives are presented.

3.1 DESCRIPTION OF THE STUDY AREA

The Coastal Andhra region of Andhra Pradesh consists of nine districts, 5 north coastal (Srikakulam, Vizianagaram, Visakhapatnam, East Godavari, West Godavari) and 4 south coastal districts (Krishna, Guntur, Prakasam and Nellore). But for the present study only Vizianagaram from north coastal districts and Prakasam from south coastal districts were selected because of more crop diversification that took place in those districts as revealed by the diversification index. The description of the study area, district-wise is briefly presented below.

3.1.1 Vizianagaram District

The district extends over an area of 6,539 Sq.Kms and is situated with in the geographical co-ordinates of 17-15' and 19-15' of the northern latitude and 83-00' and 83-45' of the eastern longitude, bounded on the east by Srikakulam district, on the west and south by Visakhapatnam district, on the South-East by the Bay of Bengal and North -West by Orissa state.

The main soils in the district are red soils, sandy loams and sandy clay and they constitute 96 per cent of the total area. The climate of Vizianagaram district is characterized by high humidity nearly all the year round with oppressive summer and

good seasonal rainfall. The district gets the benefit of both the south-west and north-east monsoons. The climate of the hill parts of the district is different from that of the plain.

The Nagavali is the main river, which flows in about 112 Km in Vizianagaram district covering an ayacut of 2,832 ha.

3.1.2 Prakasam District

The district occupies an area of 17626 Sq. Kms and is situated in tropical region between14-57'-00 to 16-17'00' Northern latitude and 78-43-00' to 80-2500" Eastern longitude. The central portion of the district contains large tracts of low shrubs jungle diversified with rocky hill and stony plains which is a peculiar feature of the district. The earstwhile taluks of Giddalur and Markapur drawn from Kurnool district are purely upland areas.

The district is bounded by Bay of Bengal on the east, by Kurnool district on the West, partly by Guntur and Mahaboobnagar districts on the north and Nellore and kadapa districts on the south.The important hill ranges in the district are the picturesque Nallamalas and the Veligondas. These hills separate the district from Kurnool and kadapa districts.

Red loamy, black cotton and sandy loams are the predominant soils in the district forming 51 per cent, 41 per cent and 6 per cent respectively over the total area of the district.

The sea breeze renders the climate moderate both in winter and summer seasons in the coastal areas of the district. The maximum temperature is usually recorded in the months of April, May and June.

The district receives its rainfall mostly and predominantly from south-west as well as from north-east monsoon. The agricultural activity in the district is deplorable owing to gambling of monsoons and unreliable rainfall and much dependence on tanks and wells for irrigation.

3.2 SAMPLING DESIGN

For the purpose of analysing the "Crop Shifts in Coastal region of Andhra Pradesh – An Economic Analysis", two districts in the Coastal Andhra region namely Vizianagaram from north coastal and Prakasam from south coastal districts were selected as primary units, based on the extent of diversification. Major foodgrain crops of the Vizianagaram district are paddy, jowar, pearl millet, finger millet, maize, small millets, pigeonpea (redgram), chickpea (bengalgram) blackgram, greengram and horsegram. Non-foodgrain crops include groundnut, sugarcane, mesta, sesamum, chillies and tobacco. Major foodgrain crops of the Prakasam district are paddy, jowar, pearl millet, finger millet, maize, small millets, pigeonpea (redgram), chickpea (bengalgram), blackgram, greengram. Non-foodgrain crops include groundnut, cotton, sunflower, sesamum, chillies and tobacco. All these crops were selected and studied keeping in view of the objectives.

3.3 DATA BASE

Data used for the study was collected from various published and unpublished sources. Time series secondary data on area, production and productivity of different crops, rainfall, prices, wage rates, fertilizer prices, land utilization particulars and other agricultural statistics were obtained from various "Statistical Abstracts" published by Directorate of Economics and Statistics, Government of Andhra Pradesh and National Agricultural Research Project (NARP) status reports published by the Acharya N.G. Ranga Agricultural University, Hyderabad, Andhra Pradesh. The data covered a period of 28 years (for estimation of growth rates of area, production and productivity and factors influencing cropping pattern changes) i.e. from 1981-82 to 2008-09. The year 2008-09 was the terminal period of the study since consolidated data were available up to this period only. For crop shifts the data for two periods viz., period I (1992-93 to 1998-99) and period II (1999-2000 to 2008-09) were used. Period I is post-liberalisation period, while Period II, post-WTO period.

3.4 ANALYTICAL TOOLS AND TECHNIQUES

The methods of analysis employed in the present study are elaborated under the following headings.

3.4.1 Growth Model

3.4.2 Markov Chain Analysis, and

3.4.3 Multiple Regression Analysis

3.4.1 Growth Model

The growth in area, production and productivity of the crops selected in two districts of Coastal Andhra region were analysed using the exponential growth function of the form.

$$Y = ab^t e \quad \text{..... (3.1)}$$

where,

Y = Dependent variable [Area (´000 ha.) / Production (´000 tonnes) / Productivity (kg ha^{-1})]

a = Intercept

b = Regression coefficient

t = Time variable

e = Error term

The compound growth rates were obtained from the logarithmic form of the equation as below:

$$\text{In } Y = \text{In } a + t \text{ In } b + e$$

The per cent compound growth rate (CGR) was derived using the relationship.

$$CGR = (\text{Anti log } b\text{-}1) \times 100$$

3.4.2 Markov Chain Analysis

Markov chain analysis is an application of dynamic programming to the solution of a stochastic decision process that can be described by a finite number of states. The Markov process was used to study the shifts in the cropping pattern and thereby gain an

understanding about the dynamics of the changes. Markov chain analysis was carried out for two sub- periods viz., period I (1992-93 to 1998-99) and period II (1999-2000 to 2008-09). Period I is post-liberalization period, while period II post-WTO period.

3.4.2.1 The Markov Probability Model: Any sequence of trails (experiments) that can be subjected to probabilistic analysis is called a stochastic process. For a stochastic process it is assumed that the movements (transitions) of objects from one state (possible outcome) to another are governed by a probabilistic mechanism or system. A finite Markov process is a stochastic process whereby the outcome of a given trial t (t = 1, 2,…….T) depends only on the outcome of the preceding trial (t-1) and this dependence is the same at all stages in the sequence of trials (Lee *et al.,* 1965). Consistent with this definition, let

S_i : represent the r state or possible outcomes; i = 1, 2, …., r.

W_{it} : represent the probability that state S_i occurs on trial t or the proportion observed in trial t in alternative outcome state i of a multinomial population based on a sample of size n, i.e. $P_r (S_{it})$.

P_{ij} : represent the transitional probability which denotes the probability that if for any time t the process is in state S_i, it moves on next trial to state S_j, i.e. $Pr(S_j, t + 1/S_{jt}) = P_{ij}$.

P=(Pij): represent the transitional probability matrix which denotes the transitional probability for every pair of states (i, j = 1, 2, ….r) and has the following properties.

$$O \leq P_{ij} \leq 1, \ldots\ldots\ldots\ldots\ldots \quad (3.2)$$

and

$$\sum_J P_{ij} = 1, \text{ for } i = 1, 2, \ldots\ldots\ldots, r \ldots\ldots\ldots\ldots\ldots\ldots \quad (3.3)$$

Given this set of notations and definitions for a first order Markov chain, the probability of a particular sequence S_i on trial t and S_j on trial t + 1 may be represented by

$$P_r (S_{it}, S_{j,t+1}) = P_r (S_{it}) P_r (S_{j,t+1} / S_{it}) = W_{it} P_{ij} \ldots\ldots\ldots\ldots\ldots\ldots \quad (3.4)$$

and the probability of being in state j at trial t + 1 may be represented by

$$P_r (S_{j,t+1}) = \sum_i W_{it} \; P_j \text{ or } W_{j,t+1} = \sum_i W_{it} \; P_{ij} \; \ldots\ldots\ldots\ldots\ldots\ldots \; (3.5)$$

The data for the study are the proportions of area under the crops. The proportionate changes from year to year are as a result of the factors like weather, technology, price and institutional changes. It is reasonable to assume that the combined influence of these individually systematic forces approximates a stochastic process and the propensity of farmers to move from one crop state to another differs according to the crop state involved. If these assumptions are acceptable, then the process of cropping pattern change may be described in the form of a matrix P of first order transition probabilities. The element of P_{ij} of the matrix indicates the probability a farmer in crop state i in one period will move to crop state j during the following period. The diagonal element P_{ij} measures the probability that the proportion share of i_{th} category of crop will be retained.

3.4.2.2 Estimation of Transition Probability Matrix: Equation (3.5) can be used as a basis for specifying the statistical model for estimating the transition probabilities. If errors are incorporated in equation (3.5) to account for the difference between the actual and estimated occurrence of $W_{j(t+1)}$, the sample observations may be assumed to be generated by the following linear statistical model :

$$W_{jt} = \sum_i W_{it} \; W_{i,t-1} \; P_{ij} + U_{jt} \; \ldots\ldots\ldots\ldots\ldots\ldots \; (3.6)$$

or in matrix form it can be written as :

$$Y_j = X_j \; P_j + U_j \; \ldots\ldots\ldots\ldots\ldots \; (3.7)$$

where, Y_j is a (Tx1) vectors of observations reflecting the proportion in cropping pattern j in time t, X_j is a (Txr) matrix of realised values of the proportion in cropping pattern i in time t-1, P_j is a (rx1) vector of unknown transition parameters to be estimated and U_j is a vector of random disturbances.

3.4.2.3 The Minimum Absolute Deviations Estimator: A method to derive parameter estimates when equality or inequality restrictions are present is to make use of Minimum Absolute Deviations (MAD) estimator. If we employ this method in

obtaining estimates of the transition probabilities, our problem may be specified as follows:

To find a vector $\overline{P}$ which minimizes

$$\left|Y - X_p\right|' E \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.8)$$

subject to

$$Y = X_p + u; \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.9)$$

$$R_p = e; \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.10)$$

$$P \geq O \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.11)$$

where E is a unit vector of order (rTx1). In order to solve the above LP problem, non-negative variables are introduced for u such that

$$u = \theta - P \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.12)$$

where $\theta = [\theta_{jt}] = [\theta_{11}\ \theta_{12} \ldots\ldots\ \theta_{1T}\ \theta_{21} \ldots.\theta_{rT}] \geq 0$ ……. (3.13)

and

$$P = [P_{jt}] = [P_{11}\ P_{12} \ldots\ldots\ P_{1T}\ P_{21} \ldots\ldots\ldots\ P_{rT}] \geq 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3.14)$$

By redefining u in this way, the LP problem may be transformed to the following form:

To minimize:

$$(\theta - P)' E \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3.15)$$

subject to

$$Y = X_p + u = X_p + [I, -I] \begin{bmatrix} \theta \\ p \end{bmatrix}; \quad \ldots\ldots\ldots\ldots\ldots \quad (3.16)$$

$$R_p = e \text{ and } \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.17)$$

$$p, \theta, P \geq O \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3.18)$$

3.4.2.4 Projection: After estimating transition probability matrix (P), proportion of area under different crops can be predicted using the following equation.

$$Y'_{(t)} = Y'_{(o)} P^t \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3.19)$$

where

$Y_{(t)}$ = (r x 1) vector of proportion of area under crops in year t,

$Y_{(o)}$ = (r x 1) vector of proportion of area under crops in base year o,

P^t = (r x r) transition probability matrix to the power of time (t)

and $Y'_{(t)}$ and $Y'_{(o)}$ are transpose of vectors $Y_{(t)}$ and $Y_{(o)}$ respectively.

3.4.3 Multiple Regression Analysis

Multiple regression analysis was carried out for the time series data for the period 1981-82 to 2008-09 to identify the important factors affecting the area changes in crops in the two districts of Coastal Andhra region viz., Vizianagaram and Prakasam districts. The functional form used was of the following type.

$$Y = b_0 + b_1X_1 + b_2X_2 + \ldots\ldots.. + u \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3.20)$$

where,

Y = Area under the crop and

$X_1, X_2 \ldots\ldots\ldots\ldots X_n$ are the explanatory variables.

b_o = Intercept ; $b_1, b_2, \ldots\ldots, b_n$ = Regression coefficients

u = Error term

A number of regressions were run taking different sets of explanatory variables. The explanatory variables considered were.

Y = Area under the crop in ´000 hectares

X_1 = Price of the crop output lagged by one year (Rs/qtl)

X_2 = Price of the competing crop lagged by one year (Rs/qtl)

X_3 = Total rainfall received during the current year (in mm)

X_4 = Gross irrigated area (`000hectares) of selected crops

X_5 = Labour wage rate (Rs/ man day)

X_6 = Composite fertilizer price (Rs/kg)

In order to detect the presence of autocorrelation in the variables, Durbin-Watson statistic (‘d’) was computed and also presence of autocorrelation if any was removed by using Cochrane-Orcutt method.

Chapter IV

RESULTS AND DISCUSSION

The results of the present study together with discussion are presented in this chapter, keeping in view of the objectives under the following sub-headings.

4.1. Studies on growth rates of area, production and productivity.

4.2. Studies on the direction of cropping pattern changes, and

4.3. Studies on the factors influencing changes in the area under different crops.

4.1 GROWTH RATES OF AREA, PRODUCTION AND PRODUCTIVITY OF DIFFERENT CROPS

For studying the trends in area, production and productivity of major crops in the selected districts over the period 1981-82 to 2008-09, compound growth rates were worked out using the exponential function $Y=ab^t$.

The results of the compound growth rates for two districts are furnished in Tables 4.1. and 4.2. respectively.

4.1.1 Vizianagaram District

The compound growth rates of area, production and productivity of different crops in Vizianagaram district of Andhra Pradesh are presented in Table 4.1. and in figures 4.1, 4.2 and 4.3 respectively. The crops were divided into foodgrain crops and non-foodgrain crops. The foodgrain crops include paddy, jowar, bajra, ragi, maize, small millets, redgram bengalgram, blackgram, greengram and horsegram, while non-foodgrain crops are groundnut, sugarcane, mesta, sesamum, chillies and tobacco.

Table 4.1. Compound growth rates of area, production and productivity of different crops in Vizianagaram district (1981-82 to 2008-09)

(Per cent)

S. No.	Crop	Area	Production	Productivity
I. Foodgrain Crops				
1.	Paddy	-0.20	0.66	0.88
2.	Jowar	-3.45**	-2.63**	0.85
3.	Bajra	-3.95**	-4.07**	-0.13
4.	Ragi	-2.59**	-2.23**	0.38
5.	Maize	10.64**	12.37**	1.57**
6.	Small millets	-1.86**	-0.26	1.63
7.	Redgram	2.64**	4.24**	1.52**
8.	Bengalgram	-2.45**	1.23**	3.80**
9.	Blackgram	5.47**	4.20***	-1.20**
10.	Greengram	3.56**	3.93**	0.37
11.	Horsegram	-0.01	0.54	0.56
II. Non-Foodgrain Crops				
1.	Groundnut	-1.09	-0.92	0.15
2.	Sugarcane	1.91**	2.20**	0.20
3.	Mesta	-0.75	0.06	0.84
4.	Sesamum	1.37**	0.40	-0.86
5.	Chillies	1.17	1.09	-0.30
6.	Tobacco	0.27	1.37	0.65

Note: ** denotes significance at 1% level.
* denotes significance at 5 % level.
*** denotes significance at 10 % level.

FIGURE 4.1

FIGURE 4.2

FIGURE 4.3

4.1.1.1 Foodgrain Crops

4.1.1.1.1 Paddy: This is the major foodgrain crop in this district and is mainly cultivated during *kharif* season with 80 per cent of the area under tanks, which in turn depends on rainfall. The results of compound growth rate (Table 4.1.) of area under paddy was found to be negative and non-significant i.e. -0.20 per cent per annum, whereas, that of production and productivity were positively significant at 0.66 per cent and 0.88 per cent per annum respectively.

The results of Rajendra Prasad *et al.* (2009) revealed a negative growth trend in area and production but showed a positive trend in yield (0.44) for paddy.

4.1.1.1.2 Jowar: The compound growth rates of area and production in jowar were found to be negative at 3.45 per cent and 2.63 per cent per annum respectively which were statistically significant, while the productivity indicated a non-significant compound growth rate of 0.85 per cent per annum.

4.1.1.1.3 Bajra: In the case of bajra two components namely area and production showed declining growth rates of 3.95 per cent and 4.07 per cent. The annual compound growth rate of productivity was negative and non-significant with 0.13 per cent per annum.

4.1.1.1.4 Ragi: The area and production of ragi in the district witnessed a significant fall as revealed by the negative significant growth rates of 2.59 per cent and 2.23per cent per annum. But the productivity recorded an annual growth rate of 0.38 per cent. The decline in area of ragi was due to acreage shift to maize, cotton etc. in north coastal districts.

4.1.1.1.5 Maize: The area and production under maize had registered a positive growth of 10.64 per cent and 12.37 per cent respectively and were statistically significant. Productivity too indicated a significantly increasing compound growth rate of 1.57 per cent per annum. The increase in area was due to the shift of area under other crops like ragi etc. to maize. Thangaraja *et al.* (2006) pointed out a decline in growth rate of productivity of maize at 0.82 per cent per annum in Tamil Nadu and stated that fluctuations in the climate, deficit rainfall, lack of drought resistant varieties etc. might be some of the reasons for negative yield growth rate.

4.1.1.1.6 Small millets: There was a significant decline in area of small millets at 1.86 per cent. Productivity had shown a positive non-significant growth rate of 1.63 per cent annually. The decline in area was due to shift from low valued coarse cereals to high valued commercial crops.

4.1.1.1.7 Redgram: It could be seen from Table 4.1 that area and productivity under redgram increased significantly at 2.64 per cent and 1.52 per cent per annum respectively, which resulted in significant increase of production at an annual growth rate of 4.24 per cent

4.1.1.1.8 Bengalgram: The area declined significantly at 2.45 per cent per annum but there was a significant increase in the productivity at 3.80 per cent. Because of this increase in productivity, the production registered a positively significant growth (1.23 per cent) even at declining area growth.

4.1.1.1.9 Blackgram: Positive significant growth rates were observed in area (5.47 per cent) and production (4.20 per cent) of blackgram at 1 per cent and 10 per cent levels respectively, whereas the productivity declined at 1.20 per cent annually which was statistically significant at 1 per cent level. Eventhough a negative growth in productivity was observed, because of increase in area over the period had led to increase in production.

4.1.1.1.10 Greengram: Area and production registered significantly positive annual growth rates of 3.56 per cent and 3.93 per cent respectively. The annual compound growth rate of productivity was positive but low at 0.37 per cent. Similar positive trends in area, production and productivity of greengram were observed by Lakshmanan *et al*. (2005).

4.1.1.1.11 Horsegram: The area declined marginally by 0.01 per cent, while there was a non-significant growth in production and productivity with 0.54 and 0.56 per cent respectively. Thangaraja *et al.* (2006) observed similar positive growth trend in the case of productivity (1.11 per cent) of horsegram which might be due to drought tolerance nature of the crop and low incidence of pest and disease attack in this crop.

4.1.1.2 Non-Foodgrain Crops

4.1.1.2.1 Groundnut: Groundnut crop recorded a non-significant decline in area by 1.09 per cent. The growth rates of production and productivity were non-significant with production bearing a negative sign and productivity with positive sign.

4.1.1.2.2 Sugarcane: Sugarcane had registered significant positive growth rate in area and production with 1.91 per cent and 2.20 per cent of compound growth rates respectively. Though the productivity growth rate was positive it was non-significant. These results were supported by Kshirsagar *et al*. (2007) who reported significant and positive growth rates of area and production.

4.1.1.2.3 Mesta: One of the important major non-foodgrain crops in this district had registered a decline in area (-0.75 per cent) annually. The production was almost static as indicated by non-significant negligible growth rate. The compound growth rate of productivity was non-significant.

4.1.1.2.4 Sesamum: It can be observed from Table 4.1 that positive and significant growth rate of 1.37 per cent in area was only recorded. The productivity growth rate was negative, while the compound growth rate of production was 0.40 per cent.

The results of Singh and Grover (2009) on sesamum indicated positive and significant growth in area (0.51 per cent) but positive and non-significant growth in production (0.37 per cent) and negatively non-significant growth in yield.

4.1.1.2.5 Chillies: Area and production under this crop grew annually at respective growth rates of 1.17 per cent and 1.09 per cent, whereas the productivity declined by 0.30 per cent. However the annual compound growth rates were non-significant for the three parameters.

4.1.1.2.6 Tobacco: Tobacco crop too registered a non-significant increase in area (0.27 per cent), production (1.37 per cent) and productivity (0.65 per cent).

4.1.2 Prakasam District

The growth rates of area, production and productivity of different crops that are grown in this district viz., paddy, jowar, bajra, ragi, maize, smallmillets, redgram bengalgram, blackgram, greengram, groundnut, cotton, sunflower sesamum, chillies and tobacco are presented in Table 4.2. and in figures 4.4, 4.5 and 4.6 respectively.

4.1.2.1 Foodgrain Crops

4.1.2.1.1 Paddy: As the estimated annual compound growth rates indicated, there was no significant growth with respect to any of the parameters. The area growth was negative with 0.07 per cent, while the same for production and productivity were positive with 0.84 and 0.91 per cent.

4.1.2.1.2 Jowar: Jowar area declined significantly by 7.25 per cent per annum, while productivity grew at an annual significant growth rate of 1.75 per cent. Significant decline in area even in the wake of significant productivity growth caused the production to decline by 5.61 per cent. The area under other crops gained from jowar and hence the decline in area.

4.1.2.1.3 Bajra: The area decreased significantly at the rate of 3.07 per cent per annum, whereas per hectare yield registered a positively significant growth rate of 1.20 per cent per annum. Of the two, area reduction was greater than the yield increase, which meant that the production of bajra registered a negative significant growth of 1.90 per cent per annum.

4.1.2.1.4 Ragi: Ragi too followed the trend of jowar regarding growth rates of area, and production. Both area and production declined significantly at the rate of 4.88 and 4.45 per cent, while productivity had registered a non-significant growth of 0.43 per cent per annum. In view of the significant reduction in the area, which was larger than the productivity increase, the production growth obviously decreased by 4.45 per cent.

4.1.2.1.5 Maize: All the three parameters *viz.*, area, production and productivity registered positive significant growth rates of 8.17 per cent, 9.51 per cent, 1.22 per cent per annum respectively. The area increase coupled with significant increase in yield increased the output to a significant rate of 9.51 per cent.

Table 4.2. Compound growth rates of area, production and productivity of different crops in Prakasam district (1981-82 to 2008-09)

(Percent)

S. No.	Crop	Area	Production	Productivity
I. Foodgrain Crops				
1.	Paddy	-0.07	0.84	0.91
2.	Jowar	-7.25**	-5.61**	1.75**
3.	Bajra	-3.07**	-1.90**	1.20**
4.	Ragi	-4.88**	-4.45**	0.43
5.	Maize	8.17**	9.51**	1.22**
6.	Small millets	-10.06**	-8.83**	1.37
7.	Redgram	3.23**	4.27**	1.00
8.	Bengalgram	10.43**	13.90**	3.10**
9.	Blackgram	3.75**	3.10**	-0.59
10.	Greengram	4.19**	4.26**	0.04
II. Non-Foodgrain Crops				
1.	Groundnut	-3.65**	-2.31**	1.38
2.	Cotton	-1.57**	-2.00*	-0.42
3.	Sunflower	7.64**	8.45**	0.69
4.	Sesamum	2.29**	2.24*	-0.10
5.	Chillies	0.45	2.52**	2.04**
6.	Tobacco	0.16	0.96	0.82

Note: ** denotes significance at 1% level.
* denotes significance at 5 % level.
*** denotes significance at 10 % level.

FIGURE 4.4

FIGURE 4.5

FIGURE 4.6

4.1.2.1.6 Small millets: There was a tremendous significant decline in the area and production as their respective growth rates were 10.06 per cent and -8.83 per cent per annum. Productivity growth was positive with 1.37 per cent per annum and non-significant. Steep fall in the area, resulted in the decrease of production. This major decline in its area was due to the shifts to other crops like, sunflower etc.

4.1.2.1.7 Redgram: It can be observed from Table 4.2 that redgram production in the district registered positive significant growth rate of 4.27 per cent per annum. This was possible by the positive significant annual growth rate of area by 3.23 per cent though the productivity growth was non-significant.

4.1.2.1.8 Bengalgram: Bengalgram production grew at an annual rate of 13.90 per cent which was statistically significant. The production growth was helped by a significant increase of area at the rate of 10.43 per cent duly accompanied by a positive and significant growth of productivity at the rate of 3.10 per cent annually. Chaudhari and Pawar (2010) found similar results of significant growth in area, production and productivity of bengalgram and stated that area increase was due to the shift in area from cereals to pulses and significant increase in productivity was due to the use of improved technology and introduction of irrigation facilities.

4.1.2.1.9 Blackgram: The results of growth rate analysis showed that over the period of 28 years, the area and production of blackgram increased significantly by 3.75 per cent and 3.10 per cent per annum respectively. But productivity registered a declining trend of -0.59 per cent. Lakshmanan *et al*. (2005) observed increased production of blackgram which was due to increased growth rate of area and productivity.

4.1.2.1.10 Greengram: The area under this crop recorded a significant increase at the rate of 4.19 per cent. The production growth was 4.26 per cent per annum even at low growth of productivity (0.04 per cent) because of positive and significant acreage growth.

4.1.2.2 Non-Foodgrain Crops

4.1.2.2.1 Groundnut: Groundnut recorded a significant declining growth of area and production, while the productivity growth was positively non-significant. The estimated growth rates were -3.65 per cent, -2.31 per cent and 1.38 per cent per year respectively.

4.1.2.2.2 Cotton: The negative growth rate in respect of area (-1.57 per cent) and productivity (-0.42 per cent) resulted in the decline of production growth rate at -2.00 per cent per annum. The significant decline in area under cotton was because of its shift to paddy, redgram and to some extent to bengalgram. Findings of Chahal *et al.* (2003) differed from the above because it was revealed by them that area, production and productivity under cotton grew at 0.25 per cent, 2.43 per cent and 2.18 per cent per annum respectively and were statistically significant.

4.1.2.2.3 Sunflower: Sunflower production increased at an annual rate of 8.45 per cent, which was statistically significant at 1 per cent level. The area under the crop registered a significant increase at the rate 7.64 per cent, whereas per hectare yield of the crop registered a positive and non-significant growth rate of 0.69 per cent. The area under small millets was shifted to sunflower.

4.1.2.2.4 Sesamum: Area and production under this crop registered a positive significant growth rate of 2.29 per cent and 2.24 per cent respectively, whereas productivity declined at 0.10 per cent per annum. But significant increase in area resulted in increase in production even at negative growth rate of productivity. Area under sesamum revealed a declining trend according to the findings of Swain (2007).

4.1.2.2.5 Chillies: Chilly output in the district showed a significant positive growth rate of 2.52 per cent per year. Productivity increased significantly at the rate of 2.04 per cent. The growth rate of area was positive but non-significant. Aparna *et al.* (2008) found positive non-significant growth trends in area, production and productivity of chillies at 2.97 per cent, 3.42 per cent and 0.43 per cent per annum respectively.

4.1.2.2.6 Tobacco: The annual compound growth rates of area, production and productivity were all positive but non-significant.

From the above analysis it was observed that in Vizianagaram district, negatively non-significant growth rates in area were observed in paddy, horsegram, groundnut and mesta, whereas positively non-significant growth rates were seen in chillies and tobacco. In the case of paddy, horsegram, mesta, sesamum, chillies and tobacco the production exhibited positively non-significant growth rates, whereas in the case of small millets and groundnut it exhibited negatively non-significant growth rates.

Productivity was positive and non-significant in the case of paddy, jowar, ragi, small millets, greengram, horsegram, groundnut, sugarcane, mesta and tobacco, while it was negative and non-significant in the case of bajra, sesamum and chillies. All the three variables *viz.,* area, production and productivity exhibited positive and significant growth rate in the case of maize and redgram, whereas positively non-significant in the case of tobacco.

In Prakasam district only area under paddy showed non-significant negative growth rate, whereas chilly area exhibited non-significant positive growth rate. All the three variables viz., area, production and productivity exhibited positively non-significant growth rates in tobacco and positively significant growth rates in the case of maize and bengalgram. Negatively non-significant growth in productivity was observed in blackgram, cotton, esamum, whereas positively non-significant growth in productivity was seen in paddy, ragi, small millets, redgram, groundnut and sunflower.

4.2 DIRECTION OF CROPPING PATTERN CHANGES

The Markov process was used to study the shifts in the cropping pattern and thereby gain an understanding about the dynamics of the changes. Markov chain analysis was carried out for two sub- periods viz., period I (1992-93 to 1998-99) and period II (1999-2000 to 2008-09). Period I is post-liberalization period while period II post-WTO period.

4.2.1 Transition Probability Matrix for Crops in Vizianagaram District (Period I)

The results of Markov chain analysis to find out changes in the direction of different crops in Vizianagaram district (Table 4.3.) over the post-liberalization period (1992-93 to 1998-99) revealed that, groundnut crop had retention probability to the extent of 0.5791 and fairly low transfer probability of 0.0296 to sesamum and 0.3913 to other crops. The other crops in the district include jowar, bajra, ragi, maize, small millets, redgram, bengalgram, blackgram, sugarcane, chillies and tobacco. Further groundnut has gained a share of 0.1336 from paddy and 0.1035 from other crops.

Table 4.3.

Greengram had a fair degree of retention probability of 0.3914 and a transfer probability to the extent of 0.6086 to other crops. It has gained a share of 0.0141 probability from paddy, 0.1084 from mesta and 0.0337 from other crops.

Next to greengram, mesta crop had a retention probability of 0.3154 and has gained its share from paddy and other crops at the rate of 0.2277 and 0.0913 probabilities respectively. Mesta had a transfer probability of 0.5763 to paddy and 0.1084 to greengram.

Paddy crop with 0.3032 retention probability gained moderate shares from mesta (0.5763) and other crops (0.5567), but a probability of 0.0141 was lost to greengram, 0.1984 to horsegram, 0.1336 to groundnut, 0.2277 to mesta and 0.1230 to sesamum. The area under other crops was not profited from paddy in this period. The area under other crops retained to a very low extent of 0.0629 probability, but gained entire share (1.00) from horsegram and sesamum, 0.6086 probability from greengram, and 0.3913 from groundnut.The findings of Tripathy and Gowda (1999) concluded that rice gained 99 per cent of previous year's share of coarse cereals (ragi, maize, millets, etc.,) and 38.63 per cent share of oilseeds during current year.

Sesamum and horsegram were highly unstable as they did not retain their areas in this period. But, both the crops had transfer probabilities of 1.00 and 1.00 to the other crops. Sesamum crop gained through diversion of paddy, groundnut and other crops with respective probabilities of 0.1230, 0.0296 and 0.0324, whereas horsegram gained small shares from paddy (0.1984) and from other crops acreage (0.1194). The percentage of area under different crops is illustrated in figure 4.7.

4.2.2 Transition Probability Matrix for Crops in Vizianagaram District (Period II)

From the transition probability matrix presented in Table 4.4. it can be observed that in the post-WTO period (1999-2000 to 2008-09) the area under other crops had shown a moderate degree of retention probability of 0.4182. It gained a share of 0.6074probability from paddy, 0.0922 from groundnut and 0.7276 from sesamum. Further it had a transfer probability of 0.3504 to paddy, 0.0819 to greengram, 0.1252 to groundnut and 0.0243 to mesta.

Figure 4.7.

Table 4,4

Mesta crop with 0.3288 retention probability has gained from horsegram (0.1867), groundnut (0.3514), sesamum (0.2724) and other crops (0.0243). It had transferred its share of 0.1480 probability to paddy, 0.1296 to greengram, 0.2292 to horsegram and 0.1643 to groundnut.

Paddy retained to an extent of 0.2550 probabilty, but has shifted its area towards sesamum and other crops with respective probabilities of 0.1374 and 0.6074. It was benefited with an entire share (1.00) from greengram, 0.2428 from groundnut, 0.1480 from mesta and 0.3504 from other crops.

The remaining crops namely greengram, horsegram, groundnut and sesamum became highly instable in this period with zero degree of retention probabilities. Greengram lost its entire share (`1.00) to paddy and retained only meager shares from groundnut (0.0182), mesta (0.1296) and other crops (0.0819). Horsegram gained a share of 0.2218 from groundnut and 0.2292 from mesta, whereas it has transferred to the extent of 0.8133 to groundnut, 0.1867 to mesta. Sesamum like in period I had a zero degree of retention and has gained its share from paddy (0.1374), groundnut (0.0736) and had a transfer probability of 0.2724 to mesta and 0.7276 to other crops. The percentage of area under different crops is illustrated in figure 4.8

By comparing cropping pattern changes in the district between two periods, it was observed that, groundnut which retained a relatively higher proportion of its area in period I was highly unstable in period II. In the first period groundnut lost its share only to sesamum and other crops, but in the second period, it has lost its share to all the remaining crops viz., paddy, greengram, horsegram, mesta, sesamum and other crops.
In period I it has gained its area only from paddy and other crops to a very low extent and had a major share from horsegram and a small share from mesta and other crops in period II.

Greengram was the next crop to groundnut in period I which exhibited retention levels of its own area, gained its share from paddy, mesta, other crops and had a transfer probability to a large extent to other crops. But in period II it had a zero degree of retention and lost its entire share to paddy, gained a very small share from groundnut, mesta and other crops.

figure 4.8

In the case of mesta, the retention probability of its own area has increased to a little extent to 0.3288 in period II from 0.3154 in period I. It has lost its major share to paddy and a small share to greengram in the first period compared to second period which lost its share to paddy, greengram, horsegram and groundnut.

Paddy one of the major crops in the district did not retain much of its area in the second period as observed in the period I in which major area had shifted from mesta and other crops to paddy, whereas in period II it was different. Paddy gained from groundnut to a small extent and entire share from greengram. In the first period, share of paddy was gained by all the remaining crops under this study except other crops and in period II small area was shifted to sesamum and a large extent to other crops.

Other crops ability to retain their own area was very less in period I but was moderate in period II, because in the first period, major area under other crops was shifted to paddy and to a small extent to greengram, horsegram, groundnut, mesta and sesamum, whereas in the second period, the share of paddy, greengram, groundnut and mesta from other crops declined and also horsegram and sesamum had zero transfer probability from other crops.

Horsegram remained as the most unstable crop in both the periods. Its entire share was profited by other crops in period I, whereas in period II, there was a zero transfer probability to other crops but groundnut has gained a large share and mesta gained to a small extent from horsegram. In period I, horsegram was profited from paddy and other crops and in period II it was profited only from groundnut and mesta.

Sesamum in both the periods did not retain any of its area i.e. it had zero retention probability. In period I, total share of it was lost to other crops but in period II sesamum lost greatest extent of its share to other crops and mesta gained a less probability from it. With regard to its gain, a very negligible area from paddy and other crops had shifted to sesamum in period I but gained from paddy and groundnut in period II.

The actual and estimated proportions of acreage under different crops considered for the study in Vizianagaram district are presented in Table 4.5. A comparison of these proportions have indicated that the actual and estimated

Table 4.5.

proportions are almost closer for all the crops implying that the model was reasonably efficient and the credibility of the cropping pattern changes identified were fairly accurate.

4.2.3 Projection of Cropping Pattern

Using transition probability matrix, projection of shares of various crops have been done for different years. These projections are based on the assumption that the forces underlying the observed change will continue in the future. Table 4.6. contains projected shares of different crops of Vizianagaram district from 2009-2010 to 2013-2014.

It may be observed from Table 4.6. that the share of paddy would be 29.06 in 2013-14 against 29.25 per cent in 2009-10. The share of greengram did not show fluctuations in future. The share of horsegram is likely to fluctuate between 3.96 and 4.35 per cent in future. The projected share of groundnut increased from 9.42 per cent in 2009-2010 to 9.83 per cent in 2013-14. The share of mesta would be 9.58 per cent in 2013-2014 which was 9.02 per cent in 2009-10. The share of sesamum is likely to go up to 4.71 per cent in 2013-2014 as against 4.68 per cent in 2009-2010. The projected share of other crops would reduce to 37.94 per cent in 2013-14 from 39.12 per cent in 2009-2010.

4.2.4 Transition Probability Matrix for Crops in Prakasam District (Period I)

The transition probability matrix presented in Table 4.7. shows the changes in areas of different crops in Prakasam district during period I. Among all the crops studied, the acreage under other crops retained fairly highest probability to the extent of 0.6951. The other crops in the district include bajra, ragi, maize, small millets, blackgram, greengram, groundnut, sunflower, sesamum and chillies. This retention of area was further reinforced by the gains from paddy (0.4609), jowar (0.4346), cotton (0.2717). The transfer probabilities from other crops to paddy, jowar, cotton and redgram were 0.1929, 0.0153, 0.0169 and 0.0798 respectively.

Tobacco had a fair degree of retention probability of 0.6256 and it gained to a small extent from paddy (0.1351). Cotton was the only crop to which there was a transfer probability of 0.3744 in this period. Rajagopal's (1988) study revealed that

Table 4.6

Table 4.7

there was a shift in the cropping pattern from tobacco to cotton due to factors attributable to the marketing costs such as transportation, weighing, grading, labour etc., and middlemen's margin. Since the price spread in tobacco crop was higher, the cotton crop was preferred by the farmers.

Regarding jowar, having a retention probability of 0.5654, gained a very negligible share from other crops (0.0153). The area under other crops was benefited from jowar to a probability of 0.4346. Hence it can be observed that loss and gain of area to jowar was only from other crops. Redgram with 0.4746 probability of retention has gained a very negligible share from other crops to an extent of 0.0798. But there was a major acreage shift from redgram to paddy to a probability of 0.4100 and a small extent to bengalgram (0.1154).

A very low degree of retention probability of 0.1880 was observed in paddy, but was further benefited by the entire share of bengal gram (1.00), major share from cotton (0.6425), moderate share from redgram (0.4100) and a small share from other crops (0.1929). It had a transfer probability of 0.4609 to other crops, while cotton and tobacco gained to an extent of 0.2153 and 0.1351 respectively from paddy. Bengalgram and cotton were found to be the most unstable crops in this period with zero retention probabilities. Bengalgram lost its entire area (1.00) to paddy, but gained a very small share of 0.1154 from redgram and a very negligible share from cotton (0.0858).

Regarding cotton, it lost its major area share to the extent of 0.6425 to paddy, 0.0858 to bengalgram and 0.2717 to other crops. From paddy and tobacco, cotton gained an area share of 0.2153 and 0.3744 respectively and a meager share of 0.0169 from other crops. The percentage of area under different crops is shown in figure 4.9.

4.2.5 Transition Probability Matrix for Crops in Prakasam District (Period II)

The transition probability matrix presented in Table 4.8. depicted changes in the direction of cropped acreage in the second period. A different scenario of crop shifts in period II was observed compared to period I. Only three crops exhibited retention probabilities and they were other crops, bengal gram and paddy. The remaining crops were highly unstable during this period.

figure 4.9.

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Table 4.8

The acreage under other crops had a high degree of retention probability of 0.8160 and meager transfer probabilities of 0.0397, 0.0419, 0.0611 and 0.0414 to paddy, cotton, redgram and tobacco respectively. Other crops gained from paddy (0.1402), bengalgram (0.2129) and tobacco (0.1623).

Bengalgram had retained to an extent of 0.6096 probability. It lost its area share to paddy, tobacco and other crops to their respective probabilities of 0.0276, 0.1499 and 0.2129. It has gained shares of 0.1853 from paddy and 0.1274 from redgram.

Paddy experienced a retention probability of 0.5980 and had a high transfer probability of 0.6006 from cotton, 0.2867 from redgram, 0.0276 from bengalgram and 0.0397 from other crops. The probabilities of gains from paddy were 0.1853 to bengalgram, 0.0765 to tobacco and 0.1402 to other crops.

Jowar, cotton, redgram and tobacco were observed as unstable crops in this period. Jowar lost its entire share (1.00) to cotton and obtained a minor share from cotton (0.1791). It was observed that gains and loss to jowar was only from cotton in this period. Rao and Shahid (2005) revealed that the area under rainy sorghum crop declined significantly and was highly unstable losing to other competing crops like cotton and ground nut.

Cotton diverted its area share to paddy, jowar and redgram with respective shares of 0.6006, 0.1791 and 0.2203. It has gained an entire share of 1.00 from jowar, moderate share from redgram (0.2016) and negligible gains from other crops (0.0419).

The transfer probabilities of redgram were 0.2867 to paddy, 0.2016 to cotton, 0.1274 to bengalgram, 0.3843 to tobacco and has gained a large share of 0.8377 from tobacco, 0.2203 from cotton and a negligible share of 0.0611 from other crops. Tobacco with its zero degree of retention probability has lost its major area share of 0.8377 to redgram and 0.1623 to other crops. With respect to gains, a moderate shift of 0.3843 probability from redgram, 0.1499 from bengalgram and 0.0414 from other crops to tobacco were observed. The percentage of area under different crops is illustrated in figure 4.10.

Figure 4.10

After comparing cropping pattern changes in both the periods in the district it was observed that, in period I, bengalgram and cotton were the only unstable crops, but in period II, bengalgram retained its area to an extent of 0.6096. Jowar, cotton, redgram and tobacco remained as unstable crops in the second period.

Paddy has improved its retention probability to 0.5980 in period II from 0.1880 in period I. In both the periods paddy did not gain any share from jowar and tobacco, but lost its share to tobacco and other crops in both periods. The area transfer from cotton to paddy was reduced from 0.6425 period I to 0.6006 in period II and maintained almost similar shares. Paddy gained from almost the same crops in both periods. But the share of bengalgram was reduced from 1.00 in period I to 0.0276 in period II. In period II cotton was replaced by bengalgram in terms of share from paddy.

Jowar which was the most stable crop in the first period became highly unstable and lost its entire share to cotton in period II, while in period I only moderate area of 0.4346 probability was shifted to other crops. It has gained a negligible share from other crops in period I and from cotton in period II.

Cotton in both the periods was unstable. In period I it was benefited from paddy, tobacco and other crops which was different in period II i.e. cotton has gained from other crops, redgram and entire share from jowar.

To redgram in period I negligible area was shifted from other crops (0.0798), while in period II it received a high transfer of area from tobacco (0.8377), cotton (0.2203), other crops (0.0611). Bengalgram has retained much of its area in period II which was highly unstable in period I as it lost its entire share only to paddy.

Tobacco a highly stable crop in period I lost its share only to cotton and gained only from paddy to a small extent, but in period II a major share was lost to redgram and a minor share to other crops and has gained its share from paddy, redgram and bengalgram.

Area under other crops retained to a high degree of probability (0.8160) in period II when compared to period I (0.6951) in which it has received its share from paddy, jowar, cotton and from paddy, bengalgram and tobacco in period II. In the case

of its transfer probabilities, negligible area was lost to paddy, cotton, redgram in both the periods. But its share to jowar in period I was replaced by tobacco in period II.

A comparison of actual and estimated proportions of area under different crops (Table 4.9.) indicated that these proportions are similar for all the crops implying that the model was reasonably efficient and the credibility of Markov process in explaining the cropping pattern changes were fairly accurate.

4.2.6 Projection of Cropping Pattern

As seen from Table 4.10., the projected share of area of most of the crops in Prakasam district would be more or less the same. The projected share of paddy would range from 20.60 per cent in 2009-10 to 20.38 per cent in 2013-14. Similarly, the projected share of jowar ranged from 0.79 per cent to 0.84 per cent for the corresponding periods. The projected share of cotton would be 4.93 per cent in 2013-14 against 5.49 per cent in 2009-10.The projected area of redgram would be 11.40 per cent in 2013-14 as against 10.86 per cent in 2009-10. The share of bengalgram would be almost similar with a slight difference and it would be 13.82 per cent in 2009-10 and 13.57 per cent in 2013-14. The share of tobacco would decline from 10.50 per cent in 2009-10 to 9.75 per cent in 2013-14. In respect of other crops the projected share for 2009-10 would be 37.94 per cent and would increase to 39.13 per cent in 2013-14.

4.3 FACTORS INFLUENCING CROPPING PATTERN CHANGES

Multiple regression analysis was carried out for the time series data for the period 1981-82 to 2008-09 to identify the important factors viz., prices of the crop output, prices of competing crops, rainfall, irrigation, fertilizer prices, wage rates etc. affecting the area changes in major crops in the selected districts. A number of regressions were run separately with area under the crop as the dependent variable and different combinations of explanatory variables for each crop in the districts. The function with the best fit for a crop was selected based on $\overline{R}^2$ and the significance of the coefficients as well as their signs. The Durbin-Watson statistic ('d') was computed to identify the problem of autocorrelation. The results are presented in Table 4.11. and Table 4.12. for Vizianagaram and Prakasam districts respectively.

(Table 4.9.)

Table 4.10.,

problem of autocorrelation. The results are presented in Table 4.11. and Table 4.12. for Vizianagaram and Prakasam districts respectively.

4.3.1 Factors Influencing Cropping Pattern Changes in Vizianagaram District

The influence of various factors on the cropped area of the important crops in Vizianagaram district is presented in Table 4.11.

4.3.1.1 Foodgrain Crops

4.3.1.1.1 Paddy: Of all the variables included in the function, only own lagged price was found to have a significant influence on the cropped area of paddy. The remaining variables viz., lagged price of the competing crop (sugarcane), total rainfall, gross irrigated area, labour wage rates and composite fertilizer prices had no significant influence on the area. $\overline{R}^2$ was 0.564.

4.3.1.1.2 Blackgram: Lagged price of the competing crop influenced the area under blackgram negatively and significantly, while total rainfall influenced it positively and was significant. Labour wage rate was negative and non-significant, while own lagged price and composite fertilizer price turned out to be positive and non-significant. $\overline{R}^2$ was estimated at 0.895.

4.3.1.1.3 Greengram: Own lagged price was found to have significant and positive influence, while lagged price of the competing crop and composite fertilizer price had significantly negative influence on the area of greengram. Total rainfall and labour wage rate were non-significant with positive and negative signs respectively. $\overline{R}^2$ was 0.749.

4.3.1.1.4 Horsegram: Horsegram area was significantly influenced by labour wage rate and composite fertilizer price. The coefficient of labour wage rate was negative, while that of composite fertilizer price was positive. The coefficients of the own lagged price and total rainfall were positive and non-significant, while that of lagged price of the competing crop was negative. $\overline{R}^2$ was 0.521.

Table 4.11.

4.3.1.2 Non-Foodgrain Crops

4.3.1.2.1 Groundnut: Area under groundnut was positively influenced by own lagged price and total rainfall and are statistically significant. Labour wage rate and composite fertilizer price had a significantly negative influence. Lagged price of the competing crop was negative and non-significant. $\overline{R}^2$ was 0.603.

4.3.1.2.2 Sugarcane: The coefficient of own lagged price was found to have positive and significant influence, while that of labour wage rate had a significantly negative influence on the area of sugarcane. The influence of other variables viz., lagged price of the competing crop, gross irrigated area were negative and non-significant, whereas, the coefficients of total rainfall and composite fertilizer price on sugarcane area were positively non-significant. $\overline{R}^2$ worked out to 0.826.

4.3.1.2.3 Mesta: The influence of own lagged price and lagged price of the competing crop were significant with positive and negative signs respectively. Total rainfall and labour wage rate were negative and non-significant, while composite fertilizer price was positive and non-significant. $\overline{R}^2$ value was estimated at 0.636.

4.3.1.2.4 Sesamum: The significant variables influencing sesamum area were its own lagged price and labour wage rate with the former bearing positive and the latter indicating negative sign. The influence of lagged price of the competing crop was positive but non-significant. The area under sesamum was not significantly influenced by either rainfall (or) composite fertilizer price. $\overline{R}^2$ was estimated at 0.377. Gajja *et al* (2008) revealed that own lagged price of sesamum had a positive and significant influence on its acreage allocation.

The response of area under different crops to their causal factors indicated that except the areas under blackgram and horsegram, the areas under remaining crops viz., paddy, greengram, groundnut, sugarcane, mesta, and sesamum were significantly influenced by their own lagged prices. Groundnut was found to be the important competing crop to blackgram, mesta and sesamum. Sugarcane was the competing crop to paddy and paddy was the competing crop to sugarcane, whereas blackgram, greengram and horsegram were found as the competing crops to greengram, horsegram and groundnut. The crops which were significantly influenced by lagged prices of their

competing crops were blackgram, greengram and mesta. Rainfall which is an important determinant of area in the dry land areas influenced significantly the area under blackgram and groundnut only. Gross irrigated area considered for paddy and sugarcane crops only, exerted non-significant influence on their area. Labour wage rate exhibited negative and significant influence on horsegram, groundnut, sugarcane and sesamum areas. Similarly, composite fertilizer price indicated negative and significant influence on the cropped area of greengram and groundnut but had a positive and significant influence on horsegram only.

The Durbin-Watson statistic ('d') was also computed to detect the presence of autocorrelation. The significant values for 'd' ranges between 0.951 to 1.958. It was observed that no autocorrelation was detected between the selected variables that influences acreage under different crops.

The own price and cross price elasticities were also calculated to know the area response of the major crops to the changes in its own price and the price of competing crops. It was observed that groundnut had a high own price elasticity of 1.1248 followed by greengram and sugarcane with 0.6782 and 0.4276 respectively. The response of mesta and sesamum to their own price was low. Paddy, blackgram and horsegram exhibited very low own price elasticities of 0.0986, 0.0512 and 0.0437 respectively. Groundnut was a very strong competing crop to blackgram and blackgram to greengram with cross price elasticities of -1.1943 and -1.1201 respectively. The degree of competition of groundnut with mesta was reasonably strong with a cross price elasticity of -0.5255. The competition of greengram with horsegram and horsegram with groundnut was moderate with -0.2184 and -0.2987 cross price elasticities respectively. The degree of competition of sugarcane with paddy and paddy with sugarcane was low at -0.0986 and -0.0602 cross price elasticities respectively.

4.3.2 Factors Influencing Cropping Pattern Changes in Prakasam District

The influence of causal factors on acreage changes of important crops was analyzed and the results presented in Table 4.12.

Table 4.12.

4.3.2.1 Foodgrain crops

4.3.2.1.1 Paddy: The variables that were positively significant for paddy area were, own lagged price and gross irrigated area. Lagged price of competing crop (cotton) was non-significant with negative sign. Rainfall, labour wage rate and price of composite fertilizers were positively non-significant. $\overline{R}^2$ was 0.450. Singh *et al.* (1997) also observed a positive and significant impact of irrigated area on the paddy acreage.

4.3.2.1.2 Jowar: The significantly influencing factors of jowar area were lagged price of the competing crop (bajra) and composite fertilizer price both with negative signs. The coefficients of own lagged price and wage rate were positive but non-significant, whereas that of total rainfall was negative and non-significant. $\overline{R}^2$ value was 0.853. Reddy (1997) on the other hand observed significant influence of rainfall on jowar area.

4.3.2.1.3 Bajra: With respect to bajra there was only one significant factor i.e. total rainfall with a negative sign. All the others were non-significant. Among the non-significant variables, lagged price of the competing crop and price of composite fertilizer had negative signs, while own lagged price and wage rate exhibited positive signs. $\overline{R}^2$ was significant at 0.766. Bhatia and Tewari (1990) in their study observed rainfall influencing significantly with a negative sign on different crop acreages.

4.3.2.1.4 Redgram: The variable which exhibited significant influence positively on redgram area was its own lagged price. Rainfall influence was negative but significant.

Lagged price of the competing crop was negative and non-significant. The coefficients of wage rate and composite fertilizer prices were positive but turned out to be non-significant. $\overline{R}^2$ value stood at 0.802.

4.3.2.1.5 Bengalgram: Own lagged price was the only variable that had positive and significant influence on bengalgram area. Lagged price of the competing crop, rainfall and composite fertilizer prices were negative and non-significant, while labour wage rate was positive and non-significant. $\overline{R}^2$ was 0.808.

4.3.2.2 Non-Foodgrain crops

4.3.2.2.1 Cotton: Cotton area was significantly influenced by the lagged price of the competing crop. It had a negative sign. Among the other variables, labour wage rate and price of the composite fertilizer had non-significant negative sign. Own lagged price and rainfall exhibited positive signs without being significant. $\overline{R}^2$ was 0.323 and significant. Khunt and Antani (1991) also reported that rainfall did not exert any significant influence on cotton acreage.

4.3.2.2.2: Chilly: The significant factor influencing chilly area was its own lagged price with positive sign. The non-significant variables with positive signs were rainfall and wage rate. Price of the competing crop and price of composite fertilizers were negatively non-significant. $\overline{R}^2$ value stood at 0.305.

4.3.2.2.3: Tobacco: Area under tobacco was positively and significantly influenced by its own lagged price. The influence of lagged price of the competing crop on its area was negatively significant. The coefficients of rainfall and composite fertilizer price were positive but non-significant, while that of wage rate was negatively non-significant. $\overline{R}^2$ was estimated at 0.433.

The above findings revealed that area under paddy, redgram, bengalgram, chilly and tobacco were positively influenced by their own lagged prices. Lagged prices of competing crops were found influencing the area under jowar, cotton and tobacco negatively. Cotton was found to be the competing crop for paddy and chilly. Chilly was an important competing crop for redgram and cotton. The competing crops for jowar, bajra, bengalgram and tobacco were bajra, bengalgram, jowar and redgram respectively. There was a significant negative effect of rainfall on bajra and redgram areas. Increase in gross irrigated area had a significant positive influence on the area under paddy. Labour wage rate did not influence any crop significantly. Price of composite fertilizers had negative significant influence on the area under jowar only, for others, its influence was non-significant.

After calculating Durbin-Watson statistic ('d') it was observed that except in the case of chilly, autocorrelation was not detected in any of the crops. Presence of autocorrelation was corrected by using Cochrane-Orcutt method.

The response of the area to the changes in its own price and price of competing crops was studied by computing the own price and cross price elasticities. Jowar had a high own price elasticity of 1.6621 followed by bengalgram, paddy and chilly with their respective own price elasticities of 0.9666, 0.7460 and 0.6444. Redgram, tobacco and cotton responded moderately to their prices with the corresponding elasticities of 0.4597, 0.3552 and 0.2327 respectively. The response of bajra to its own price was very low at 0.0807.

Jowar had a high competition with bajra with cross price elasticity of -0.9120, while cotton, tobacco, chilly and redgram indicated moderate competition to chilly, redgram, cotton and chilly with the cross price elasticities of -0.5791, -0.4337, -0.3422 and -0.3011 respectively. The degree of competition of bajra with bengalgram, paddy with cotton and bengalgram with jowar was low with respective cross price elasticities of -0.2150, -0.1830 and -0.1082.

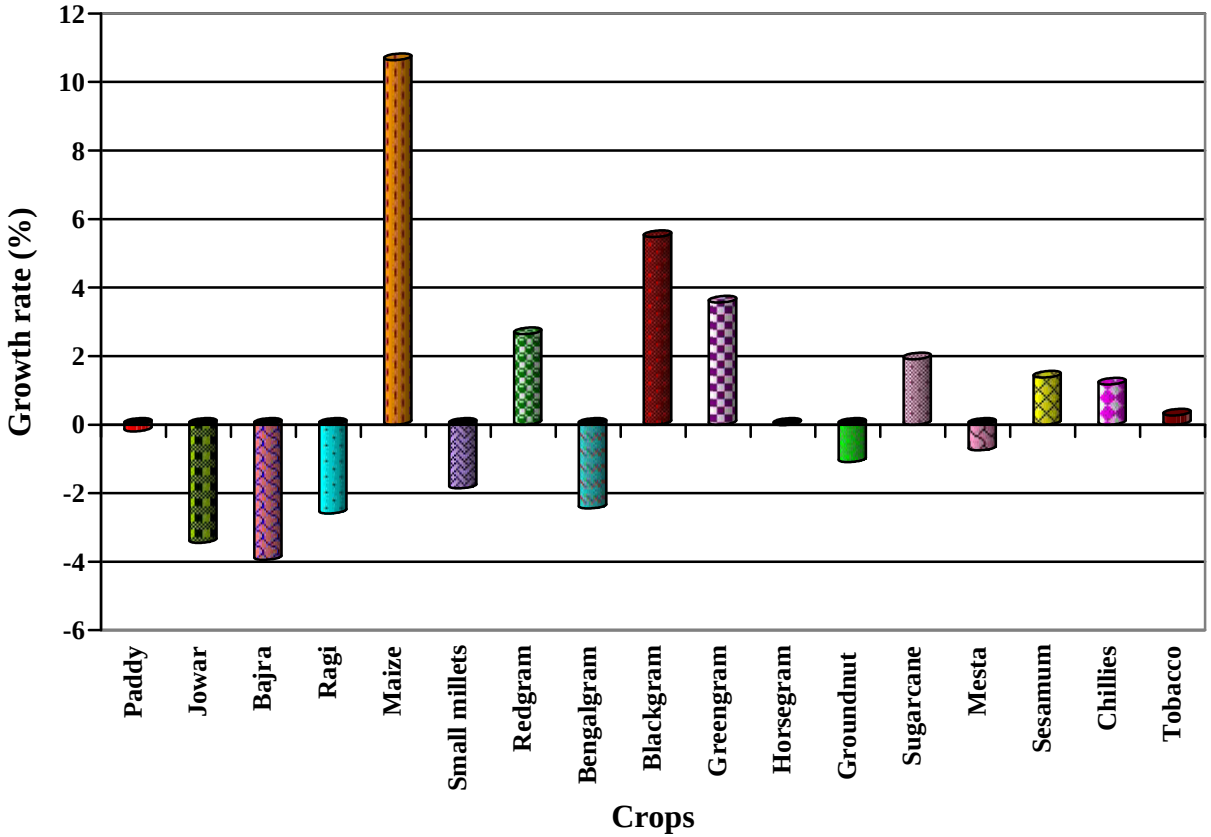

Figure 4.1 Compound growth rates (%) of area under different crops in Vizianagaram district (1981-82 to 2008-09).

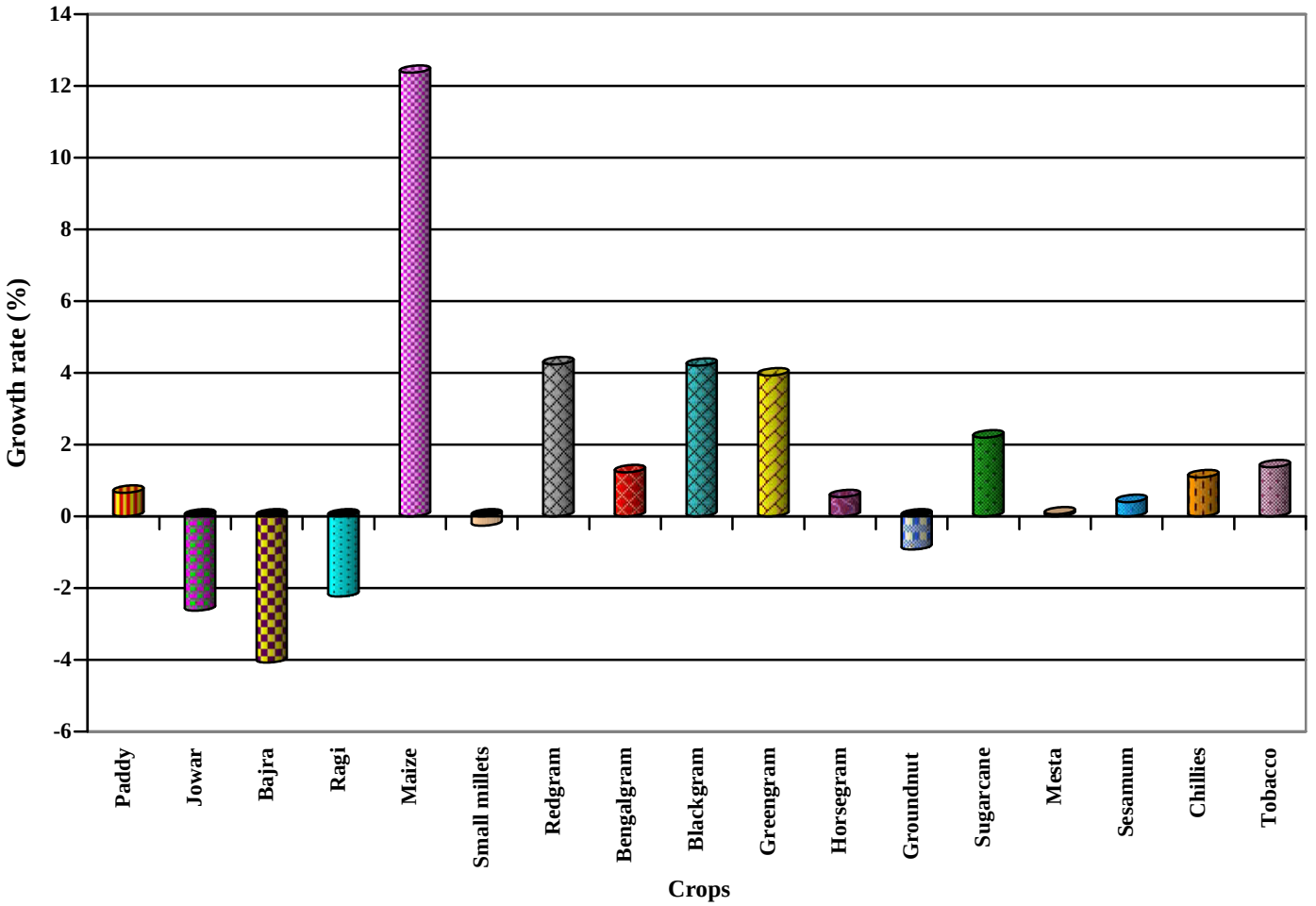

Figure 4.2 Compound growth rates (%) of production of different crops in Vizianagaram district (1981-82 to 2008-09).

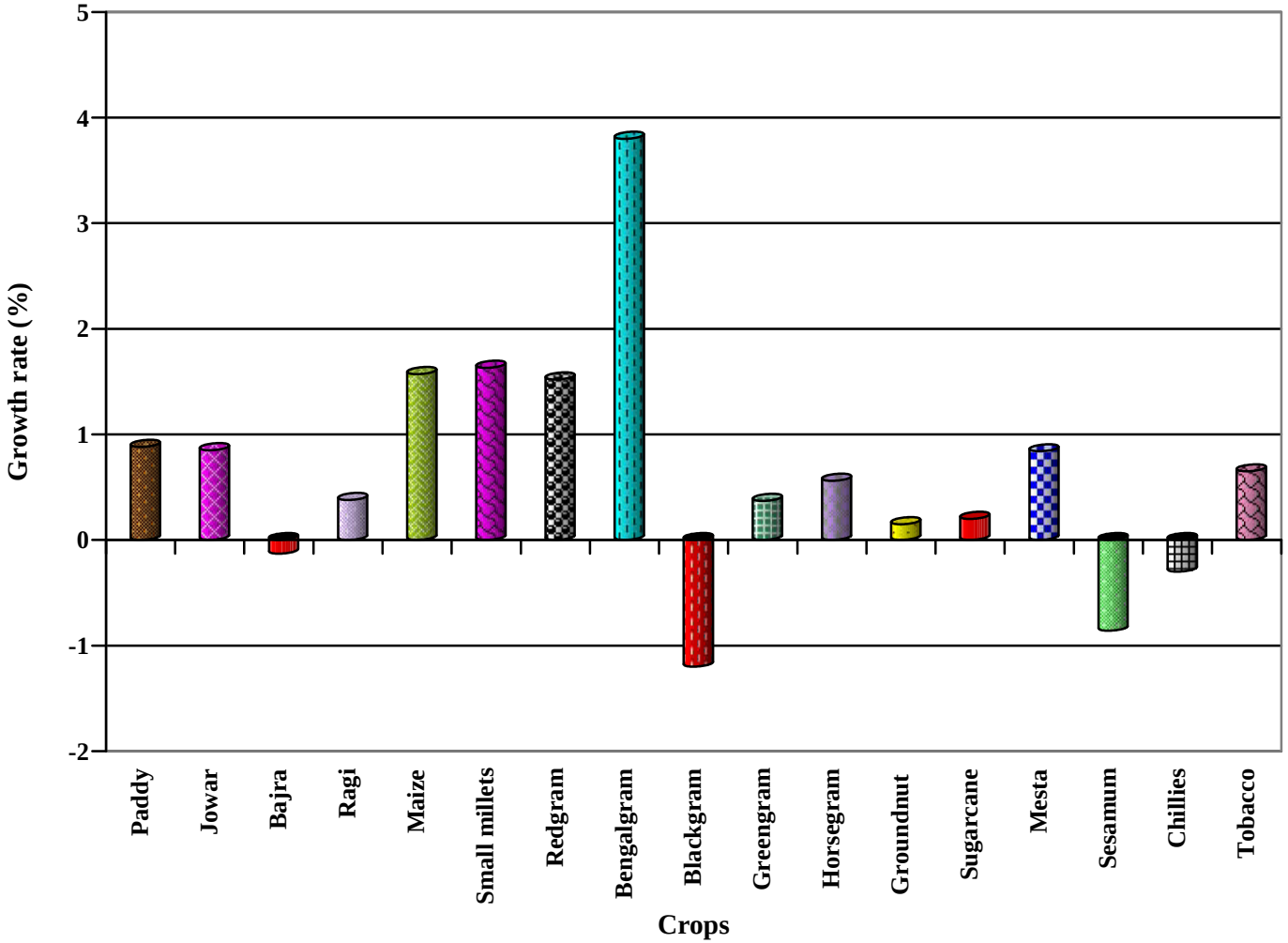

Figure 4.3 Compound growth rates (%) of productivity of differerent crops in Vizianagaram district (1981-82 to 2008-09).

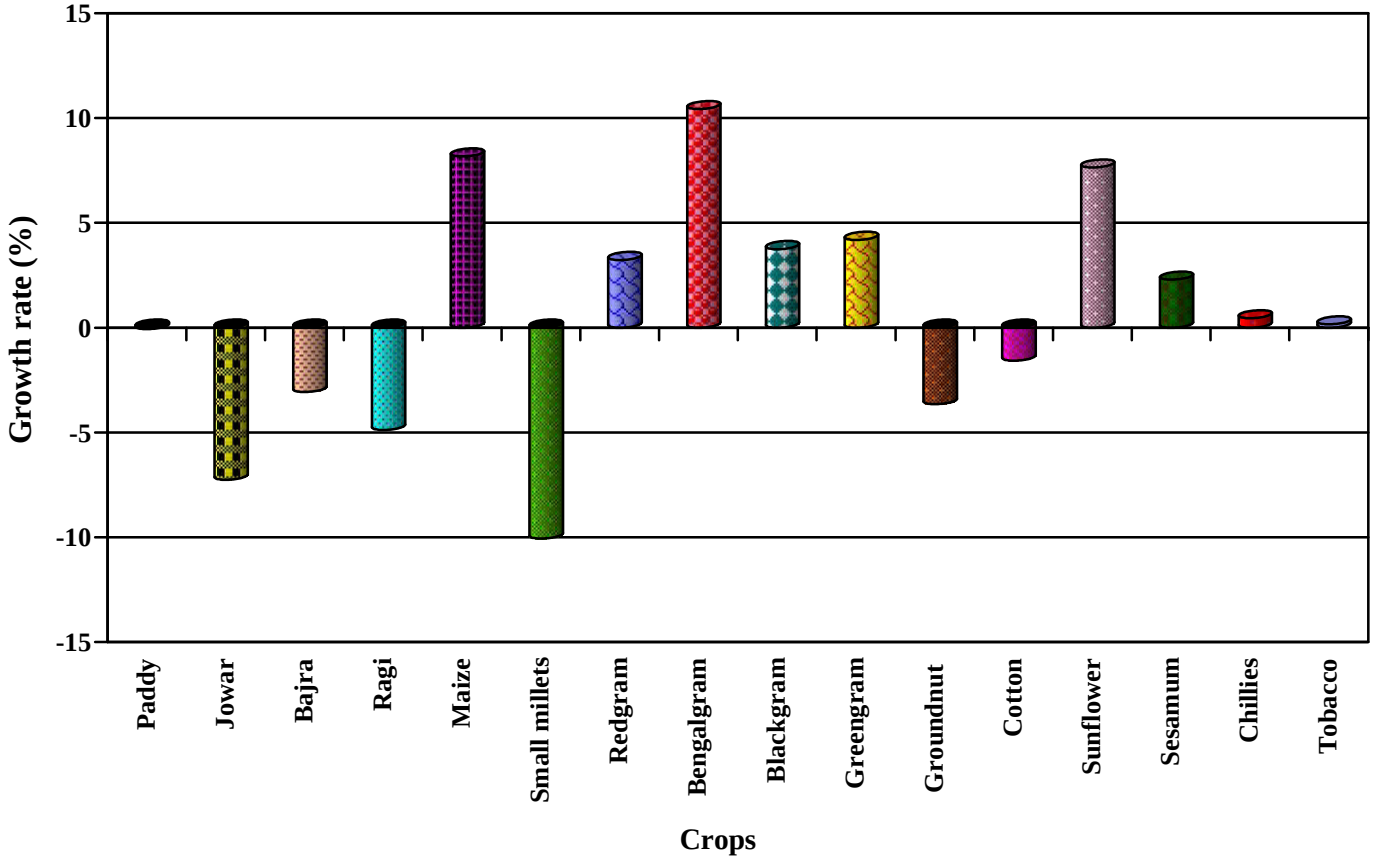

Figure 4.4 Compound growth rates (%) of area under different crops in Prakasam district (1981-81 to 2008-09).

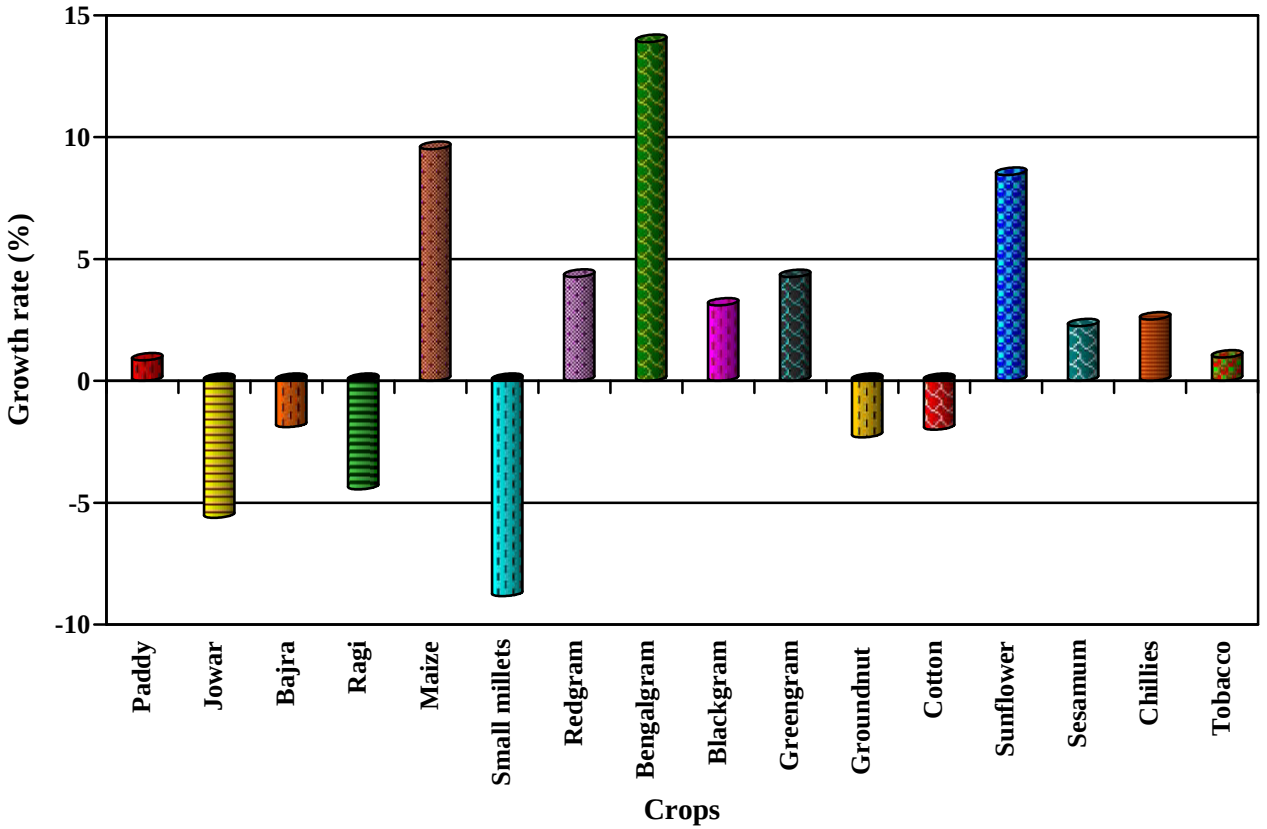

Figure 4.5 Compound growth rates (%) of production of different crops in Prakasam district (1981-82 to 2008-09).

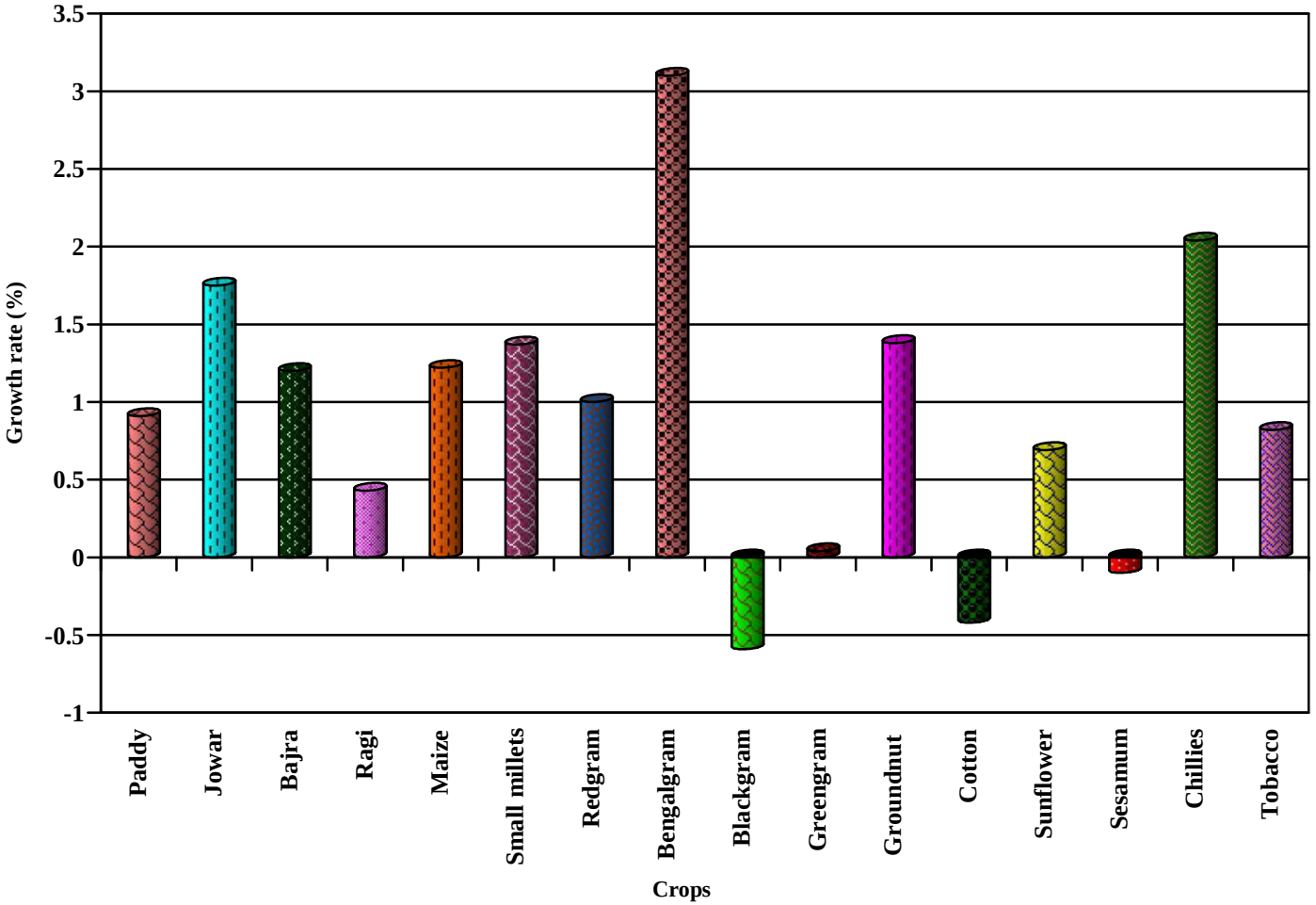

Figure 4.6 Compound growth rates (%) of productivity of different crops in Prakasam district (1981-82 to 2008-09).

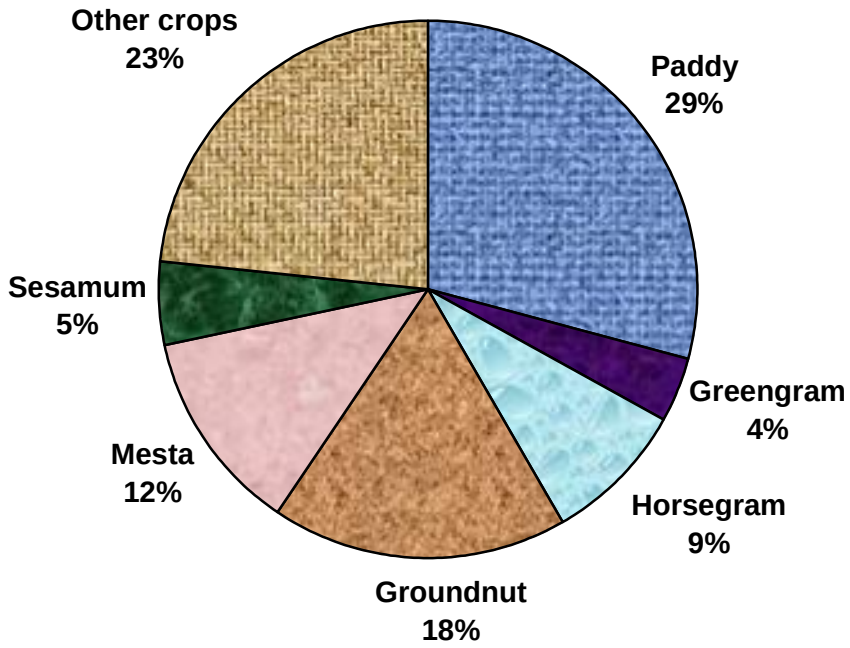

Figure 4.7 Percentage of area under different crops in Vizianagaram district in period I (1992-93 to 1998-99).

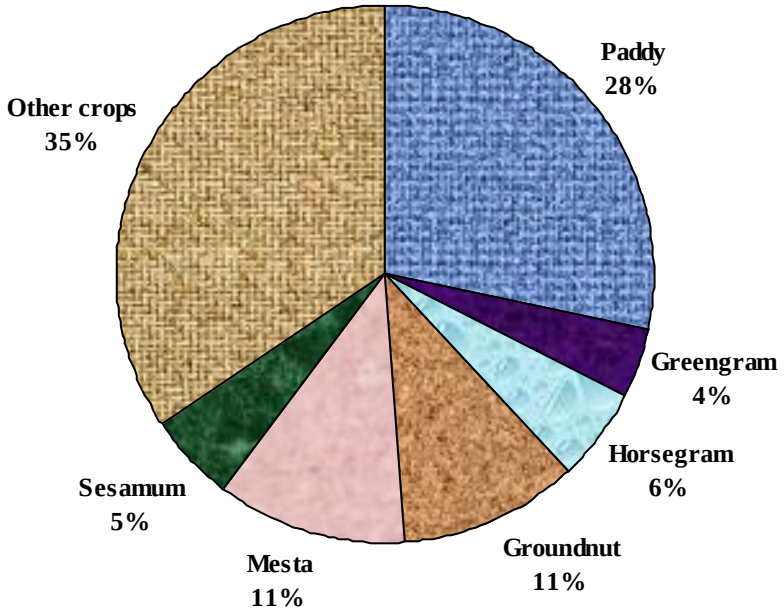

Figure 4.8 Percentage of area under different crops in Vizianagaram district in period II (1999-2000 to 2008-09).

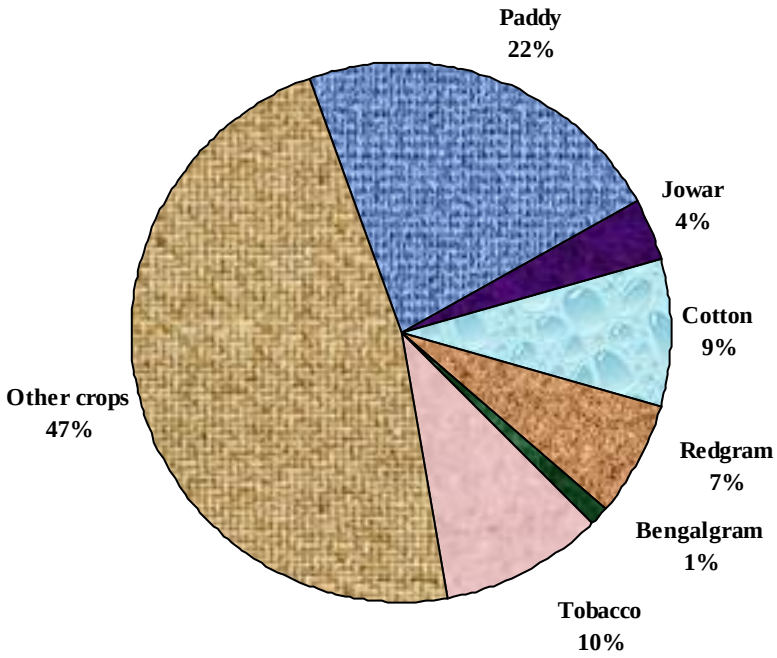

Figure 4.9 Percentage of area under different crops in Prakasam district in Period I (1992-93 to 1998-99).

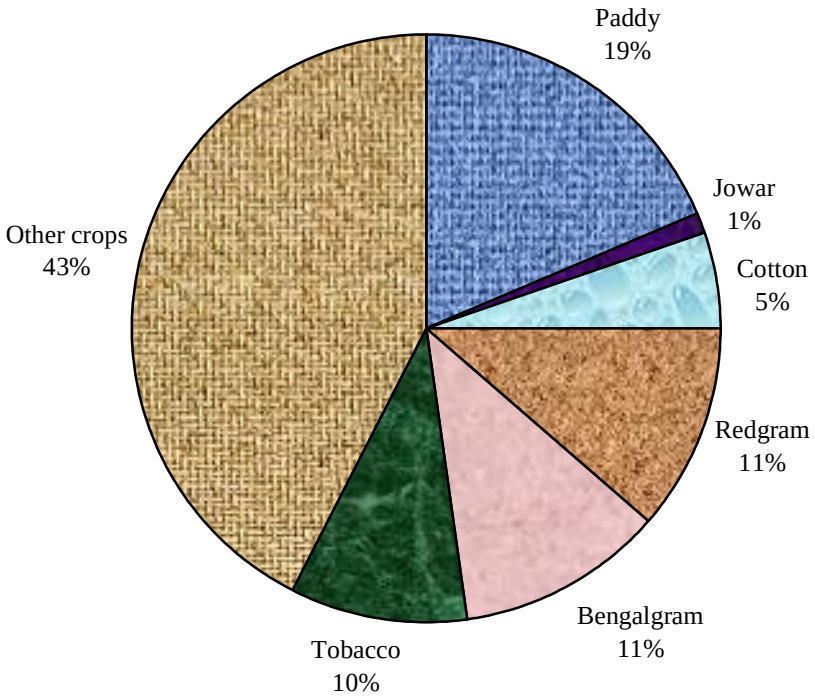

Figure 4.10 Percentage of area under different crops in Prakasam district in Period II (1999-2000 to 2008-09).

Table 4.3. Transition probability matrix for shifts in cropping pattern in Vizianagaram district in post-liberalisation period (1992-93 to 1998-99)

Crop	Paddy	Green gram	Horse gram	Groundnut	Mesta	Sesamum	Other crops
Paddy	0.3032	0.0141	0.1984	0.1336	0.2277	0.1230	0.0000
Green gram	0.0000	0.3914	0.0000	0.0000	0.0000	0.0000	0.6086
Horse gram	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
Groundnut	0.0000	0.0000	0.0000	0.5791	0.0000	0.0296	0.3913
Mesta	0.5763	0.1084	0.0000	0.0000	0.3154	0.0000	0.0000
Sesamum	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
Other crops	0.5567	0.0337	0.1194	0.1035	0.0913	0.0324	0.0629

Table 4.4. Transition probability matrix for shifts in cropping pattern in Vizianagaram district in post-WTO period (1999-2000 to 2008-09)

Crop	Paddy	Green gram	Horse gram	Groundnut	Mesta	Sesamum	Other crops
Paddy	0.2550	0.0000	0.0000	0.0000	0.0000	0.1374	0.6074
Green gram	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Horse gram	0.0000	0.0000	0.0000	0.8133	0.1867	0.0000	0.0000
Groundnut	0.2428	0.0182	0.2218	0.0000	0.3514	0.0736	0.0922
Mesta	0.1480	0.1296	0.2292	0.1643	0.3288	0.0000	0.0000
Sesamum	0.0000	0.0000	0.0000	0.0000	0.2724	0.0000	0.7276
Other crops	0.3504	0.0819	0.0000	0.1252	0.0243	0.0000	0.4182

Table 4.5. Actual and estimated proportions of area under different crops in Vizianagaram district (1992-93 to 2008-09)

Year	Paddy		Greengram		Horsegram		Groundnut		Mesta		Sesamum		Other crops	
	Actual	Estimated	Actual	Estimated	Actual	Estimated	Actual	Estimated	Actual	Estimated	Actual	Estimated	Actual	Estimated
1992 - 93	0.3001	0.2843	0.264	0.0352	0.0791	0.0860	0.2054	0.1820	0.1209	0.1267	0.0456	0.0502	0.2208	0.2353
1993 - 94	0.3226	0.2536	0.0351	0.0358	0.0889	0.0837	0.2218	0.1886	0.1109	0.1235	0.0554	0.0516	0.1650	0.2630
1994 - 95	0.2534	0.2994	0.0359	0.0398	0.0837	0.0817	0.1886	0.1703	0.1234	0.1207	0.0516	0.0453	0.2631	0.2475
1995 - 96	0.2788	0.3020	0. 0373	0.0405	0.0816	0.0870	0.1703	0.1633	0.1207	0.1258	0.0452	0.0479	0.2660	0.2330
1996 - 97	0.3036	0.2869	0.0432	0.0431	0.0958	0.0849	0.1582	0.1536	0.1384	0.1316	0.0538	0.0487	0.2066	0.2509
1997 - 98	0.2878	0.3028	0.0432	0.0436	0.0902	0.0870	0.1502	0. 1514	0.1316	0.1300	0.0458	0.0479	0.2509	0.2369
1998 - 99	0.2969	0.2953	0.0436	0.0417	0.0860	0.0895	0.1603	0.1590	0.1087	0.1253	0.0480	0.0495	0.2562	0.2395
1999 - 00	0.2888	0.2628	0.0427	0.0408	0.0767	0.0573	0.1314	0.1169	0.1228	0.1246	0.0625	0.0493	0.2748	0.3480
2000 - 01	0.3027	0.2601	0.0344	0.0428	0.0596	0.0564	0.1169	0.1062	0.1330	0.1210	0.0665	0.0502	0.2866	0.3629
2001 - 02	0.2570	0.2820	0.0467	0.0488	0.0630	0.0515	0.0934	0.1189	0.1346	0.1091	0.0420	0.0421	0.3630	0.3471
2002 - 03	0.2506	0.2710	0.0369	0.0503	0.0606	0.0646	0.1240	0.1174	0.1623	0.1256	0.0343	0.0435	0.3310	0.3271
2003 - 04	0.2709	0.2802	0.0503	0.0435	0.0647	0.0513	0.1175	0.1122	0.1103	0.1127	0.0551	0.0459	0.3309	0.3539
2004 - 05	0.2935	0.2853	0.0435	0.0438	0.0504	0.0469	0.1123	0.1016	0.0963	0.1017	0.0458	0.0486	0.3577	0.3717
2005 - 06	0.2558	0.2859	0.0417	0.0472	0.0469	0.0476	0.1096	0.1040	0.1018	0.1045	0.0522	0.0432	0.3916	0.3673
2006-07	0.2860	0.2905	0.0484	0.0466	0.0484	0.0476	0.0969	0.1041	0.1139	0.1000	0.0387	0.0464	0.3673	0.3645
2007-08	0.2956	0.2848	0.0465	0.4434	0.0395	0.0415	0.0838	0.0942	0.1000	0.0976	0.0698	0.0468	0.3644	0.3905
2008-09	0.3221	0.2924	0.0403	0.0426	0.0367	0.0367	0.0942	0.0901	0.0690	0.0849	0.0468	0.0512	0.3905	0.4018

Note : Estimated values are calculated using transition probability matrix for the period 1992-93 to 2008-09

Table 4.6. Projected share (%) of crops in Vizianagaram district (2009-10 to 2013-14)

Year	Paddy	Greengram	Horsegram	Groundnut	Mesta	Sesamum	Other crops
2009 – 10	29.25	4.55	3.96	9.42	9.02	4.68	39.12
2010 – 11	29.34	4.54	4.16	9.59	9.26	4.71	38.40
2011 – 12	29.18	4.51	4.24	9.71	9.42	4.74	38.20
2012 – 13	29.09	4.52	4.32	9.78	9.53	4.72	38.04
2013 – 14	29.06	4.53	4.35	9.83	9.58	4.71	37.94

Note: The sum of the share of crops in each row adds to 100%

Table 4.7. Transition probability matrix for shifts in cropping pattern in Prakasam district in post- liberalisation period (1992-93 to 1998-99)

Crop	Paddy	Jowar	Cotton	Redgram	Bengalgram	Tobacco	Other crops
Paddy	0.1880	0.0000	0.2153	0.0000	0.0000	0.1351	0.4609
Jowar	0.0000	0.5654	0.0000	0.0000	0.0000	0.0000	0.4346
Cotton	0.6425	0.0000	0.0000	0.0000	0.0858	0.0000	0.2717
Redgram	0.4100	0.0000	0.0000	0.4746	0.1154	0.0000	0.0000
Bengalgram	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tobacco	0.0000	0.0000	0.3744	0.0000	0.0000	0.6256	0.0000
Other crops	0.1929	0.0153	0.0169	0.0798	0.0000	0.0000	0.6951

Table 4.8. Transition probability matrix for shifts in cropping pattern in Prakasam district in post-WTO period (1999-2000 to 2008-09)

Crop	Paddy	Jowar	Cotton	Redgram	Bengalgram	Tobacco	Other crops
Paddy	0.5980	0.0000	0.0000	0.0000	0.1853	0.0765	0.1402
Jowar	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000
Cotton	0.6006	0.1791	0.0000	0.2203	0.0000	0.0000	0.0000
Redgram	0.2867	0.0000	0.2016	0.0000	0.1274	0.3843	0.0000
Bengalgram	0.0276	0.0000	0.0000	0.0000	0.6096	0.1499	0.2129
Tobacco	0.0000	0.0000	0.0000	0.8377	0.0000	0.0000	0.1623
Other crops	0.0397	0.0000	0.0419	0.0611	0.0000	0.0414	0.8160

Table 4.9. Actual and estimated proportions of area under different crops in Prakasam district (1992-93 to 2008-09)

Year	Paddy		Jowar		Cotton		Redgram		Bengalgram		Tobacco		Other crops	
	Actual	Estimated	Actual	Estimated	Actual	Estimated	Actual	Estimated	Actual	Estimated	Actual	Estimated	Actual	Estimated
1992 - 93	0.2311	0.2071	0.0573	0.0399	0.0731	0.0946	0.0418	0.0600	0.0040	0.0111	0.0972	0.0921	0.4949	0.4954
1993 - 94	0.2072	0.2253	0.0576	0.0399	0.1037	0.0873	0.0529	0.0635	0.0052	0.0150	0.0923	0.0857	0.4808	0.4831
1994 - 95	0.2254	0.2330	0.0398	0.0299	0.0873	0.0883	0.0634	0.0688	0.0150	0.0148	0.0844	0.0833	0.4844	0.4817
1995 - 96	0.2331	0.2283	0.0297	0.0244	0.0862	0.0884	0.0614	0.0693	0.0068	0.0144	0.0793	0.0811	0.5031	0.4936
1996 - 97	0.1716	0.2368	0.0268	0.0234	0.0883	0.0759	0.0796	0.0811	0.0102	0.0167	0.0795	0.0721	0.5436	0.4927
1997 - 98	0.2663	0.2451	0.0234	0.0190	0.0928	0.1059	0.1060	0.0806	0.0186	0.0202	0.1126	0.1064	0.3800	0.4224
1998 - 99	0.2453	0.2687	0.0092	0.0124	0.1058	0.1157	0.0806	0.0769	0.0218	0.0198	0.1260	0.1212	0.4109	0.4669
1999 - 00	0.2196	0.2227	0.0149	0.0132	0.0737	0.0537	0.1001	0.1424	0.0296	0.0715	0.1183	0.0780	0.4434	0.4182
2000 - 01	0.2228	0.2354	0.0135	0.0127	0.0709	0.0603	0.1450	0.1065	0.0513	0.0910	0.0780	0.0977	0.4181	0.3960
2001 - 02	0.2567	0.2416	0.0087	0.0118	0.0662	0.0468	0.1066	0.1139	0.0757	0.1073	0.0897	0.0883	0.3960	0.3899
2002 - 03	0.1204	0.1505	0.0175	0.0080	0.0448	0.0582	0.1011	0.1296	0.1231	0.1102	0.2215	0.0866	0.4854	0.4566
2003 - 04	0.808	0.1446	0.0201	0.0108	0.0603	0.0665	0.1306	0.1252	0.1306	0.1112	0.0988	0.0957	0.4786	0.4457
2004 - 05	0.1446	0.1826	0.0108	0.0119	0.0664	0.0544	0.1236	0.1222	0.1112	0.1103	0.0958	0.937	0.4473	0.4245
2005 - 06	0.2292	0.2109	0.0061	0.0057	0.0323	0.0470	0.1246	0.1086	0.1384	0.1427	0.0938	0.1017	0.3753	0.3831
2006-07	0.2050	0.1814	0.0050	0.0060	0.0338	0.0345	0.0593	0.1182	0.1762	0.1529	0.1016	0.0822	0.4188	0.4245
2007-08	0.1841	0.1858	0.0048	0.0062	0.0346	0.0464	0.1182	0.1024	0.1514	0.1415	0.0822	0.0997	0.4244	0.4177
2008-09	0.1972	0.1784	0.0075	0.0097	0.0617	0.0383	0.1023	0.1226	0.1415	0.1195	0.1234	0.0799	0.3660	0.3313

Note : Estimated values are calculated using transition probability matrix for the period 1992-93 to 2008-09

Table 4.10. Projected share (%) of crops in Prakasam district (2009-10 to 2013-14)

Year	Paddy	Jowar	Cotton	Redgram	Bengalgram	Tobacco	Other crops
2009 – 10	20.60	0.79	5.49	10.86	13.82	10.50	37.94
2010 – 11	20.62	0.98	4.57	12.33	13.62	9.39	38.49
2011 – 12	20.50	0.83	5.08	11.22	13.69	9.95	38.73
2012 – 13	20.45	0.90	4.71	11.82	13.58	9.54	39.00
2013 – 14	20.38	0.84	4.93	11.40	13.57	9.75	39.13

Note: The sum of the share of crops in each row adds to 100%

Table 4.11. Factors influencing area changes in major crops in Vizianagaram district

S. No.	Crop	Intercept	Regression coefficients						$\bar{R}^2$	D value	Competing crop	Own price elasticity	Cross price elasticity
			Price of the crop lagged by one year (X_1)	Price of the competing crop lagged by one year (X_2)	Total rainfall (X_3)	Gross irrigated area (X_4)	Labour wage rate (X_5)	Composite fertilizer price (X_6)					
I. Foodgrain Crops													
1.	Paddy	123.3201 (22.3953)	0.0340** (0.0194)	-0.0175 (0.0234)	-0.0084 (0.0140)	0.1935 (0.1150)	0.2600 (0.2679)	-0.0852 (2.2932)	0.564**	0.826	Sugarcane	0.0986	-0.0986
2.	Blackgram	-6.0792 (2.2467)	0.0004 (0.0010)	-0.01015* (0.0031)	0.0037* (0.0017)	-	-0.0321 (0.0437)	0.1844 (0.2285)	0.895**	0.992	Groundnut	0.0512	-1.1943
3.	Greengram	-0.4945 (4.4743)	0.0085*** (0.0048)	-0.0153** (0.0039)	0.0009 (0.0035)	-	-0.0900 (0.0724)	-1.1190* (0.3930)	0.749**	1.130	Blackgram	0.6782	-1.1201
4.	Horsegram	19.6868 (11.3298)	0.0028 (0.0264)	-0.0056 (0.0090)	0.0024 (0.0087)	-	-0.3877* (0.1798)	2.0562* (0.9028)	0.521**	1.957	Greengram	0.0437	-0.2184
II. Non-Foodgrain Crops													
1.	Groundnut	55.3861 (16.1514)	0.0816* (0.0225)	-0.0456 (0.0330)	0.0228*** (0.0124)	-	-0.8590* (0.2911)	-4.0686* (1.6462)	0.603**	1.090	Horsegram	1.1248	-0.2987
2.	Sugarcane	1.1697 (3.2018)	0.0066** (0.0033)	-0.0017 (0.0114)	0.0033 (0.0020)	-0.0039 (0.0164)	-0.1007* (0.0383)	0.1720 (0.3279)	0.826**	1.922	Paddy	0.4276	-0.0602
3.	Mesta	68.9699 (8.2183)	0.0162*** (0.0086)	-0.0321* (0.0112)	-0.0092 (0.0065)	-	-0.2256 (0.1414)	1.9592 (0.8337)	0.636**	1.770	Groundnut	0.1944	-0.5255
4.	Sesamum	2.2503 (6.6014)	0.0036* (0.0017)	0.0148 (0.094)	0.0057 (0.0051)		-0.2763* (0.1308)	0.1598 (0.6520)	0.377***	1.500	Groundnut	0.2171	0.7020

Note : **, *, *** denote significance at 1, 5 and 10 per cent respectively
Figures in parentheses are standard errors.

Table 4.12. Factors influencing area changes in major crops in Prakasam district

S. No.	Crop	Intercept	Regression coefficients						$\bar{R}^2$	D value	Competing crop	Own price elasticity	Cross price elasticity
			Price of the crop lagged by one year (X_1)	Price of the competing crop lagged by one year (X_2)	Total rainfall (X_3)	Gross irrigated area (X_4)	Labour wage rate (X_5)	Composite fertilizer price (X_6)					
I. Foodgrain Crops													
1.	Paddy	40.5786 (34.109)	0.2336* (0.1017)	-0.0151 (0.0163)	0.0254 (0.0301)	0.2857* (0.1281)	0.9959 (0.7268)	3.7428 (3.9144)	0.450**	0.969	Cotton	0.7460	-0.1830
2.	Jowar	159.2815 (19.6871)	0.2124 (0.1243)	-0.1204* (0.0564)	-0.0358 (0.0216)	-	0.6497 (0.6932)	-7.1120* (2.5401)	0.853**	1.236	Bajra	1.6621	-0.9120
3.	Bajra	75.4611 (9.1164)	0.0070 (0.0237)	-0.0063 (0.0078)	-0.0211* (0.0098)	-	0.2186 (0.3764)	-3.1093 (0.9853)	0.766**	1.293	Bengalgram	0.0807	-0.2150
4.	Redgram	30.3236 (13.3326)	0.0182*** (0.0093)	-0.0064 (0.0039)	-0.0327* (0.0147)	-	0.1864 (0.2976)	2.5584 (1.6481)	0.802**	1.880	Chilly	0.4597	-0.3011
5.	Bengalgram	21.2129 (19.5899)	0.0267* (0.0106)	-0.0086 (0.0872)	-0.0490 (0.0220)	-	1.0625 (0.8665)	-1.2732 (2.3468)	0.808**	1.134	Jowar	0.9666	-0.1082
II. Non-Foodgrain Crops													
1.	Cotton	71.0778 (17.6937)	0.0078 (0.0104)	-0.0139* (0.0050)	0.0028 (0.0199)	-	-0.2849 (0.4285)	-1.0665 (2.5864)	0.323**	1.804	Chilly	0.2327	-0.5791
2.	Chilly	19.7852 (5.5982)	0.0058** (0.0016)	-0.0043 (0.0033)	0.0013 (0.0063)	-	0.0950 (0.1356)	-1.0777 (0.8183)	0.305**	0.681	Cotton	0.6444	-0.3422
3.	Tobacco	42.8173 (12.2263)	0.0070* (0.0032)	-0.0229*** (0.0118)	0.0075 (0.0140)	-	-0.2431 (0.3693)	2.1016 (1.6949)	0.433**	1.220	Redgram	0.3552	-0.4337

Note : **, *, *** denote significance at 1, 5 and 10 per cent respectively
Figures in parentheses are standard errors.

Chapter V

SUMMARY AND CONCLUSIONS

India's record of progress in agriculture over the past four decades has been quite impressive. The success of India's agriculture is attributed to a series of steps that led to availability of farm technologies which brought about dramatic increases in productivity in 70s and 80s often described as the Green Revolution era. The major sources of agricultural growth during this period were the spread of modern crop varieties, intensification of input use and investments leading to expansion in the irrigated area. Indian agriculture has progressed a long way from an era of frequent droughts and vulnerability to food shortages to becoming a significant exporter of agricultural commodities. This has been possible due to persistent efforts at harnessing the potential of land and water resources for agricultural purposes. Indian agriculture, which grew at the rate of about 1 per cent per annum during the fifty years before independence, has grown at the rate of about 3 per cent per annum in the post-independence era.

India's impressive growth during and after Green Revolution propelled overall growth rate during the 1970s and 1980s. Subsequently, the industry and services sectors played a key role in taking the Indian economy to almost a double-digit growth rate. However, agriculture could not maintain or take off in maintaining higher growth rate due to many reasons. The decreasing contribution of agriculture to GDP is a cause of concern because of its impact on the millions of livelihoods. Hence in order to analyze the growth, direction of changes in agriculture and to identify the factors affecting it, the present study, "Crop Shifts in Coastal region of Andhra Pradesh" is made with the following objectives

5.1 OBJECTIVES

1. to estimate the compound growth rates of area, production and productivity of different crops in coastal region.
2. to study the direction of cropping pattern changes and to find out the nature of substitution of crops, and
3. to analyze the factors influencing changes in the area under different crops

5.2 HYPOTHESIS

In order to attain the set objectives, the following hypotheses have been formulated.

1. There is a positive growth in the area, production and productivity of different crops in coastal region.
2. There is a shift from low value to high value crops.
3. Both price and non-price factors influence the changes in the area under different crops

5.3 METHODOLOGY

Data used for the study was collected from various published and unpublished sources. Time series secondary data on area, production and productivity of different crops, rainfall, prices, wage rates, fertilizer prices, land utilization particulars and other agricultural statistics were obtained from various "Statistical Abstracts" published by Directorate of Economics and Statistics, Government of Andhra Pradesh and National Agricultural Research Project (NARP) status reports published by the Acharya N.G. Ranga Agricultural University, Hyderabad, Andhra Pradesh. The data covered a period of 28 years (for estimation of growth rates of area, production and productivity and factors influencing cropping pattern changes) *i.e.* from 1981-82 to 2008-09. The year 2008-09 was the terminal period of the study since consolidated data were available up to this period only. For crop shifts the data for two periods viz., period I (1992-93 to 1998-99) and period II (1999-2000 to 2008-09) were used. Period I is post-liberalisation period, while Period II, post-WTO period.

5.4 GROWTH RATES OF AREA, PRODUCTION AND PRODUCTIVITY OF DIFFERENT CROPS

5.4.1 Vizianagaram District

In Vizianagaram district, jowar, bajra, ragi, small millets, bengalgram, recorded significant negative area growth. On the other hand, crops like maize, redgram, blackgram, greengram, sugarcane and sesamum were found associated with positive significant growth of area. Area under paddy declined at an annual rate of 0.20 per cent but it was non-significant. Among the foodgrains, bengalgram recorded the highest growth rate of productivity (3.80 per cent). All the three variables *viz.*, area, production and productivity exhibited positive and significant growth rate in the case of maize, redgram, whereas positively non-significant in the case of tobacco.

5.4.2 Prakasam District

The area growth rate was the highest for bengalgram followed by maize and sunflower. Productivity growth rate was the highest in bengalgram (3.10 per cent) followed by chillies (2.04 per cent). All the three variables *viz.*, area, production and productivity exhibited positively non-significant growth rates in tobacco and positively significant growth rates in the case of maize and bengalgram. Negatively non-significant growth in productivity was observed in blackgram, cotton, sesamum, whereas positively non-significant growth in productivity was seen in paddy, ragi, small millets, redgram, groundnut and sunflower.

5.5 DIRECTION OF CROPPING PATTERN CHANGES

5.5.1 Vizianagaram District

By comparing cropping pattern changes in the district between two periods, it was observed that, groundnut which retained a relatively higher proportion of its area in period I was highly unstable in period II. In the first period groundnut lost its share only to sesamum and other crops, but in the second period, it has lost its share to all the remaining crops *viz.*, paddy, greengram, horsegram, mesta, sesamum and other crops. In period I it has gained its area only from paddy and other crops to a very low extent and

had a major share from horsegram and a small share from mesta and other crops in period II.

Greengram was the next crop to groundnut in period I which exhibited retention levels of its own area, gained its share from paddy, mesta, other crops and had a transfer probability to a large extent to other crops. But in period II it had a zero degree of retention and lost its entire share to paddy, gained a very small share from groundnut, mesta and other crops.

In the case of mesta, the retention probability of its own area has increased to a little extent to 0.3288 in period II from 0.3154 in period I. It has lost its major share to paddy and a small share to greengram in the first period compared to second period which lost its share to paddy, greengram, horsegram and groundnut.

Paddy, one of the major crops in the district did not retain much of its area in the second period as observed in the period I in which major area had shifted from mesta and other crops to paddy, whereas in period II it was different. Paddy gained from groundnut to a small extent and from greengram to a very large extent. In the first period, share of paddy was gained by all the remaining crops under this study except other crops and a small area was shifted from paddy to sesamum.

Other crops ability to retain their own area was very less in period I but was moderate in period II, because in the first period, major area under other crops was shifted to paddy and to a small extent to greengram, horsegram, groundnut, mesta and sesamum, whereas in the second period, the share of paddy from other crops declined and also horsegram and sesamum had zero transfer probability from other crops.

Horsegram remained as the most unstable crop in both the periods. Its entire share to other crops in period I, whereas in period II, there was a zero transfer probability to other crops but groundnut has gained a large share and mesta gained to a small extent from horsegram. In period I, horsegram was profited from paddy and other crops and in period II it only from groundnut and mesta.

Sesamum in both the periods did not retain any of its area i.e. it had zero retention probability. In period I, total share of it was lost to other crops but in period II

sesamum lost greatest extent of its share to other crops and mesta gained a less probability from it. With regard to its gain, a very negligible area from paddy and other crops had shifted to sesamum.

After comparing the actual and estimated proportions of acreage under crops, it was observed that they were almost closer for all the crops implying that the model was reasonably efficient and the credibility of the cropping pattern changes identified were fairly accurate.

The share of paddy would be 29.06 in 2013-14 against 29.25 per cent in 2009-10. The share of greengram did not show fluctuations in future. The share of horsegram is likely to fluctuate between 3.96 and 4.35 per cent in future. The projected share of groundnut increased from 9.42 per cent in 2009-2010 to 9.83 per cent in 2013-14. The share of mesta would be 9.58 per cent in 2013-2014 which was 9.02 per cent in 2009-10. The share of sesamum is likely to go up to 4.71 per cent in 2013-2014 as against 4.68 per cent in 2009-2010. The projected share of other crops would reduce to 37.94 per cent in 2013-14 from 39.12 per cent in 2009-2010.

5.5.2 Prakasam District

After comparing cropping pattern changes in both the periods in the district it was observed that, in period I, bengalgram and cotton were the only unstable crops, but in period II, bengalgram retained its area to an extent of 0.6096. Jowar, cotton, redgram and tobacco remained as unstable crops in the second period.

Paddy has improved its retention probability to 0.5980 in period II from 0.1880 in period I. In both the periods paddy did not gain any share from jowar and tobacco, but lost its share to tobacco and other crops in both periods. The area transfer from cotton to paddy was reduced from 0.6425 period I to 0.6006 in period II and maintained almost similar shares. Paddy gained from almost the same crops in both periods. But the share of bengalgram was reduced from 1.00 in period I to 0.0276 in period II. In period II cotton was replaced by bengalgram in terms of share from paddy.

Jowar which was the most stable crop in the first period became highly unstable and lost its entire share to cotton in period II, while in period I only moderate area of

0.4346 probability was shifted to other crops. It has gained a negligible share from other crops in period I and from cotton in period II.

Cotton in both the periods was unstable. In period I it has benefited from paddy, tobacco and other crops which was different in period II i.e. cotton has gained from other crops, redgram and entire share from jowar.

To redgram in period I negligible area was shifted from other crops (0.0798), while in period II it received a high transfer of area from tobacco (0.8377), cotton (0.2203), other crops (0.0611). Bengalgram has retained much of its area in period II which was highly unstable in period I as it lost its entire share only to paddy.

Tobacco a highly stable crop in period I lost its share only to cotton and gained only from paddy to a small extent, but in period II a major share was lost to redgram and a minor share to other crops and has gained its share from paddy, redgram and bengalgram.

Area under other crops retained to a high degree of probability (0.8160) in period II when compared to period I (0.6951) in which it has received its share from paddy, jowar, cotton and from paddy, bengalgram and tobacco in period II. In the case of its transfer probabilities, negligible area was lost to paddy, cotton, redgram in both the periods. But its share to jowar in period I was replaced by tobacco in period II.

A comparison of actual and estimated proportions of area under crops indicated that these proportions were similar for all the crops implying that the model was reasonably efficient and the credibility of Markov process in explaining the cropping pattern changes were fairly accurate.

The projected share of paddy would range from 20.60 per cent in 2009-10 to 20.38 per cent in 2013-14. Similarly, the projected share of jowar ranged from 0.79 per cent to 0.84 per cent for the corresponding periods. The projected share of cotton would be 4.93 per cent in 2013-14 against 5.49 per cent in 2009-10.The projected area of redgram would be 11.40 per cent in 2013-14 as against 10.86 per cent in 2009-10. The share of bengalgram would be almost similar with a slight difference and it would be 13.82 per cent in 2009-10 and 13.57 per cent in 2013-14. The share of tobacco would

decline from 10.50 per cent in 2009-10 to 9.75 per cent in 2013-14. In respect of other crops the projected share for 2009-10 would be 37.94 per cent and would increase to 39.13 per cent in 2013-14.

5.6 FACTORS INFLUENCING CROPPING PATTERN CHANGES

5.6.1 Viziangaram district

The response of area under different crops in Vizianagarm district to their causal factors indicated that except the areas under horsegram and blackgram, the areas under remaining crops *viz.*, paddy, greengram, groundnut, mesta, sugarcane and sesamum were significantly influenced by their own lagged prices. Groundnut was found to be the important competing crop to blackgram, mesta and sesamum. Sugarcane was the competing crop to paddy and paddy was the competing crop to sugarcane, whereas blackgram, greengram and horsegram were found as the competing crops to greengram, horsegram and groundnut. The crops which were significantly influenced by lagged prices of their competing crops were greengram, blackgram and mesta. Rainfall which is an important determinant of area in the dry land areas influenced significantly the area under blackgram and groundnut only. Gross irrigated area considered for paddy and sugarcane crops only, exerted non-significant influence on their area. Labour wage rate exhibited negative and significant influence on horsegram, groundnut, sugarcane and sesamum areas. Similarly, composite fertilizer price indicated negative and significant influence on the cropped area of greengram and groundnut but had a positive and significant influence on horsegram only.

It was observed from Durbin-Watson statistic (‘d’) that no autocorrelation was detected between the selected variables that influence acreage under different crops.

The own price and cross price elasticities indicated that groundnut had a high own price elasticity of 1.1248 followed by greengram and sugarcane with 0.6782 and 0.4276 respectively. The response of mesta and sesamum to their own price was low. Paddy, horsegram and blackgram exhibited very low own price elasticities of 0.0986, 0.0437 and 0.0512 respectively. Groundnut was a very strong competing crop to blackgram and blackgram to greengram with cross price elasticities of -1.1943 and -1.1201 respectively. The degree of competition of groundnut with mesta was reasonably strong with a cross price elasticity of -0.5255. The competition of greengram with

horsegram and horsegram with groundnut was moderate with -0.2184 and -0.2987 cross price elasticities respectively. The degree of competition of sugarcane with paddy and paddy with sugarcane was low at -0.0986 and -0.0602 respectively.

5.6.2 Prakasam district

The area under paddy, redgram, bengalgram, chilly and tobacco were positively influenced by their own lagged prices. Lagged prices of competing crops were found influencing the area under jowar, cotton and tobacco negatively. Cotton was found to be the competing crop for paddy and chilly. Chilly was an important competing crop for redgram and cotton. The competing crops for jowar, bajra, bengalgram and tobacco were bajra, bengalgram, jowar and redgram respectively. There was a significant negative effect of rainfall on bajra and redgram areas. Increase in gross irrigated area had a significant positive influence on the area under paddy. Labour wage rate did not influence any crop significantly. Price of composite fertilizers had negative significant influence on the area under jowar only, for others, its influence was non-significant.

It was also observed that except in the case of chilly, autocorrelation was not detected in any of the crops. Presence of autocorrelation was corrected by using Cochrane-Orcutt method.

The response of the area to the changes in its own price and price of competing crops was studied by computing the own price and cross price elasticities. Jowar had a high own price elasticity of 1.6621 followed by bengalgram, paddy and chilly with their respective own price elasticities of 0.9666, 0.7460 and 0.6444. Redgram, tobacco and cotton responded moderately to their prices with the corresponding elasticities of 0.4597, 0.3552 and 0.2327 respectively. The response of bajra to its own price was very low at 0.0807.

Jowar had a high competition with bajra with cross price elasticity of -0.9120, while cotton, tobacco, chilly and redgram indicated moderate competition to chilly, redgram, cotton and chilly with the cross price elasticities of -0.5791, -0.4337, -0.3422 and -0.3011 respectively. The degree of competition of bajra with bengalgram, paddy with cotton and bengalgram with jowar was low with respective cross price elasticities of -0.2150, -0.1830 and -0.1082.

5.7 POLICY IMPLICATIONS

1. As area under cultivation cannot be increased beyond certain level, the growth in production should come from yield attributing factors like development of high yielding specific varieties and improvement in input use efficiency.

2. Identifying the high and low growth rate for crops and crop groups will be better utilized in the local specific and crop specific research schemes and growth oriented development programmes.

3. Reduction of area under coarse cereals and small millets through shifts to relatively more remunerative crops is a cause of concern when we look at the food security concerns. Research on development of improved varieties of coarse cereals and millets including hybrids is a possible answer.

4. In the case of sesamum where productivity is found to be decling, technological breakthrough is required to enhance productivity and provide effective price support to make it relatively more profitable.

5. A pre-condition for sustaining the process of crop diversification is the availability of adequate marketing infrastructure and enabling environment for emergence of market support services.

6. Training of farmers in maintenance of quality of products and producing in accordance with the demand pattern and creation of minimum post-harvest handling facilities like cleaning, sorting/grading, and packaging of the produce at the farm gate/village level will be quite important in sustaining and accelerating the process of crop diversification.

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