IMPACT OF CROP DIVERSIFICATION ON FARM INCOME IN EAST GODAVARI DISTRICT OF ANDHRA PRADESH

M.Sc. (Ag.) Thesis

by

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DEPARTMENT OF AGRICULTURAL ECONOMICS
COLLEGE OF AGRICULTURE
(FACULTY OF AGRICULTURE)
INDIRA GANDHI KRISHI VISHWAVIDYALAYA
RAIPUR (Chhattisgarh)
2018

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Thesis

Submitted to the

Indira Gandhi Krishi Vishwavidyalaya, Raipur

by

Karri V S D Pravallika

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

Master of Science

in

Agriculture

(Agricultural Economics)

UE.ID.No. 20161724843 ID No. 120116086

July, 2018

CERTIFICATE - I

This is to certify that the thesis entitled **"Impact of Crop Diversification on Farm Income in East Godavari District of Andhra Pradesh"** submitted in partial fulfilment of the requirements for the degree of **Master of Science in Agriculture** of the Indira Gandhi Krishi Vishwavidyalaya, Raipur, is a record of the bonafide research work carried out by **Karri V S D Pravallika** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma (certificate, award etc.) or has been published/published part has been fully acknowledged. All the assistance and help received during the course of the investigations have been duly acknowledged by her.

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Co- chairman
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CERTIFICATE - II

This is to certify that the thesis entitled "**Impact of Crop Diversification on Farm Income in East Godavari District of Andhra Pradesh**" submitted by **Karri V S D Pravallika** to the Indira Gandhi Krishi Vishwavidyalaya, Raipur, in partial fulfilment of the requirements for the degree of **Master of Science in Agriculture** in the Department of Agricultural Economics has been approved by the external examiner and Student's Advisory Committee after oral examination.

Signature of External

Date: 16/07/2018

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Director of Instructions _____

ACKNOWLEDGEMENT

An accomplishment of this thesis is the result of benevolence of Almighty, love of my parents and blessings of my teachers and motivation of my friends.

I am privileged to grab this opportunity to express my deep and heartfelt gratitude and veneration to my major advisor and chairman of the advisory committee ***Dr. V.K. Choudhary****, professor, Department of Agricultural Economics, IGKV, Raipur for his impeccable and highly informative advice and guidance and for his munificence showered on me and incessant encouragement during the course of study.*

I am heavily indebted to ***Dr. P.A. Lakshmi Prasanna****, Senior scientist, Agricultural Economics, Indian Institute of Rice Research, Hyderabad for her concern in enlightening me on various aspects of research methodology and for her constant appraisal on subject matter to bring out a refined dissertation to recon with set standards. Her scientific approach and generosity without any reservation have my privilege to work under her supervision, which she provided me throughout my M.Sc. degree and research investigation despite her busy schedule of work.*

I feel immense pleasure in expressing my heartiest thank and deep sense of gratitude to ***Dr. A.K. Koshta****, Professor and Head of the department, Agricultural Economics for his enduring interest, inspiring suggestions and sustained support during the entire investigation.*

I extend my thanks with utmost devotion to Dr. M.L. Lakhera, Professor, Department of Statistics and Mathematics, and Dr. Ravindra Verma, Senior Scientist, Department of Genetics and Plant breeding, the members of the advisory committee for their rational approach in conducting analysis and constructive interpretation of data and precious guidance given to me during the course of investigation.

I wish to express my grateful thanks to Dr. Muthuraman, Scientist and Head of the TTT section, ICAR-IIRR and all staff members of Department of TTT for providing necessary facilities and constant encouragement in successful conduction of this research work.

It is high time to surface out my adoration and most affectionate gratitude to my beloved parents K. Chandra Rao and K. Umadevi and most effable, amiable and caring brother K. Murty for their inspiration given from time to time in educating and moulding me to accomplish set goals and for their constant encouragement to bring out my best in all my endeavors.

I am highly thankful to my colleagues Maitri, Hehlangki, Soham, Shobana for their constant cooperation and timely help. I am grateful to my seniors Bhavana, Lahari for their help, guidance and suggestions. I feel myself lucky to be associated with my juniors who are always helpful in my work.

To my friends, Varsha, Prashanthi, Vijaya durga, Vedasri, Swathi, Surya, Vinay, Madhu kiran, Vyshali, Pranavi, Prasanna, Yamini, Bhaskar thank you for listening, offering me advice, supporting me through this entire process, for your thoughts, phone calls, e-mails, texts, visits, editing advice and being there whenever I needed you all.

I acknowledge and appreciate my colleagues, Kavya, Priyanka, Vijay, Jyoti, Sushmita, Mamata, Mahesh, Sashank, for their support and extended to boost up my morale in carrying out this thesis research work.

I am grateful to Indian Council of Agricultural Research for providing financial help in the form of stipend during my course of study.

And lastly I would like to convey my cordial thanks to all those who helped me directly or indirectly to fulfill my dreams.

College of Agriculture, Raipur (C.G.)

Date: 2/7/18

(Karri V S D Pravallika)

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LIST OF ABBREVIATIONS

HI	Herfindahl Index
HVC	High Value Crops
GVA	Gross Value Added
GSA	Gross sown Area
NSA	Net Sown Area
GIA	Gross Irrigated Area
NIA	Net Irrigated Area
MD	Mandal Dummy
ZD	Zone Dummy
LPM	Linear Probability Model
CDZ	Central Delta Zone
EDZ	Eastern Delta Zone
UAZ	Upland Area Zone
AAZ	Agency Area Zone
MSP	Minimum Support Price
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
GoAP	Government of Andhra Pradesh
DAC&FW	Department of Agriculture, Cooperation and Farmers welfare
MDP	Mandal Domestic Product
DES	Directorate of Economics and Statistics
GoI	Government of India
SID	Simpson Index of Diversification
OI	Ogive Index
EI	Entropy Index
MEI	Modified Entropy Index
NSSO	National Sample Survey Organisation
CSO	Central Statistics Office
CDI	Crop Diversification Index
HYV	High yielding varieties

THESIS ABSTRACT

a)	Title of the Thesis	:	Impact of Crop Diversification on Farm Income in East Godavari District of Andhra Pradesh
b)	Full Name of the Student	:	Karri V S D Pravallika
c)	Major Subject	:	Agricultural Economics
d)	Name & Address of the Major Advisor	:	Dr. V. K. Choudhary Professor Department of Agricultural Economics College of Agriculture, I. G. A. U. Raipur (C.G.) 492012.
e)	Degree to be awarded	:	M.Sc. Agriculture (Agricultural Economics)

Signature of the student

Signature of the Major Advisor

Date: 2/7/18

Signature of Head of the Department

ABSTRACT

Crop diversification means shift in cultivation from traditional, less-remunerative crops to higher-value crops leads to higher incomes for the producer. An attempt has been made in the study to examine the impact of crop diversification on farm income in East Godavari district of Andhra Pradesh. The study was undertaken (i) to examine the trend and pattern of crop diversification, (ii) to identify the determinants of crop diversification, (iii) to evaluate the impact of crop diversification on farm income and (iv) to identify the problems and prospects of crop diversification in the study area.

The present study was conducted in the East Godavari district of Andhra Pradesh. Four mandals namely, Samalkota, Jaggampeta, Rajavommangi, Amalapuram were selected from East Godavari district of Andhra Pradesh. Total

160 farmers were selected for the present study and were categorized into marginal, small, semi medium and medium categories based on their farm size of holdings. The study was based on both primary and secondary data. The primary data were collected for the year 2015-16 from the sampled farmers with the help of well prepared schedules whereas secondary data was collected from Directorate of Economics and Statistics, Chief Planning Office and other sources. The major findings of this study revealed that most of the farmers (30% of sampled farmers) belonged to the age of between 36-45 years. Out of 160 farmers, 45% of sampled farmers were pure tenants. The average farm size of holding among sampled farmers was 1.77 ha. For analyzing overall diversification level of sampled farmers, Herfindahl Index (HI) values were calculated for each farmer and also different farm groups. HI value of sampled farmers was lower in case of owned farmers compared to pure tenant farmers across all farm size categories, which means owned farmers were more diversified than tenant farmers. Average gross income ranged from Rs. 68042 to Rs. 109808 across farm size and across tenancy categories. Over the years, except in Jaggampeta crop diversification decreased in district as well as in the selected mandals i.e., moving towards crop specialization. Total six regression analysis were carried out to know the determinants of crop diversification and to evaluate the impact of crop diversification on farm income using primary and secondary data separately. Irrigation and farm size were most significant determinants for crop diversification. Farm size showed positive influence on crop diversification whereas irrigation showed negative influence on crop diversification. Increase in farm size and decrease in irrigated area leads to more crop diversification. Diversification showed positive influence on farm income, i.e., diversified farmers yields more income. But due to the constraints, farmers were not able to diversify crops.

The major constraints reported by the farmers for not moving towards crop diversification were land suitability, no awareness about benefits of crop diversification, small size of farm and unavailability of labour etc,. Soil suitability and tenancy were restricting diversification.

शोधग्रंथ सारांश

अ	शोधग्रंथ का शीर्षक	:	आन्ध्रप्रदेश के पूर्व गोदावरी जिले में कृषि आय पर फसल विविधीकरण पर असर
ब	छात्रा का नाम	:	कररी वी.एस.डी. प्रवल्लिका
स	प्रमुख विषय	:	कृषि अर्थशास्त्र
द	प्रमुख सलाहकार का नाम	:	डॉ. वी.के. चौधरी वैज्ञानिक, (कृषि अर्थशास्त्र) इंदिरा गाँधी कृषि विश्वविद्यालय, रायपुर (छ.ग.)
ई	प्रदान की जाने वाली उपाधि	:	एम.एस.सी. (कृषि) कृषि अर्थशास्त्र

प्रमुख सलाहकार के हस्ताक्षर

छात्रा के हस्ताक्षर

दिनांक : 2/7/18

विभागाध्यक्ष के हस्ताक्षर

सारांश

फसल विविधीकरण से ताप्पर्य परम्पागत् खेती से कम लाभकारी फसलों से खेती में बदलाव, उच्च मूल्य वाली फसलों से उत्पादक के लिए उच्च आय होना है। आन्ध्र प्रदेश के पूर्वी गोदावरी जिले में कृषि आय पर फसल विविधीकरण के प्रभाव की जांच के लिए अध्ययन में एक प्रयास किया गया है। उद्देश्य –

(1) फसल विविधीकरण की प्रवृत्ति और तरीका की जांच करने के लिए किया गया था।

(2) फसल विविधीकरण के निर्धारकों की पहचान करने के लिए।

(3) कृषि आय पर फसल विविधीकरण के प्रभाव का मूल्यांकन करने के लिए और

(4) समस्याओं की पहचान करने के लिए और अध्यन क्षेत्र में फसल विविधीकरण की संभावनाएं।

वर्तमान अध्ययन आन्ध्र प्रदेश के पूर्वी गोदवारी जिले में आयोजित किया गया था। आन्ध्र प्रदेश के पूर्वी गोदावरी जिले से चार मण्डल अर्थात् सामलकोटा, जगगम्पेता, राजवोमांगी, अमलापुरम् का चयन किया गया था। वर्तमान अध्ययन के लिए कुल 160 किसानों का चयन किया गया था और उन्हें अपने खेतों के आकार के आधार पर मामूली, छोटी, अर्द्ध मध्यम और मध्यम श्रेणियों में वर्गीकृत किया गया था। अध्ययन प्राथमिक और द्वितीयक आंकड़ों दोनों पर आधारित था।

प्राथमिक आंकड़ों एकत्रित किसानों से वर्ष 2015–16 के लिए अच्छी तरह से तैयार कार्यक्रमों की सहायता से एकत्र किये गये थे, जबकि द्वितीयक आंकड़ा अर्थशास्त्र और सांख्यिकी निदेशालय, मुख्य योजना कार्यालय और अन्य स्रोतों से एकत्रित किया गया था। इस अध्ययन के प्रमुख निष्कर्षों से पता चला कि, अधिकांश किसान (नमूने वाले किसानों का 30.) 36–45 साल के बीच के थे। 160 किसानों में से, नमूने वाले किसानों का 45. शुद्ध किरायेदार थे। नमूने वाले किसानों के बीच होने का औसत कृषि आकार 1.77 हेक्टेयर था। नमूने वाले किसानों के समग्र विविधीकरण स्तर का विश्लेषण करने के लिये, हरफिंडहल इंडेक्स (ॅ) मूल्यों की गण्ना प्रत्येक किसान और विभिन्न कृषि समूहों के लिए की जाती है। सभी कृषि आकार श्रेणियों में शुद्ध किरायेदार किसानों की तुलना में स्वामित्व वाले किसानों के मामलों में नमूने वाले किसान का ॅ मूल्य कम था, जिसका मतलब है कि स्वामित्व वाले किसान किरायेदार किसानों की तुलना में अधिक विविध थे। औसत सकल आय रूपये 68042 से लेकर रूपये 109808 है जो कि खेत के आकार और किरायेदारी श्रेणियों में पायी गई है। वर्षों से जगगम्पेता फसल विविधीकरण को छोड़कर जिले में और चयनित मंडलों में भी कमी आई, जैसे–फसल विशेषज्ञता की ओर बढ़ रहा है।

फसल विविधीकरण के निर्धारकों को जानने के लिये कुल प्राथमिक रिग्रेशन विश्लेषण किया गया था और प्राथमिक और माध्यमिक डेटा का अलग–अलग उपयोग करके कृषि आय पर फसल विविधीकरण के प्रभाव का मूल्यांकन किया गया था। फसल विविधीकरण के लिए सिंचाई और खेत का आकार सबसे महत्वपूर्ण

निर्धारक थे। कृषि के आकार ने फसल विविधीकरण पर सकारात्मक प्रभाव दिखाया, जबकि सिंचाई ने फसल विविधीकरण पर नकारात्मक प्रभाव दिखाया। खेत के आकार में वृद्धि और सिंचित क्षेत्र में कमी से अधिक फसल विविधीकरण होता है। विविधीकरण ने कृषि आय पर सकारात्मक प्रभाव दिखाया, यानी विविधता वाले किसान अधिक आय अर्जित करते हैं, लेकिन बाधाओं के कारण, किसान फसलों को विविधता देने में सक्षम नहीं थे।

फसल विविधीकरण की ओर बढ़ने के लिय किसानों द्वारा रिपोर्ट की गई प्रमुख बाधांए भूमि उपयुक्तता, फसल विविधीकरण के लाभ, खेत के छोटे आकार और श्रम की अनुपलब्धता आदि के बारे में कोई जागरूकता नहीं थी। मृदा उपयुक्तता और किरायेदारी विविधीकरण प्रतिबंधित कर रहे थे।

CHAPTER I
INTRODUCTION

1.1 Background

Poverty alleviation has been a pre-eminent goal of India's development efforts since its independence. In recent years, the emphasis on having a more desirable composition of GDP growth by targeting an average 4 percent per annum growth in agriculture GDP has found favour with the policy makers in the country's 12th five year plan i.e.2012-17 (Anjani kumar *et al.,* 2012). According to the Tendulkar report, poverty ratio in India was 21.9% for the year 2010-11. Indian population according to the 2011 census was 121 crores.

According to the World Bank collection of development indicators, poverty headcount ratio in rural India was 25.7 % in 2011. Rural poverty is largely a result of low productivity and unemployment. The farmers are poor because of small land holdings (Mahendra Dev, 2012; Joshi *et al.,* 2007). The average farm size in India was only 1.15 hectare in 2011. Around 85 percent of farmers have land holdings smaller than 2 ha and they have cultivated nearly 45 percent of the arable land (Ag census, 2010-11). Chand *et al.* (2011) observed that while these small holdings were superior in terms of production performance, but they are weak in earning adequate income. For reducing rural poverty agricultural development is being considered as important, as agriculture plays a vital role in India's economy.

Nearly 52% of agricultural households in India were indebted and levels of debt was as high as 93% in Andhra Pradesh, shows key indicators from an National Sample Survey Organization (NSSO) report for the year 2012-13. According to Central Statistics Office (CSO) data, agriculture along with fisheries and forestry, contributed 17.32% of total Gross Domestic Product (GDP) for the year 2016-17 at current prices. The share of agriculture and allied sectors (including agriculture, livestock, forestry and fishery) was 15.11 per cent of the Gross Value Added (GVA) during 2016-17 at 2011-12 prices.

At micro level, agrarian distress has been responsible for more than a quarter million farmers ending their lives between 1997 and 2012 (Nagaraj et al.,

2014). The key reason for the crisis, however, lies in a fundamental characteristic of agriculture. It is an economic activity that requires a significant part of the expenditures to be incurred upfront, without certainty of outcome.

Agricultural and crop diversification is regarded as an important strategy to mitigate risk and enhance income of farmers. Several studies indicate that agricultural development (De Janvry and Sadoulet, 2010, Ravallion and Datt, 1996) and diversification in general and crop diversification in particular (Birthal *et al.,* 2015; Michler *et al.,* 2017) can play role in poverty reduction. This is one way to address the problems of poverty and agrarian crisis. The concept of agricultural diversification implies reallocation of resources in a large mix of diverse and complementary activities within agriculture. The process of crop diversification involves a shift of the resources particularly cultivated area from cereals and low value crops to high value crops like fruits and vegetables. Literature shows that households which grow a diverse set of crops are less likely to be poor than households that specialize in their crop production. (Michler *et al.,* 2017; Lathar *et al.,* 1996). Diversification towards High Value Crops (HVC) including fruits and vegetables, compatible with the comparative advantage of the region, is suggested as a viable solution to stabilise and raise farm income (Joshi *et al.,* 2003; Brij Bala and Sharma, 2005), increase employment opportunities for small and marginal farmers, boost exports and conserve and enhance natural resource base. Households diversifying towards HVCs are less likely to be poor, the biggest impact being for smallholders (Birthal *et al.,* 2015; Parthasarathy Rao *et al.,* 2006).

Increasing urbanization, increasing per-capita income, changing food habits, price sensitive consumers are some factors that are being viewed as favourable for increased demand for output of high value crops like fruits and vegetables. Hence, several initiatives to promote crop diversification are being implemented under National Horticultural Mission. Market infrastructure development and certain other price related supports also being provided to induce crop shift often low value to high value crops like fruits, spices etc.,.

In this backdrop the study aims at examining the impact of crop diversification on farm income in different agro climatic zones of East Godavari district of Andhra Pradesh.

Agriculture plays a crucial role in the economy of Andhra Pradesh. Large segment of the population is dependent on the agriculture sector for employment and income. About 60% population of A.P. lives in rural areas and depends for this livelihood on agriculture and the rural non-farm sector. Expansion of farm incomes continues to be an effective strategy for reducing poverty. According to Tendulkar report, poverty ratio in Andhra Pradesh was 32.3% in rural and 23.4% in urban areas in 2010-11. The Andhra Pradesh Economic Restructuring Programme (APERP) has estimated the 51.33 percentage of households in East Godavari district was below poverty line for the year 2010-11.

East Godavari offers an important case study not only because of its importance in contribution to rice production in the state but also because of observed crop holiday in the district in 2011-12, and planned crop-holiday in Kharif 2016. During 2011, the paddy farmers of East Godavari, West Godavari and parts of Khammam districts in Andhra Pradesh state declared Crop Holiday i.e. they did not go for paddy cultivation and the fields were left fallow. Crop Holiday was observed in 13 mandals of East Godavari district, out of which, in four mandals namely, I.Polavaram, Katrenikona, Upalaguptam and Allavaram, it was almost total crop holiday. In the 13 mandals actual rice cultivated area was 43087 ha. Due to the crop holiday the actual sown area in these 13 mandals was 7515 hectares. As a result of crop holiday 85,050 acres was not cultivated by the paddy farmers during the 2011 Kharif season (Deepthi, 2013).

The farmers who went on crop holiday reported the problems as Minimum Support Price (MSP) not covering actual cost of production, high cost of cultivation on account of high cost of labour, labour shortage due to Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), late release of canal water, increasing tenancy and tenancy costs, dependency on traders and dealers for credit, increasing ecological problems, natural calamities thus decreasing margin leading to reduction in incomes (Deepthi, 2013). In this backdrop the present study

attempts to identify reasons for farmers opting for crop holiday rather than going for crop diversification in specific mandals?

The specific objectives of the study are

1. To examine the trend and pattern of crop diversification in East Godavari district.
2. To identify determinants of crop diversification in East Godavari district.
3. To evaluate the impact of crop diversification on farm income in East Godavari district and
4. To identify the problems and prospects in crop diversification.

1.2 Significance of the study

The results of the study can be utilized to identify the enabling factors to achieve the desired and positive effects of crop diversification. The results of the study can also be utilized by the policy makers for suggesting the suitable policy measures which helps to diversify area under different crops depending on the prevailing domestic demand in the country. The study may also yield some insights which helps the government to arrive at suitable steps to promote diversification the cropping pattern, which will enhance employment generation, income growth, poverty alleviation, etc., so as to achieve the developmental goals.

1.3 Limitations of the study

The study is confined to East Godavari district only, given the limitations of resources and time. This study is based on both secondary data and primary data collected from a sample of farmers. Most of the farmers of the study area have not maintained any farm records and often forced to get data from their memory and experience over years. Hence the study also encounters usual recall bias. The illiteracy of farmers also added in this problem.

The study is confined to four mandals of East Godavari district. The findings of the study may be relevant only to those areas with similar socio economic background,

agro climatic conditions and crop diversification. Therefore, the generalization of the research findings should be made with utmost care.

1.4 Structure of the thesis

The study is presented in five chapters as follows:

I. Introduction: In this chapter the background of the research topic, objectives, significance, limitations of the study are presented.

II. Review of Literature: In the second chapter review of the available relevant literature related to the present study are presented.

III. Methodology: In the third chapter method of data collection and tools employed to analyse the data, description of study area, general characteristics, agro climatic conditions, demographics and socio economic characters of the selected mandals along with the district are presented, compared, contrasted and discussed.

IV. Results and discussions: In the fourth chapter the study results are presented and discussed under sections, trend and pattern of crop diversification, determinants and impact of crop diversification on farm income, problems and prospects of crop diversification.

V. Summary and conclusions: In the final chapter, the study is summarised, along with the major findings of the study. In subsequent sections of the chapter, conclusions drawn from the study are presented followed by policy implications.

CHAPTER II
REVIEW OF LITERATURE

A review of past research helps in identifying the conceptual and methodological issues relevant to a study. It also helps in identifying research gaps. It provides the researchers a proper direction to carry out their research work by enabling them to formulate hypotheses, test them and arrive at meaningful conclusions. Keeping these facts in view and also the objectives of the present study, in this chapter a brief presentation of review of the relevant research literature is attempted. Available literature related to crop diversification was reviewed and is presented in this section under the following headings.

2.1 Trends and patterns of crop diversification

2.2 Determinants of crop diversification

2.3 Impact of crop diversification

2.1 Trends and patterns of crop diversification

Shiyani & Pandya (1998) have examined the levels of crop diversification in different agro-climatic zones of Gujarat for the period of 1960-61 to 1995-96. They have used five measures of crop diversification in the empirical analysis. They observed wide spatio-temporal variations in the acreage allocation under different crops.

Parthasarathy Rao *et al.* (2008) tested the hypothesis that the agricultural sector in Andhra Pradesh is gradually diversifying towards HVCs. They observed that as expected, the HVCs occupy a major share of agricultural output in the high-diversification zones that are close to the HVCs demand centres characterized by high population density and a higher share of urban population in the total population.

Shyamal Dutta (2012) examined the spatio-temporal variation of agricultural diversification in eighteen (18) blocks of Hugli District using Crop Diversification

Index (CDI). It was reported that within the whole district, crop diversification was very high (CDI>0.60) only in four blocks. In rest of the blocks, crop diversification index ranged below 0.50, whereas in 3 blocks, CDI was very low i.e. below 0.30. The author observed that in blocks like Pandua, Polba-Dadpur low level of diversification in comparison to rest of the blocks mainly due to rice monoculture and jute monoculture.

Kalaiselvi (2012) examined the pattern of crop diversification in India. The state-wise pattern of diversity on the basis of 30 crops revealed that most of the states in the northern region were less diversified, whereas almost all the eastern and southern states were highly diversfied as they produced relatively more number of crops. On the whole, the regions that showed stagnancy in their index of concentration or spread include Jammu and Kashmir, Kerala and Rajasthan. States from the northern and eastern regions are the ones showed increasing trend towards higher concentration including Punjab, Haryana and Uttar Pradesh, whereas most of the southern states fall under the category of increasing trend towards spread of cropping pattern. The results showed that there is a mixed picture regarding the typology of diversification within the states. Some states exhibited more diversification; in there is no direct link between the number of crops and spread in the cropping pattern. The picture for states was completely diverse.

Kumar and Singh (2013) studied the growth and trends in area, production and productivity under food grains in Himachal Pradesh in general and district Una in particular in the light of economic development in the state. The study was basically a review study and relied entirely upon the secondary sources. The study period covered from 1997-98 to 2007-08. On the basis of secondary data they used the Herfindhal index to know the nature and extent of agricultural diversification in the study area.

Their results showed that only some reallocation of land, has taken place mainly from pulses to cereals. The remaining crop categories maintained their relative position in the total area. Thus the cereals crops wheat, maize and rice still

dominated the cropping pattern even though of introduction of the technique of agricultural diversification. There was also some evidence of a small rise in the share of vegetables and oilseeds in area. Their results showed that there exists complete diversification of agriculture in Himachal Pradesh as well as in Una district. The value of the Herfindhal index of diversification remained equal to zero.

Ravendra Singh (2015) analyzed the spatial and temporal changing pattern and level of crop diversification in Indian agriculture between 2002-03 and 2012-13. For measuring the level of crop diversification, Bhatia's method, Herfiindahl method, Gibb's and Martin's methods have been used.

Results of the study have revealed that the level of crop diversification in Indian agriculture has increased during the study period. Karnataka has topped among the most crop diversified states in India which is followed by Jammu and Kashmir, Uttarakhand, Rajasthan, Gujarat, Maharashtra, Uttar Pradesh, Andhra Pradesh, Madhya Pradesh and Tamil Nadu. Chhattisgarh, Tripura and Odisha have been found among the less crop diversified states. It has also been noticed that the level of crop diversification in larger states of India have shown a decreasing trend whereas in smaller states it has increased during the study period. He stated that there is still requirement of farmer's interest along with government and institutional support to increase the level of crop diversification in Indian agriculture.

Suseela and Chandrasekaran (2016) examined the state and regional level pattern of crop diversification in Andhra Pradesh during the post liberalization period from 1990-91 to 2014-15 using Herfindahl Index of crop diversification. Their study revealed that food grains dominated in the Coastal Andhra region where, paddy is a major crop and oil seeds dominated in the Rayalaseema region where, groundnut is a major crop.

The cropping pattern is transforming from food grains to high value crops like fruits and vegetables (10% per annum) and oil seeds to commercial crops like fiber crops. The growth rate of total food crops is declining. Total food

and non-food crops showed negative and declining trend. The crop diversification index results revealed that both the regions and state showed very low level of crop diversification.

Meena *et al.* (2016) have measured crop diversification for a uniform data set of 35 year for two districts of Rajasthan state of India namely Kota and Jaisalmer. They focused on status and changing pattern of crop diversification in the districts with a comparative outlook of both Herfindahl index, Simpson index and Index of maximum proportion were used to measure the crop diversification in the districts for comparative study. Five time periods of 1980-86, 1987-93, 1994-01, 2002-07 and 2008-14 were taken measuring crop diversification in the selected districts and separate analysis was done for all period.

This study found complete diversification in the Kota district in all period through all indices and likewise in Jaisalmer district crop specialization was found in first and second period through all indices. Moderate diversification was found in third and fourth period through all indices and finally complete diversification was found in firth period through all three indices in Jaisalmer district.

Mithiya *et al.* (2018) investigated the pattern, trend of crop diversification in different districts of West Bengal, based on secondary data. The study focused on 17 major districts of West Bengal during 1990-91 to 2013-14. Simpson index was used to estimate diversification. They reported that all the districts of West Bengal and the state as a whole have exhibited a higher crop diversification during new millennium than the nineties. On the basis of the magnitude of Simpson index, they categorized the districts in four groups‟ namely low, moderate, high and excellent. The study revealed that the crop sector in the West Bengal, in general, has been diversifying towards high-value crops from the traditional ones. However, there are considerable variations in terms of intensity of the diversification across the districts. Few districts showed no tendency towards crop diversification. The rest of the state, however, moved strongly towards the cultivation of high value crops.

2.2 Determinants of Crop Diversification

Saleth (1997) conducted a study to identify the economic and non-economic factors behind group- specific variations in crop and livestock diversifications in Tiruchirapalli district of Tamil Nadu. Vegetable and horticultural crops were confined mostly to larger farms. The study also revealed that commercial crops (especially banana and sugarcane) were grown mostly in canal and tank areas whereas coarse cereals, oilseeds, cotton and pulses dominated the water scarce regions. Small farms showed their tendency of cereals-based specialization while medium farms displayed a crop pattern which was both diversified and balanced.

Joshi *et al.* (2003) attempted to identify determinants of agricultural diversification. They have used Simpson Index to assess the extent of diversity in crop, livestock and fisheries activities. They have used Generalized Least Square (GLS) technique with fixed-effect model to examine how different forces have influenced crop and livestock diversification in India Their analysis was based on pooling of cross section and time series information from major states (19 out of 28) in India for the period 1980-81 to 1998-99.

Their study revealed that markets, roads and relative profitability of horticultural commodities had positive and significant influence on diversification of crop sector. The irrigated area and farm size showed a negative and significant relationship with diversification. The results indicated that rainfall is the other variable which was highly significant with negative sign indicating that crop diversification is limited in higher rainfall areas. They have suggested that assured markets and good road network could stimulate agricultural diversification in favour of high value crops as they help maximize profits and minimize uncertainty in the output prices. Their study also highlighted the implications of diversification on food security, employment generation and export earnings.

Birthal *et al.* (2006) examined the driving forces that enable the producers to harness the potential of high-value agriculture in northern eastern regions of Indian. Data was collected for the period 1982-83 to 2002-03 from National Accounts Statistics of the Central Statistical Organization (CSO). Logit regression was used

for the analysis of data. It was found that high-value agriculture was labour intensive and tends to be concentrated among the households having sufficient supply of family labour. The tendency to grow high value crops was found to be stronger among the households primarily engaged in agriculture. Irrigation appeared to be a significant determinant of diversification. The study also revealed that road density showed positive and significant relation with diversification. The effect of farm size on diversification was found to be insignificant implying that high value agriculture was not confined to any specific farm group and was practiced by all categories of farmers.

Singh *et al.* (2006) studied the various infrastructural and technological factors affecting diversification of agriculture across different states of India. Simpson Diversification Index was considered as dependent variable in double log regression equation estimated by Ordinary Least Squares (OLS) to capture the effect of different factors. The SID ranged from 0.47(WB) to 0.90 (Karnataka), in 1990-91, and from 0.40 (Orissa) to 0.92 (Karnataka) in 2000-01.The results indicated that the presence of electricity and road density were negatively associated with the diversification.

Majumdar (2014) studied crop diversification in India for the pre and post reform periods. The study was based on secondary data which was collected from CMIE for various years. The whole study period (1980-81 to 2000-2001) was divided into two sub-periods viz. pre reform period (1980-81 to 1989-90) and post reform period (1990-91 to 2000-2001). Both food and non-food crops have been considered in his study. Herfindahl-Hirschman Index (HHI) was used to measure the extent of diversification in the study.

He interpreted that with the advent of modern seed-fertilizer-water technology specially since the Green Revolution, there was a continuous surge for crop diversification in India primarily on the economic consideration. He observed a clear diversification towards high value commodities during the last two decades. He stated that besides modern seed-fertilizer technology, resource related factors like rainfall, soil fertility; price related factors like input and output prices, institutional factors like tenancy reforms, government regulatory policies etc. are

the important causes of crop diversification in India. Change in food habit, lifestyle are also to a great extent responsible for the crop diversification in the country during the post reform era.

Anjani Kumar *et al.* (2012) focussed on identifying the determinants of crop diversification towards high-value crops, by using primary data collected in four eastern states, Bihar, Jharkhand, Odisha and West Bengal. They have adopted three-stage sampling procedure for the selection of districts, blocks and villages. They have used Herfindahl-Hirschman index, to measure the extent of diversification. Tobit model was employed to ascertain the determinants of diversification towards vegetable cultivation among households in the study area.

Their results showed that age and gender did not have a significant influence on farmer's decision to diversify in favour of vegetables, though the coefficients were negative for both these variables. Education and area under irrigation yielded a positive and significant influence on crop diversification in favour of vegetable cultivation. Household-size and value of productive assets were also a significant determinant of agricultural diversification in terms of high-value crops. The households' primary occupation was an important determinant of its crop choices and allocation of land to different crops. Further, caste of a household also influenced farmers' decision to allocate higher proportion of their land for cultivation of vegetables. The land size had a negative influence on farmers' decision to allocate their land for cultivation of high-value crops. They felt that infrastructure played an important role in the process of diversification towards high-value commodities, and suggested the need for increased public investment in the development of markets and roads to help accelerate the pace of diversification.

Kimty Seng (2015) has employed Heckman sample selection approach with the data on Cambodia Socio-Economic Survey *CSES-2007* to explore price and non-price factors determining farmers' crop diversification decision, and consequently affecting diversification intensity. Irrigation, agricultural equipment ownership and farming expenditure have significantly positive effects on the decision, and sequentially increasing the intensity. Arable land size per household member,

agricultural and transportation equipments have positive correlation with the diversification decision. Small scale of farming is a major hindrance to the decision, and consequently reducing the intensity. Land dispute, one of the main institutional matters in Cambodia, is found to have significantly negative marginal effect on farmers' decision on crop diversification.

Kumar and Gupta (2015) examined state-level trends and patterns in crop diversification in India for the period 1990-91 to 2011-12. Their study was based on the secondary data sources. For analytical convenience, they divided the period into two sub periods, viz., 1990-91 to 1999-2000 (first sub-period) and 2000-01 to 2011-12 (second sub-period).Their study has covered seventeen major Indian states which contributes more than 90 per cent gross cropped area to the agriculture sector. They have used Simpson Index of crop Diversification (SID) and panel regression analysis to assess the extent of crop diversification. To discern the determinants of crop diversification at the state level, Fixed Effect Model (FEM) and Random Effect Model (REM) were used. The regression equation specification was used to find association between SID (dependent variable) and cropping intensity, gross irrigated area and annual rainfall (independent variables).

Their study had revealed that cropping pattern at state level is transforming from food grains to high-value crops but the transformation is not uniform across the states/regions. They confirmed by the values of SID that the agricultural economy has diversified in all the states with some fluctuations in case of food crops and non-food crops. The results of Fixed Effect Model have revealed cropping intensity, average annual rainfall and gross irrigated area to be the major determinants of crop diversification. The study has suggested that policy support in terms of enhanced cropping intensity, gross irrigated area, insurance coverage, investment in agricultural research and education, and technology development need to be extended to the farmers

Monika Aheibam *et al.* (2017) aimed to identify those factors which influence household decision to crop diversification and further attempts to identify what factors influence the degree to which this diversification takes place. They have

adopted Heckman's Two Stage Model to estimate separately the determinants of household diversification decision and intensity of diversification by the households. They have conducted the study at Ukhrul district which is entirely rural economy and agriculture is the most important source of livelihood for the people of the district. Samples of 80 households were selected proportionate to the population size of the respective villages by using multistage random technique. Out of several diversity measures, they have used SID for computing diversity index values of the households.

The results of their study found that education of the household head is found to have positive association with the level of crop diversification. The farming experience of the farmer is found to have positive influence only while taking decision to diversify crops. Access to plough has positively affected both the household's decision to diversify crop as well as level of crop diversification. Access to fertilizer and availability of irrigation has effect on propensity to diversify crops. Exposure to farming information by the households significantly affected level of diversification. Farmers who attend farming training regularly were more likely to diversified. The distance to the nearest market from homestead also positively affected crop diversification level.

Raj Kumar and Apurba Kumar (2018) identified the factors affecting crop diversification along with spatio-temporal variations in the Damodar Valley Corporation command (DVC) area in West Bengal.They have used both secondary and primary data for linear regression analysis separately to identify factors affecting crop diversification in command area. They have calculated Transformed Herfindahl Index which is same as simpson index and used it as dependent variable in analysis. In case of analysis using secondary data (1995-2011), reciprocal of number of rural markets and share of population engaged in agriculture in each block were considered as important factors explaining crop diversification. Whereas in case of primary data (2012-13), proportion of family income from agriculture, distance of cultivated land from home, reciprocal of number of adult family member participated in agriculture were considered as variables. To look into the spatial effect they have introduced two dummy variables, head reach area (DHR) and tail-end area (DTE) within the DVC area.

Out of these, number of rural markets, share of population engaged in agriculture, proportion of family income from agriculture and number of family members participating in agriculture positively influenced crop diversification. In case of secondary data, regarding spatial effect, it has been found that location of the concerned block in the head-reach area (with assured canal water for irrigation) negatively influenced crop diversification, while location had a positive influence in the tail-end area (with insufficient and uncertain supply of canal water). In case of primary data, location of plot in the head-reach area had a negative influence on crop diversification while the location of plot in the tail-end had a positive influence on crop diversification.

The study also found that farmers belonging to the head reach use more than three-fourths of their land for cultivation of paddy during monsoon and summer alone. On the other hand, in the tail-end area almost 90% of farmers cultivate paddy only once i.e., during monsoon. They have suggested that if it is possible to reduce the wide gaps in water availability between the head-reach and tail-end areas by proper management, then it may be possible to stimulate crop diversification and improve water use efficiency in the DVC command area.

2.3 Impact of Crop Diversification

Lathar *et al.* (1996) examined the prospects of enhancing the income of the marginal and small farmers through diversification of farming in Sonepet district of Haryana for the year 1993-94. The results revealed that the farmers of both the categories were found to be quite close to the optimal plan which was derived by considering the commonly prevalent crop production activities at the existing level of technology. However with the adoption of advanced production technology being followed by the top 10 per cent of the progressive farmers for various crops and high value farm products, the return over variable cost increased by 356 and 184 per cent over the base period for marginal and small farms respectively. Similarly, it was also found that the magnitude of gainful employment has also increased by 30 and 71 per cent over the base period in the case of marginal and small farms respectively. The study suggested that for achieving the gains of diversification of farming, there is an urgent need for further strengthening the

required infrastructure pertaining to input supply system, marketing system and the existing research and extension programmes to increase the adoption of advanced production technologies.

Gopalappa (1996) conducted a study on crop diversification and income levels in Karimnagar district of Andhra Pradesh. The study was based on primary data collected from Gopalpur and pertained to the agricultural years 1984-85 and 1991-92 to 1993-94. Purposive sampling was followed for the study. Data was collected from 66 marginal sericulturists and 42 small sericulturists. The information on the socio-economic profile of farm, process of diversification in cropping system, number of households engaged in sericulture and income from crop were collected. Farm income was calculated by deducing all paid costs from realized total revenue. It was observed that there was good scope to increase the income through crop diversification. Further, the study revealed that a significant change in the income levels and standard of living of marginal and small farmers have been realized due to diversification of the farm activities.

Brij Bala and Sharma (2005) has examined the extent of changes in cropping pattern and their effect on income and employment over the period 1990-91 to 2002-03 in the Kullu district of Himachal Pradesh. Data collected through the three-stage stratified random sampling technique have been used to analyze the impact of diversification and commercialization over time.

The study has reported a spectacular shift in the cropping pattern over the period 1990-91 to 2002-03 in the Kullu district. The traditional cereal crops have been almost completely replaced by the vegetable crops. The dominance of relatively short-duration vegetable crops in the cropping pattern has raised the cropping intensity. The vegetable crops being highly labour intensive have generated more employment opportunities in the villages. The overall labour employment has increased by about 49 per cent. The agricultural income per farm has increased by 32 per cent over the period. Consequently, the general standard of living of the farming community has been perceived to be uplifted. This hike in income level, which is due to agricultural diversification, has raised the living standards of the farmers of this area.

Joshi *et al.* (2006) assessed the impact of diversification of agriculture towards vegetables on farm income and employment using household level information from the Indian state of Uttar Pradesh. The study was based on primary data obtained from 178 randomly selected farmers through survey conducted in 2002-3. The results revealed that vegetable production was found to be more profitable and labour-intensive and was efficient in small holders in contrast to large farmers. Vegetable production was found to be emerging sector in agricultural diversification that augmented the income of small holders and generate employment opportunities in rural areas. Women were also benefited as the vegetable production engaged relatively higher woman labour in various operations. They have identified major constraints in vegetable production are lack of assured markets and a well-developed seed sector. Other important factors that restrict expansion of area under vegetables are higher price and yield risks as compared to cereals and low marketable surplus that increases transaction costs. They had felt that the possible solution for overcoming this is through developing institutional arrangements that strengthen farm-firm linkages.

Birthal *et al.* (2015) observed that Crop diversification into high-value crops (HVCs) can be a strategy to improve livelihood outcomes for farmers by analysing NSSO data (GoI, 2005). They found that households diversifying toward HVCs are less likely to be poor, the biggest impact being for smallholders. Furthermore, using continuous treatment matching, they established the relationship between degree of diversification (share of area dedicated to HVC) and poverty. They suggested that growers of HVCs need to allocate at least 50% area to HVCs to escape poverty.

Michler *et al.* (2017) used household panel data from Ethiopia they developed a diversity index to measure the effect of crop diversity on poverty status. To control for endogeneity and selection bias resulting from unobserved heterogeneity they utilized parametric method for estimating dynamic binary response models with endogenous contemporaneous regressors. Their results provide evidence that households which grow a diverse set of crops are less likely to be poor than households that specialize in their crop production. Additionally, crop diversity

reduces the probability that a non-poor household will fall into poverty and the probability that a poor household will remain in poverty.

Maila Lama (2016) examined the extent of crop diversification and its impact on farm income in the hilly districts of Arunachal Pradesh. The survey was based on multi-stage random sampling technique. He observed a high and growing degree of crop diversification using Simpson Index of Diversification (SID). The relationship between crop diversification and farm income was investigated with the multiple regression model.

In order to examine the impact of crop diversification on farm income, net farm income (FI) generated per hectare (in thousand rupees) was taken as dependent variable. Net farm income was computed by deduction costs on inputs from gross farm income. In the explanatory variables, apart from crop diversification index (Y), farm size (FS) and machinery use were added. His results showed a high and positive correlation between crop diversification index and machinery use. He inferred that crop diversification can be adopted as an effective strategy to improve well-being of farmers.

Amit Kumar *et al.* (2017) examined the extent of crop diversification and its impact on farm income across all the districts of Odisha. The crop diversification was measured using Herfindahl Index (HI). The determinants and its impact of diversification in Odisha were investigated through a regression equation, having household diversification index as dependent variable and various explanatory variables, by using ordinary least square method. Using the NSSO data, the study has found three districts, namely Anugul, Jharsuguda, and Balangir, to be highly diversified districts and the average farm income in these districts is significantly higher than in both moderately and least diversified districts. The medium farmers are the most diversified category of farmers in two out of the three highly diversified districts. The marginal farmers are the most diversified category of farmers in one highly diversified district. On the basis of regression analysis, the study has found that scheduled caste households in Odisha are less diversified in comparison to other households and higher the extent of irrigated land, lower is the extent of crop diversification.

CHAPTER III
MATERIALS AND METHODS

This chapter deals the methodology adopted for present investigation of the study and it is presented in the following headings.

3.1 Sampling procedure

3.2 Method of enquiry and collection of data.

3.3 Analytical framework and tools.

3.4 Description of study area.

3.1 Sampling procedure:

Keeping in view the objectives of the study, a multistage sampling procedure was adopted in selection of the State, district, sample farmers for getting primary data. Government of Andhra Pradesh (GoAP) as a part of its' Swarnandhra vision 2029 launched a primary sector mission. The mission is intended for overall development of Agriculture and allied sectors in the state. Further to provide special emphasis to these sectors, GoAP has introduced separate agricultural budget in 2014-15. Under Mission for Integrated development of Horticulture (MIDH) programme which is implemented through Department of Agriculture, Cooperation and Farmers Welfare (DAC&FW) Andhra Pradesh is covered. In the past also several initiatives were implemented to promote crop diversification in the state under National Horticultural Mission (NHM). Having these facts under consideration Andhra Pradesh (A.P) state was selected for the present study purposively.

3.1.1 Selection of district:

From the A.P State, East Godavari district was selected purposely because it stood at 4^{th} rank in District wise and sub sector wise Gross Value Added (GVA) in agriculture in 2014-15 & 2015-16 also. It is one of the agriculturally potential districts in Andhra Pradesh, contributing about 10% of the total food production of the state. Cropping intensity in East Godavari district was 159.83% in 2014-15.

East Godavari consists of 4 Zones namely Central Delta Zone (CDZ), Eastern Delta Zone (EDZ), Upland Area Zone (UAZ), and Agency Area Zone (AAZ).

3.1.2 Selection of mandals:

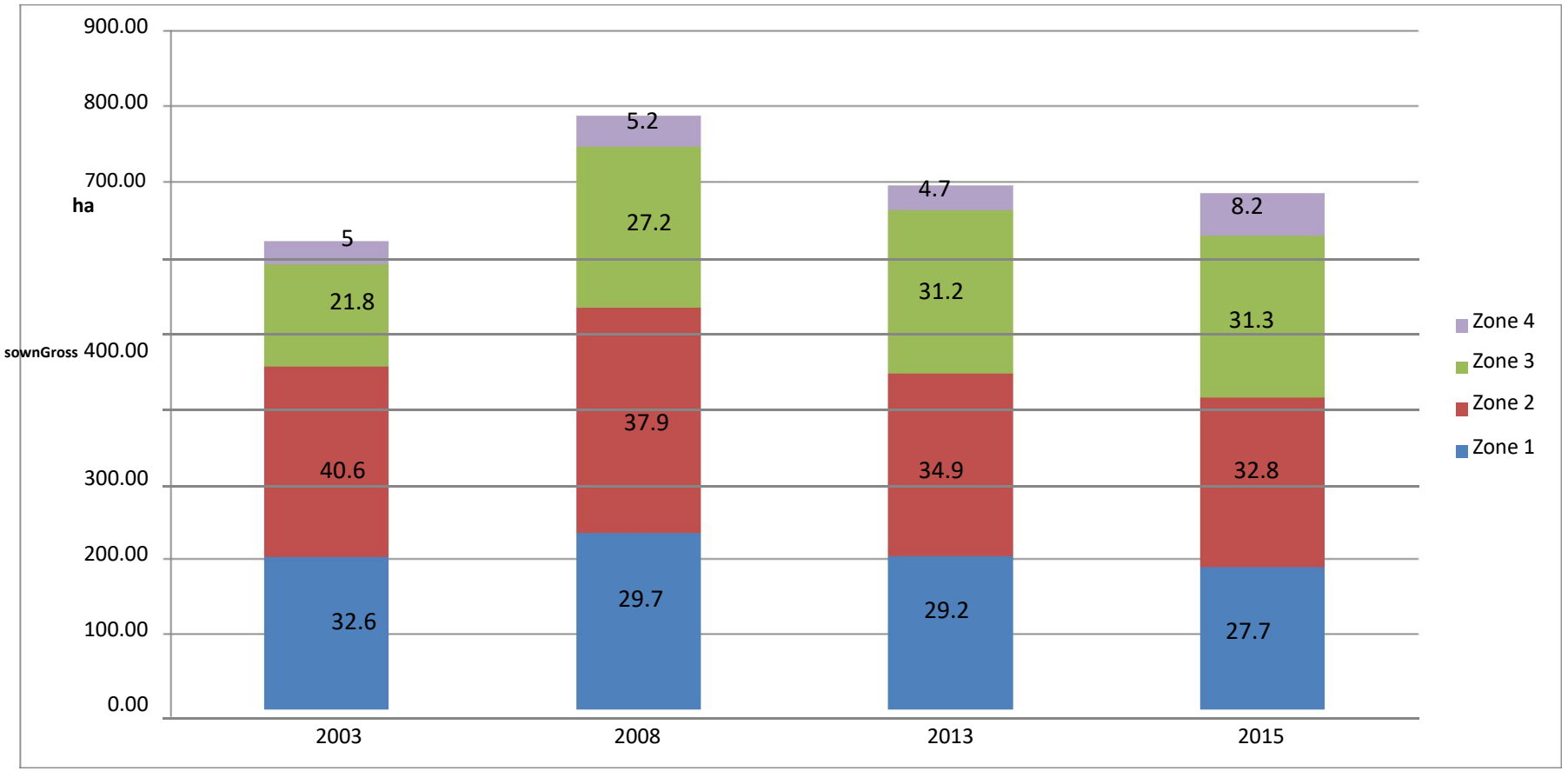
As the main focus of this study is to evaluate impact of crop diversification on farm income, in the first stage Herfindahl index (HI) was calculated for all the mandals of the district using 2014-15 data under different crops. In the next step all the mandals were categorized under 3 groups i.e; high, medium and low diversified mandals based on Herfindahl Index. In the final stage Samalkota mandal from low diversified group, Amalapuram mandal from medium diversified group and Jaggampeta mandal from high diversified group were selected so as to represent mandals with different levels of crop diversification. These mandals also represented three different zones of East Godavari district. In order to have representation from fourth zone also i.e; Agency Area Zone (AAZ) of East Godavari, Rajavommangi mandal was selected (Table 3.1). This type of mandal selection ensured capturing the agro-climatic contextual diversity in crop cultivation.

Table 3.1 Selection of mandals

Name of the Zone	No. of mandals	Geographical area (ha) 2014-15	GSA in ha 2014-15	Selected mandal
Central Delta Zone (zone 1)	17	159004 (12.6)	189232 (27.7)	Amalapuram
Eastern Delta Zone (zone 2)	18	210089 (16.7)	224471 (32.8)	Samalkota
Upland Area Zone (zone 3)	18	268269 (21.3)	214055 (31.3)	Jaggampeta
Agency Area Zone (zone 4)	11	622795 (49.4)	56101 (8.2)	Rajavommangi
East Godavari district	64	1260157	683859	

* Figures in parentheses represent percentages to the district total.

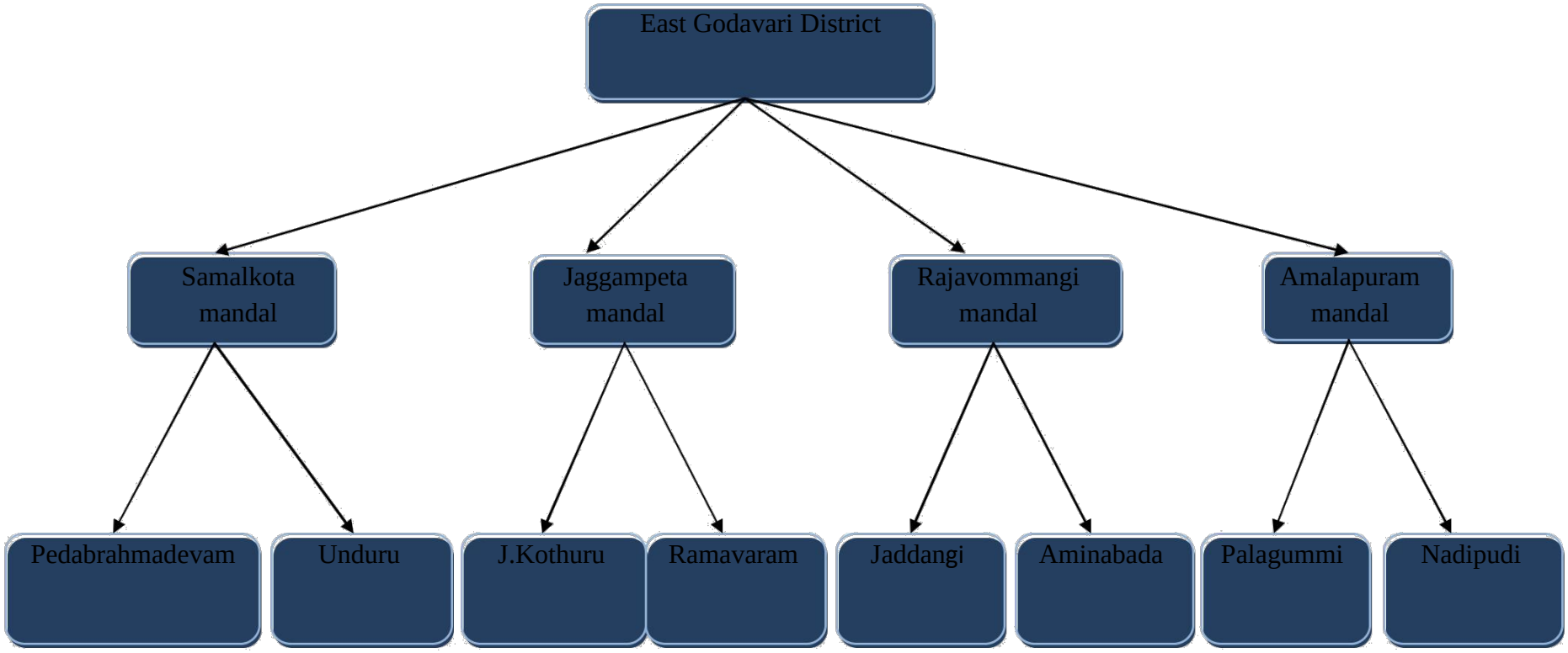
Fig. 3.1 Zone wise gross sown area in East Godavari District (ha) in selected years



Source: Hand Book of Statistics, East Godavari.

*Figures in the bars represent percentage share of respective zone GSA in total GSA of East Godavari district.

Fig. 3.2 Farmers sampling plan



As mentioned in previous paragraph East Godavari comprises of four zones. Agency Area Zone (zone 4) contributed highest share (49.4%) in geographic area of the district followed by Upland Area Zone i.e; zone 3 (21.3%). But contribution of zone 4 in 2014-15 GSA was 8.2% only. In 2014-15, zone 2 contributed highest share of GSA in East Godavari district followed by Zone 3 (Table 3.1). On the contrary in the year 2003, zone 1 followed Zone 2 is contributing to district GSA (Fig. 3.1). Agency area Zone (i.e; zone 4) contribution in district GSA was lowest in all selected years (Fig: 3.1) however, it increased from 5% in year 2003 to 8.2% in year 2015.

3.1.3 Selection of farmers:

From each selected mandal, two villages were selected as given in Fig. 3.2. A sample of 20 farmers from each of the selected village were selected randomly. Thus a total 160 farmers constituted sample for the present study. For further analysis farmers were post stratified into marginal (<1 ha), Small (1-2 ha), semi medium (2-4 ha) and medium (4-10 ha) categories based on the size of their operational land holdings. Small farmers occupied highest share of 34% followed by semi medium farmers (33%). Whereas marginal and medium farmers accounted for 25% and 8% respectively.

Table 3.2 Distribution of sampled farmers according to land size in selected mandals

Particular	Samalkota	Jaggampeta	Rajavommangi	Amalapuram	Total
Marginal (<1 ha)	11	14	8	7	40
Small (1-2 ha)	12	16	14	13	55
Semi medium (2-4 ha)	14	7	16	16	53
Medium (4-10 ha)	3	3	2	4	12
Total	40	40	40	40	160

3.2 Method of enquiry and data collection:

The study is based on both primary as well as secondary data. Primary data was collected by using separate specifically designed schedules for farmers. Secondary data was collected from review of literatures and from various government publication sources including the various departments such as Directorate of Economics and Statistics (DES), Government of Andhra Pradesh, and other authentic sources.

3.2.1 Data framework:

Data was collected from farmers on various aspects such as age, farming experience, gender, farm size, family size, education, village, land holding pattern, crops grown, costs and returns of different crops in the year 2015-16, distance from village to market, etc. Secondary data on mandal wise cropping pattern for the years 2003 to 2015 were collected from Chief Planning Office, East Godavari district. Other secondary data were collected from district handbook of East Godavari. Data on Mandal Domestic Product (MDP) 2014-15 was collected from publication of Directorate of Economics and Statistics, Government of Andhra Pradesh (GOI).

3.3 Analytical framework and analytical tools:

Both tabular and functional analysis was carried out in the study for getting insights.

3.3.1 Tabular analysis:

Tabular analysis was carried out for getting answers to questions like what are the general characteristics of agriculture in the district and selected mandals? What are the crops that are being grown in sampled villages? What are the top most three crops that are being grown? How much is the income from crops at farmer's level etc.

For measuring extent of diversification Herfindahl Index was computed using the formula.

Herfindahl Index (HI) = ΣP_i^2

Where, $P_i = A_i / \Sigma A_i$ A_i = Actual Area under i_{th} Crop ΣA_i = Total Cropped Area

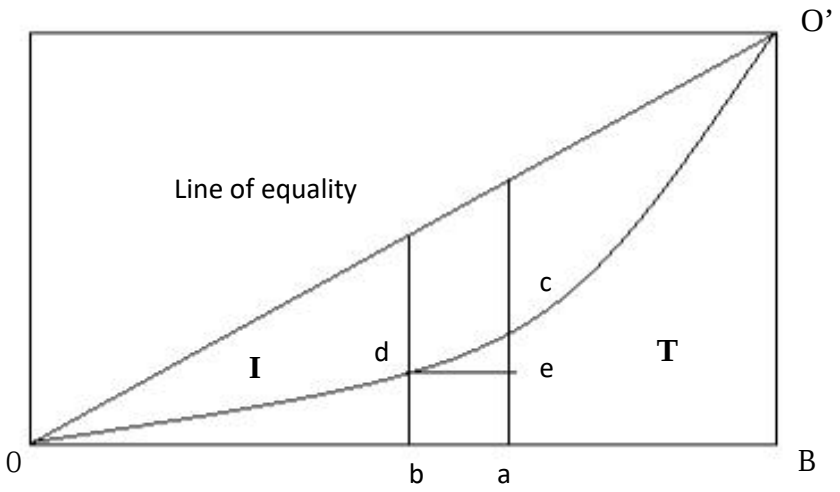
HI is sum of squares of acreage proportion of each crop in the total cropped area. In the HI formula P_i represents area proportion of the i^{th} crop in total cropped area. In 1967 Theil first used this index to measure the regional concentration of industries. With the increase in diversification, the Herfindahl Index would decrease. Hence HI, is inversely related to diversification. The value of index is one when there is complete concentration and approaches zero as diversification increases. Thus the index value ranges from 0 to 1.

Gini ratio:

For measuring land inequality at mandal level, gini ratio for the year 2010-11 was computed using agricultural census data. The Gini coefficient of inequality is derived from the Lorenz curve.

In Fig. 3.3, the degree of inequality is represented by the size of the area I. The line segment OO' represents the line of perfect equality. The area I represents the difference between the area T defined by the right angle triangle OBO' and the actual distribution of income described by the curve between OO'. The ratio between I and T is the Gini ratio. If incomes are distributed equally i.e; all points lie on the diagonal line segment, the area I is the zero and so is the index of inequality

Fig. 3.3 Lorenz curve



By approximating the area of the figure with straight lines, one can easily derive Gini coefficient of inequality (G).

$$\mathbf{G = 1 - \{(1/2) \sum^{n} (ab)\ (bd+ac)\} / T}$$

Since T is half the area of unit square and can be written as T = ½

$$\mathbf{G = 1 - \sum^{n} (ab)\ (bd+ac)}$$

Percent (straight-line) growth rate:

The percentage change from one period to another was calculated by the formula:

PR = ——————————

Where, PR = percent rate

V present = present value

V past = past value

The annual percentage growth rate is simply divided by the N, the number of years.

3.3.2 Functional analysis:

For analysing extent of influence of different socio-economic factors on diversification, regression analysis was carried out. The details specification for regression analysis is given below:

3.3.2.1 Determinants of diversification

Extent of Diversification is captured in terms of two measures viz; (i) Herfindahl Index and (ii) share of high value crops i.e; fruits and vegetables in total cropped area. This analysis was done using primary data and secondary data separately.

In the case of analysis of determinants of diversification using primary data the explanatory variables were farming experience(X_1), age of the farmer(X_2), number of family members participating in agriculture(X_3), education(X_4), total land in ha(X_5), market distance(X_6), share of irrigated area(X_7), partially owned

dummy(X_8), owned dummy(X_9), institutional credit dummy(X_{10}), non-institutional dummy(X_{11}), mandal dummies i.e., MD1(X_{12}), MD2(X_{13}) and MD3 (X_{14})

$$\mathbf{Y1 = A + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + \ldots\ldots\ldots\ldots + b_{13} X_{13} + b_{14} X_{14} \ldots (1)}$$

Y1 is 1- Herfindahl index (1-HI) whereas A is the intercept

For analyzing determinants of diversification towards high value crops namely fruits and vegetables using primary data Linear Probability Model (LPM) was carried out. Some of the farmers don't have the area under high value crops, hence Linear Probability Model was used by taking dependent variable as binary i.e; 1 is for presence of high value crops and 0 for absence of high value crops as given in equation (2).

$$\mathbf{Y2 = A + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + \ldots\ldots\ldots\ldots + b_{13} X_{13} + b_{14} X_{14} \ldots (2)}$$

Y2 = 1 in case of farmers having high value crops, 0 in case of absence of high value crops.

Explanatory variables used in the equation (2) were same as that of equation (1).

In the case of analysis of determinants of diversification using secondary data the explanatory variables were average farm size(X_1), share of agricultural labours and cultivators in total population(X_2), actual rainfall(X_3), share of canal irrigated area(X_4), share of urban population(X_5), area available per agricultural labour(X_6), GIA share in GSA(X_7), share of marginal and small farmers in total farmers(X_8), land inequality (gini ratio)(X_9), zonal dummies i.e., ZD1(X_{10}), ZD2(X_{11}) and ZD3(X_{12}). Here also two equations were estimated as given below.

$$\mathbf{Y3 = A + b_1 X_1 + b_2 X_2 + b_3 X_3 + \ldots\ldots\ldots\ldots + b_8 X_8 + b_{10} X_{10} \ldots + b_{12} X_{12} \ldots (3)}$$

Y3 is 1- Herfindahl index (1-HI) whereas A is the intercept.

$$\mathbf{Y4 = A + b_1 X_1 + b_2 X_2 + b_3 X_3 + \ldots\ldots\ldots\ldots + b_7 X_7 + b_9 X_9 + \ldots\ldots b_{12} X_{12} \ldots (4)}$$

Y4 is share of high value crops whereas A is the intercept.

The explanatory variables considered in estimating equation (3) and (4) are same.

3.3.2.2 Impact of crop diversification on farm income

This analysis was also done using both primary and secondary data separately. Impact of crop diversification on farm income was analysed using primary data by estimating equation (5).

$$\mathbf{Y5 = A + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + \ldots\ldots\ldots\ldots\ldots + b_{12} X_{12} + b_{13} X_{13} \ldots (5)}$$

Y5 is Gross returns/ ha whereas A is the intercept

Explanatory variables used in the equation (5) were 1-HI(X_1), farming experience(X_2), education(X_3), total land in ha(X_4), fertilizer consumption/ha(X_5), share of irrigated area(X_6), partially owned dummy(X_7), owned dummy(X_8), institutional credit dummy(X_9), non-institutional dummy(X_{10}), and mandal dummies i.e., MD1(X_{11}), MD2(X_{12}) and MD3 (X_{13}).

Impact of crop diversification on farm income was analysed using secondary data by estimating equation 6.

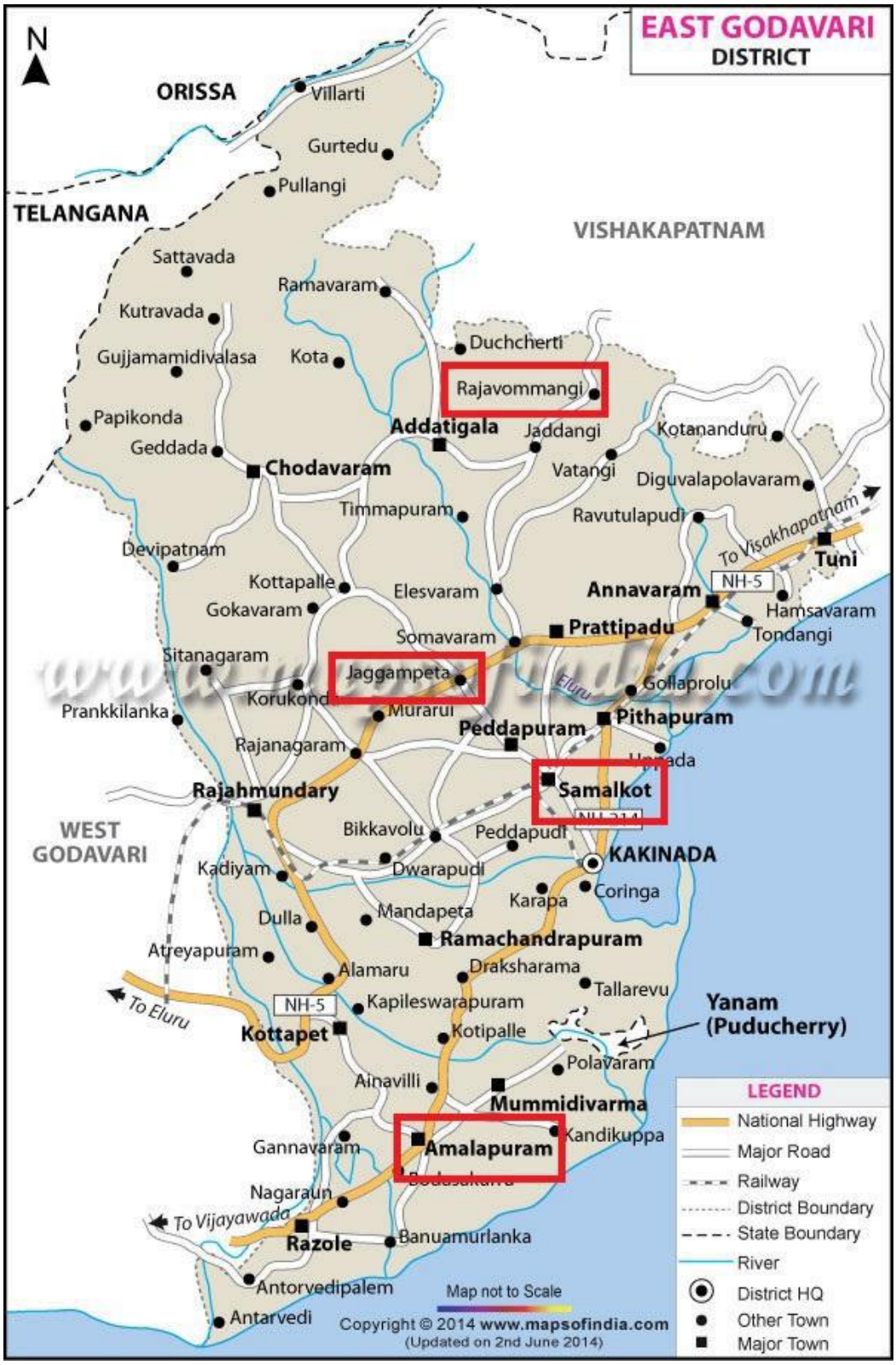
$$\mathbf{Y6 = A + b_1 X_1 + b_2 X_2 + b_3 X_3 + \ldots\ldots\ldots\ldots\ldots + b_8 X_8 + b_9 X_9 \quad \ldots (6)}$$

Y6 is GVA/hectare whereas A is the intercept

Explanatory variables used in the equation (6) were High value crops share(X_1), Rice area share(X_2), Fertilizer consumption per ha(X_3), Ratio of non Agril GVA/ Agril.GVA(X_4), average farm size(X_5), land inequality (gini ratio)(X_6), GIA share in GSA(X_7), zonal dummies i.e.,ZD1(X_8), ZD2 (X_8) and ZD3 (X_9).

Fig. 3.4 Map of selected state.

Fig. 3.5 Map of selected district with mandals



3.4 Description of the study area

Understanding of the general characteristics of the study area is essential for proper interpretation of the results with contextual backdrop. As stated earlier, this study is confined to the Samalkota, Jaggampeta, Rajavommangi, Amalapuram mandals of East Godavari district. The selected mandals represent fairly well diverse agro-climatic, socio-economic situation of the East Godavari district in Andhra Pradesh.

In this section the general characteristics of the study area, are presented in 11 sub sections namely location, climate and rainfall, soils, water resources and irrigation, land use pattern, demographics, land distribution, general economic characteristics, basic infrastructure facilities, agricultural extension and research facilities, transport facilities in the district.

3.4.1. Location - Boundaries and topography

East Godavari district is situated on north east coast of Andhra Pradesh in the geographical co-ordination of 160 30’ and 180 20’ of the northern latitude and 810 30’ and 820 36’ of the eastern longitude. The district is bounded on the north by Visakhapatnam district and state of Orissa, on the east by Bay of Bengal and on the south and west by West Godavari district and Khammam districts respectively. The headquarters of East Godavari district is Kakinada with coastal length of 144 Km. The total geographical area of the district is 10.81 lakh hectares.

3.4.2. Climate and Rainfall

In East Godavari the climate is comparatively equitable although it is very warm in the month of May with a maximum temperature of 38.3^{0}c and with a minimum temperature of 18.9^{0}c in the month of January. In East Godavari the actual rainfall received was 642.3 mm. as against the normal rainfall 1216.8 mm. from June 2014 to May 2015. The details of distribution of rainfall across different monsoon periods during the year 2014-15, in selected mandals and also at aggregate district level are presented in the table 3.3.

Table 3.3: Season wise actual and normal rainfall in 2014-15 (mm)

Season	Samalkota		Jaggampeta		Rajavommangi		Amalapuram		East Godavari	
	Actual	**Normal**	**Actual**	**Normal**	**Actual**	**Normal**	**Actual**	**Normal**	**Actual**	**Normal**
South West Monsoon (June - Sept)	315	666.2	451.7	712.7	412.7	1039.2	443.31	764	440.5	768
North East Monsoon (Oct - Dec)	111.5	318	164.9	255.9	132.9	263.6	172.9	436.5	122.9	305.4
Winter Period (Jan - Feb)	0	18	0	17.7	26.6	28.3	0	17.1	1.2	19.7
Hot Weather Period (March - May)	32.2	141.5	213.3	151.7	144.2	172.3	128.9	91.7	77.7	124.5
Total	458.5	1143.7	829.9	1138	715.7	1503.4	744.8	1309.3	642.3	1216.8
Deviation from normal	-685.2		-308.1		-787.7		-564.5		-574.5	
% of deviation from normal	59.9 %		27.1 %		52.4 %		43.1 %		47.2 %	

Source: Hand Book of Statistics 2014-15 East Godavari.

In East Godavari, more than half of the annual rainfall 440.5 mm was received during South West Monsoon period (against the normal of 768 mm) while the large portion of the rest i.e. 122.9 mm. received during the North East Monsoon period (against the normal of 305.4 mm). Rainfall received in East Godavari district in 2014 – 15 was lower than normal rainfall indicating deficient year. In all the selected mandals also actual rainfall received in 2014-15 was less than the normal rainfall. The extent of deficit rainfall varied from 27.1 to 59.9 percent across selected mandals. In Jaggampeta and Amalapuram during hot weather period rainfall received was higher than normal.

3.4.3. Soils

The main soils in the East Godavari district are alluvial (Clay loamy) Red Soils, Sandy Loams and Sandy Clay. The soils are the mostly alluvial in Godavari Delta area accounting for 15% of the total area and Sandy Clay at tail end portions of Godavari. There is Red loamy soils in uplands and agency area of the district.

3.4.4. Water Resources and Irrigation

Details of distribution of source wise area irrigated in selected mandals of East Godavari in 2014-15 are presented in Table 3.4.

At district level and in all the 4 mandals selected, the major source of irrigation was canals. The second major source of irrigation was lift irrigation in Samalkota, tubewells in Jaggampeta and Amalapuram and tanks in Rajavommangi. Irrigation intensity in East Godavari district was 176.59 %, among selected mandals it was highest in the case of Amalapuram mandal. Irrigation intensity ranged from 110.06 % to 203.28% across the selected mandals. In Samalkota and Amalapuram irrigation intensity was higher than that of district irrigation intensity whereas in other two mandals it was lower than that of district level irrigation intensity.

Table 3.4: Details of source wise area irrigated in 2014-15 (ha.)

Source of Irrigation	Samalkota	Jaggampeta	Rajavommangi	Amalapuram	East Godavari
Canals	**9150**	**2796**	**1067**	**2985**	**336735**
Tanks	0	886	671	0	25146
Tube wells	422	2039	79	1102	114276
Dug wells	0	0	0	0	109
Lift irrigation	533	0	0	0	15383
Other sources	0	0	12	0	2692
Net irrigated area (NIA)	10105	5721	1829	4087	279932
Area irrigated more than once	9708	1198	184	4221	214409
Gross Irrigated Area (GIA)	19813	6919	2013	8308	494341
Irrigation Intensity (%)	196.07	120.94	110.06	203.28	176.59

Source: Hand Book of Statistics 2014-15 East Godavari.

3.4.4.1. Rivers

The principal Rivers flowing in the East Godavari district are Godavari and Yeleru.

The Thandava and Pampa river channels supply water to a limited area in the district

3.4.5 Land use pattern

A look into the details of land use pattern of study mandals (Table 3.5) yielded the following insights. In East Godavari, share of land under forests was highest (35.02%) followed by net sown area (33.95%). Gross Sown Area in East Godavari District in 2014-15 was 683859 ha and it amounted to 54.3 percent of total geographic area. 7.6% of geographic area in East Godavari was left as fallow in 2014-15 which was higher than previous year due to deficit rainfall.

Table 3.5: Land use pattern in selected mandals of East Godavari districts in 2014-2015 (ha.)

Particulars	Samalkota	Jaggampeta	Rajavommangi	Amalapuram	East Godavari
Total geographical area	14664	16059	46541	8060	1260157
Area under forests	0	0	**28501 (61.2)**	0	**441311 (35.02)**
Barren & uncultivable land	0	0	3877 (8.3)	0	84881 (6.74)
Land put to non-agricultural uses	**3763 (25.7)**	1808 (11.3)	2087 (4.5)	1664 (20.7)	155065 (12.31)
Cultivable waste	0	224 (1.4)	1272 (2.7)	0	17503 (1.39)
Permanent pastures and other grazing lands	0	94 (0.6)	859 (1.9)	0	22047 (1.75)
Land under miscellaneous tree crops & groves	0	0	879 (1.9)	0	7826 (0.62)
Other fallow lands	0	1183 (7.4)	2747 (5.9)	3 (0.00)	43613 (3.46)
Current fallows	411 (2.8)	1757 (10.9)	103(0.20)	325 (4.0)	52513 (4.17)
Net Sown Area (NSA)	10105 (68.9)	10993 (68.5)	6216 (13.4)	**6016 (74.6)**	427862 (33.95)
Total cropped area	20033	13124	6758	11835	683859
Area sown more than once	9928	2131	542	**5819**	255997
Cropping intensity (%)	**198.24**	119.38	108.71	196.72	159.83

Note: Figures in parentheses indicate percentages to total geographical area.

Source: Hand Book of Statistics 2014-15 East Godavari.

In case of selected mandals (Table 3.5), the share of area under forest was more in Rajavommangi compared to other mandals. Share of land put to non agricultural uses was highest in Samalkota and lowest in Rajavommangi. The cropping intensity was highest in Samalkota mandal. Cropping intensity ranged from 108.71 % to 198.24% across selected mandals. In Samalkota and Amalapuram cropping intensity was higher than that of district cropping intensity whereas in other two mandals it was lower than that of district level cropping intensity.

3.4.6 Demographics

According to the 2011 census, East Godavari district has a population of 51.54 lakhs and has a population density of 413 inhabitants per square kilometre. East Godavari has a sex ratio of 1007 females for every 1000 males. Among four mandals, total population and density is highest in Amalapuram mandal whereas sex ratio (females for 1000 males) is highest in Rajavommangi mandal (1072).

3.4.6.1 Population distribution

In East Godavari 25% population live in urban areas and 75 % people in rural areas (Table 3.6). Male literacy rate was comparatively higher than female literacy rate at district level. At district level, the share of non workers was 58.95%. The rural population was highest (both in absolute terms and percentage terms) in Jaggampeta mandal. Literacy rate was highest in Amalapuram mandal (84.22%) compared to other three mandals. Agriculture workers share in total population and share of cultivators in agricultural workers was highest in case of Rajavommangi mandal among the selected mandals.

Table 3.6: Demographic statistics of selected mandals of district in 2011

Particulars	Samalkota	Jaggampeta	Rajavommangi	Amalapuram	East Godavari
Total population	137979	79640	39582	141693	5285824
Male population	68663	39422	19102	71098	2633304
Female population	69316	40218	20480	70595	2652520
Sex ratio	1010	1020	1072	993	1007
Density	941	496	85	1758	413
Urban population	56864 (41)	0	0	64701 (46)	1313972 (25)
Rural population	8115 (59)	**79640 (100)**	39582 (100)	76992 (54)	3971852 (75)
Total literacy rate	69.39%	57.08%	56.47%	**84.22%**	70.5 %
Male literacy rate	72.51%	58.40%	60.53%	88.35%	74.10 %
Female literacy rate	66.32%	55.79%	52.69%	80.09%	66.95%
Schedule caste Population	266657	11324	821	32623	957302
Schedule tribe	1184	1383	22786	1499	297044
Total workers (Main+Marginal)	53303	33058	23249	54434	2169558
Main workers	45545	29295	15957	46362	1804748
Marginal workers	7758	3763	7292	8072	364810
Agricultural labourers	30697	23969	17443	20421	1169767
Cultivators	3398	2641	3603	2527	179660
Agriculture workers (cultivars+agril.labour)	34095 (24.7)	26610 (33.4)	21046 (53.1)	22948 (16.2)	1349429 (25.53)
Non workers	84676 (61.37)	46582 (58.5)	16333 (41.26)	87259 (61.58)	3116266 (58.95)

Note: Figures in parentheses indicate percentages to total population.

Source: Hand Book of Statistics 2014-15 East Godavari.

3.4.7 Distribution of land holdings

The details of distribution of land holdings in selected four mandals of East Godavari district as per 2010 - 2011 agricultural census are given in Table 3.7. The largest number of holdings were observed under small holders. The share of small holders (< 2 ha) was highest in Amalapuram mandal (96.86%) followed by Samalkota mandal (95.24%). Similarly marginal holdings were maximum in Amalapuram (87.75%) and it was followed by Samalkota mandal (84.29%). In all the selected mandals average farm size was less than that of district average farm size (0.73 ha) except in Jaggampeta where it was 2.07 ha.

3.4.8 General economic characteristics

Total Gross Value Added (GVA) in 2015 – 16 was Rs. 59593 crores whereas in 2014-15 it was 53057 crores in East Godavari district. The per capita income at current price in 2015 - 16 & 2014-15 was Rs.105000 & Rs.92526 respectively in East Godavari. The GVA from agriculture and allied sectors in 2015-16 was Rs.16396 crores which accounted for 27 % to total GVA of district whereas in 2014-15 it was Rs. 14722 crores (28%).

Table 3.7: Mandal wise distribution of land holdings in 2011 census

Particulars	Samalkota			Jaggampeta			Rajavommangi			Amalapuram			East Godavari		
	No.	Area (ha)	Average farm size	No.	Area (ha)	Average farm size	No.	Area (ha)	Average farm size	No.	Area (ha)	Average farm size	No.	Area (ha)	Average farm size
Marginal (upto 1 ha)	14793 (84.29)	5460.6 (50.09)	0.37	10627 (74.25)	4470.9 (34.42)	0.42	3247 (42.78)	1829.1 (11.63)	0.56	11635 (87.75)	3498.5 (54.79)	0.30	577260 (79.70)	210466 (39.42)	0.36
Small (1 to 2 ha)	1921 (10.95)	2587.3 (23.73)	1.35	2274 (15.89)	3154.9 (24.29)	1.39	2315 (30.50)	3313.3 (21.07)	1.43	1208 (9.11)	1645.5 (25.77)	1.36	92886 (12.82)	128306 (24.03)	1.38
Semi medium (2 to 4 ha)	582 (3.32)	1535.5 (14.08)	2.64	1031 (7.20)	2729.1 (21.01)	2.61	1715 (22.30)	4477.1 (28.48)	2.61	360 (2.71)	940.6 (14.73)	2.61	40407 (5.58)	108149 (20.26)	2.67
Medium (4 to 10 ha)	246 (1.40)	1201.9 (11.02)	4.88	329 (2.30)	1831.4 (14.10)	5.61	842 (11.09)	4729.7 (30.08)	5.61	57 (0.43)	300.8 (4.71)	5.27	12605 (1.74)	69632 (13.04)	5.52
Large (above 10 ha)	8 (0.05)	117.3 (1.08)	14.6	51 (0.36)	802.1 (6.18)	15.7	86 (1.13)	1240.9 (7.89)	14.4	0	0	0	1122 (0.15)	17309 (3.24)	15.42
Total	17550	10902.5	0.62	14312	12988.5	**2.07**	7590	15721.6	0.48	13260	6385.5	0.48	724280	533863.2	0.73

Note: Figures in parentheses indicate percentages to total. **Source** : Hand Book of Statistics, 2014-15, East Godavari

3.4.9 Basic infrastructural facilities

The details regarding basic infrastructure network in terms of transport facilities, health care, education facilities, godowns in the four mandals are shown in Table 3.8.

Primary schools, Upper primary schools, Banks, Post offices, veterinary clinics per 1000 sq.km of geographic area were highest in Amalapuram mandal whereas rural banks and warehouses were highest in Samalkota mandal. A total of 3 government hospitals and 6 rural bank branches are there in entire district.

Table 3.8: Infrastructure facilities in the selected mandals of East Godavari (/"000 sq.km)

Particulars	Samalkota	Jaggampeta	Rajavommangi	Amalapuram	East Godavari
Primary school	5.11	2.37	1.63	14.64	3.12
Upper primary school	1.70	1.18	0.19	2.73	0.80
Hospitals	0.07	0.00	0.00	0.00	0.00
Primary health centres	0.07	0.12	0.06	0.12	0.02
Veterinary clinics	0.34	0.19	0.04	0.37	0.13
Warehouses	0.68	0.06	0.00	0.50	0.13
Rural banks	0.14	0.12	0.00	0.12	0.00
Banks	1.23	0.44	0.04	4.09	0.55
Post office	1.16	0.56	0.49	2.73	0.66

Source: Computed from Hand Book of Statistics, 2014-15, East Godavari

3.4.10 Agricultural extension and research facilities

The important Agricultural research and extension institutes now functioning in the district are:

1. ICAR-Central Tobacco Research Institute (CTRI) – Rajahmundry

2. Agricultural college (under ANGRAU) - Rajahmundry
3. Regional Coconut Research Station (YSR Horticultural university) - Ambajipeta
4. Agricultural Research Station (ANGRAU) - Peddapuram
5. Extension Training Centre - Samalkota

3.4.11 Transport and Communication

East Godavari district is served by Rail line (broad gauge) which is double line from Rajahmundry to Tuni and single line from Kakinada to Samalkota and Kakinada to Kotipalli covering a distance of 172.52 Km. People have to depend upon road transport. All most all the places in the district are connected by well laid roads with the construction of the bridges across river Godavari at Alamuru and Siddantham and Rail- Cum-Road bridge at Rajahmundry connecting East and West Godavari districts the movements of passengers and transport of goods to several parts of the state have become easy. Agricultural commodities like coconut and other marketing goods are carried through water transport system. There are 34 railway stations on broad-gauge in the district with 172.52 K.M.s National Highways i.e. (NH 5 & NH 214) are passing through this district. One air port also exists in Rajahmundry.

CHAPTER IV
RESULTS AND DISCUSSIONS

This chapter deals with results and discussion of the study. For the convenience of logical interpretation, the results are presented and discussed under the following headings.

4.1 Trend and pattern of crop diversification

4.2 Determinants of crop diversification

4.3 Impact of crop diversification

4.4 Problems and prospects of crop diversification

4.1 Trend and pattern of crop diversification

4.1.1 Land utilization pattern

Details of land utilization pattern in East Godavari district and selected mandals in selected years are presented in Table 4.1. In East Godavari, Gross Sown Area (GSA) increased in year 2008 compared to year 2003. In the years 2013 and 2015, GSA at district level was more than GSA of year 2003 but lesser than GSA in year 2008. Similarly in the years 2013 and 2015, NSA at district level was more than NSA of year 2003 but lesser than NSA in year 2008. In East Godavari both Net Irrigated Area (NIA) and Gross Irrigated Area (GIA) increased during the years 2003 to 2008 and then declined. In East Godavari district between the years 2003 and 2015 growth rate of GSA was 0.85% on the other hand growth rate of NSA was 1.82%.

GSA was higher in Samalkota mandal compared to other selected mandals in all the selected years. In Samalkota and Amalapuram, GSA in the year 2015 was lower than the GSA in the year 2003. On the contrary, in Jaggampeta and Rajavommangi mandals GSA in year 2015 was higher than the GSA in year 2003. In the years 2013 and 2015, GSA in all the selected mandals was lesser than GSA in year 2008. In Samalkota and Amalapuram, growth rate of GSA was negative between the years 2003 and 2015. Growth rate of GSA between the years 2003 and

2015 was 6.32% in the case of Jaggampeta and 4.34% in the case of Rajavommangi.

Net Sown Area (NSA) also followed the same trend as that of GSA. In Samalkota and Amalapuram NSA decreased between the years 2003 to 2015. This could be due to increase in urban population and associated increase in land under non-agricultural uses. NSA growth rate was also negative in case of Samalkota and Amalapuram as observed in the case of GSA. Growth rate of NSA between the years 2003 and 2015 was 4.36% in case of Jaggampeta and 3.76% in the case of Rajavommangi. Growth rate of NSA was growth rate of GSA in both Jaggampeta and Rajavommangi, but at aggregate level i.e; in the case of East Godavari district growth rate of NSA was higher than growth rate of GSA.

Gross Irrigated Area (GIA) increased between the years 2003 to 2015 in all selected mandals except Rajavommangi. Accordingly, growth rate of GIA was negative in Rajavommangi, ranged between 2.17% to 20.99% in other selected mandals. The growth rate of GIA in Jaggampeta was higher than growth rate of GIA at district level.

Except in Jaggampeta, in all other selected mandals Net Irrigated Area (NIA) decreased in 2015 compared to year 2003. As observed in description of study area section, major source of irrigation in Rajavommangi was canals followed by tanks. In the year 2014-15, in Rajavommangi rainfall received was deficient compared to normal by 52.4%. This facts and associated deterioration in tanks could be the reasons behind this decline in GIA and NIA. Growth rate of NIA in Jaggampeta was higher than growth rate at district level.

In all the selected years, only in Samalkota and Amalapuram mandals cropping intensity was higher than cropping intensity at district level. In 2003, irrigation intensity of Amalapuram only was higher than irrigation intensity of the district. In other selected years, irrigation intensity in both Samalkota and Amalapuram was higher than district level irrigation intensity.

Table 4.1 Trend in land utilization pattern of selected mandals in East Godavari district (1000 ha.)

Particulars	2003	2008	2013	2015	Annual Growth rate (%)
Gross Sown Area (GSA)					
Samalkota	21.39	28.31	20.95	20.03	-0.53
Jaggampeta	7.46	14.33	14.05	13.12	6.32
Rajavommangi	4.44	6.81	5.64	6.76	4.34
Amalapuram	12.02	13.66	11.87	11.84	-0.13
East Godavari	620.58	786.62	694.07	683.86	0.85
Net Sown Area (NSA)					
Samalkota	10.64	10.45	10.30	10.11	-0.42
Jaggampeta	7.22	12.65	11.90	10.99	4.36
Rajavommangi	4.28	6.35	5.64	6.22	3.76
Amalapuram	6.39	6.34	6.05	6.02	-0.49
East Godavari	351.15	434.11	417.06	427.86	1.82
Gross Irrigated Area (GIA)					
Samalkota	15.31	20.26	20.10	19.81	2.45
Jaggampeta	1.97	5.41	6.83	6.92	20.99
Rajavommangi	4.75	2.39	1.79	2.01	-4.80
Amalapuram	6.59	8.70	8.35	8.31	2.17
East Godavari	375.53	504.11	501.56	494.34	2.64
Net Irrigated Area (NIA)					
Samalkota	10.61	10.39	10.30	10.11	-0.39
Jaggampeta	1.86	4.50	5.91	5.72	17.29
Rajavommangi	3.22	1.80	1.79	1.83	-3.60
Amalapuram	4.13	4.40	4.12	4.09	-0.08
East Godavari	250.71	291.87	287.05	279.93	0.97
Cropping Intensity (%)					
Samalkota	201.00	271.07	203.31	198.25	
Jaggampeta	103.42	113.33	118.09	119.39	
Rajavommangi	103.76	107.24	100.00	108.72	
Amalapuram	187.96	215.31	196.23	196.73	
East Godavari	176.73	181.20	166.42	159.83	
Irrigation Intensity (%)					
Samalkota	144.34	195.09	195.20	196.07	
Jaggampeta	105.65	120.30	115.58	120.94	
Rajavommangi	147.46	132.49	100.00	110.06	
Amalapuram	159.64	197.61	202.50	203.28	
East Godavari	149.79	172.72	174.73	176.59	

Source: Hand Book of Statistics, East Godavari.

4.1.2 Cropping pattern in East Godavari district

Details of cropping pattern in East Godavari district for selected years are presented in Table 4.2. In 2003, paddy constituted 48.62 % of GSA followed by fruits (10.33%) and blackgram (9.45%). These three crops constituted 68.40 % in GSA. In 2015, paddy (57.63%) occupied the major share of GSA followed by fruits (11.44%) and coconut (7.36%). These three crops constituted 76.43 % in GSA. Gross sown area of East Godavari showed a growth rate of 0.85%. Among crops, cotton showed a highest growth rate of 32.53% followed by jowar (25.16%) and spices & condiments (18.42%).

Total fruits and vegetables showed a growth rate of 2.55% whereas sugarcane showed a negative growth rate of 0.51%. Vegetables growth rate (6.29%) was higher than fruits growth rate (1.83%).

In the year 2015, at district level share of total cereals and millets stood at 59.96% compared to 50.19% in the year 2003. On the other hand, share of pulses in the year 2015 was 5.9% compared to 17.73% in the year 2003. Among cereals and millets negative growth rate was observed only in the case of bajra. Growth rate of paddy was 2.55 %. In the case of pulses, other than Red gram, remaining pulses showed a negative growth rate.

Table 4.2 Details of cropping pattern in East Godavari district (in ha)

Particulars	2003		2015		Annual Growth rate (%)
	Area	Share in GSA (%)	Area	Share in GSA (%)	
Rice	301710.53	48.62	394117.00	57.63	2.55
Jowar	519.00	0.08	2086.00	0.31	25.16
Bajra	1201.00	0.19	58.00	0.01	-7.93
Maize	7432.77	1.20	12911.00	1.89	6.14
Other millets	600.00	0.10	881.00	0.13	3.90
Total cereals and millets	**311463.30**	**50.19**	**410053.00**	**59.96**	**2.64**
Horse gram	770.76	0.12	87.00	0.01	-7.39
Green gram	49832.40	8.03	16687.00	2.44	-5.54
Black gram	58671.07	9.45	21105.00	3.09	-5.34
Red gram	764.00	0.12	2220.00	0.32	15.88
Other pulses	0.00	0.00	263.00	0.04	37.82*
Total pulses	**110038.22**	**17.73**	**40362.00**	**5.90**	**-5.28**
Fruits	64122.64	10.33	78225.00	11.44	1.83
Vegetables	12316.00	1.98	21619.00	3.16	6.29
Total fruits and vegetables	**76438.64**	**12.32**	**99844.00**	**14.60**	**2.55**
Groundnut	578.03	0.09	365.00	0.05	-3.07
Sesamum	2614.55	0.42	3452.00	0.50	2.67
Coconut	49696.00	8.01	50301.00	7.36	0.10
Total oilseeds	**52888.58**	**8.52**	**54118.00**	**7.91**	**0.19**
Spices and condiments	1113.16	0.18	3574.00	0.52	18.42
Sugarcane	24704.29	3.98	23187.00	3.39	-0.51
Cotton	4575.00	0.74	22433.00	3.28	32.53
Tobacco	4595.67	0.74	4017.00	0.59	-1.05
Other food crops	19019.08	3.06	0.00	0.00	-8.33
Other non food crops	15744.61	2.54	26271.00	3.84	5.57
Other crops	**69751.81**	**11.24**	**79482.00**	**11.62**	**1.16**
GSA	**620580.55**	**100.00**	**683859.00**	**100.00**	**0.85**

Source: Hand Book of Statistics, East Godavari.

*In 2003, there was no area under other pulses hence, used the data of 2005 to calculate growth rate of other pulses

4.1.3 Change in cropping pattern in selected mandals of the district

Particulars regarding cropping pattern in selected mandals of East Godavari district for the years 2003 and 2015 are given in Table 4.3.

Table 4.3 Change in cropping pattern in selected mandals of the district (% of GSA)

Name of the Mandal	Year	Paddy	Cereals & Millets	Pulses	Fruit & vegetable	Oilseed	Other crops
Samalkota	2003	**69.68**	**69.69**	27.64	0.11	0.34	2.23
	2015	**97.00**	**97.00**	1.07	0.05	0.02	1.85
	Growth rate	2.53	2.53	-8.03	-4.71	-7.75	-1.84
Jaggampeta	2003	14.76	16.26	4.73	**61.10**	0.68	17.22
	2015	**37.85**	**38.56**	6.62	29.82	1.26	23.74
	Growth rate	29.26	26.42	12.16	-1.18	18.79	11.87
Rajavommangi	2003	18.61	21.99	7.00	**37.19**	2.62	31.20
	2015	**31.64**	**32.58**	9.43	26.59	0.64	30.76
	Growth rate	13.21	10.45	8.72	0.73	-5.25	4.16
Amalapuram	2003	43.43	43.43	24.57	4.15	25.35	2.50
	2015	50.44	50.44	7.20	10.15	25.61	6.60
	Growth rate	1.20	1.20	-5.93	11.72	-0.04	13.37

Source: Computed using data from Hand Book of Statistics, East Godavari.

In the year 2003 in Samalkota cereals occupied major share in GSA (69.69 %) followed by pulses (27.64 %). In 2015 pulses share was drastically decreased to 1 %, which was replaced with paddy leading to increased paddy share (97%). Between the years 2003 & 2015 in Samalkota mandal, growth rate was positive in case of cereals. Other crop groups i.e; pulses, fruits and vegetables, oilseeds and other crops showed negative growth rate. In Jaggampeta and Rajavommangi mandals, fruits and vegetables constituted major share in GSA in the year 2003 but it was reduced in the year 2015. In Amalapuram paddy occupied major share in

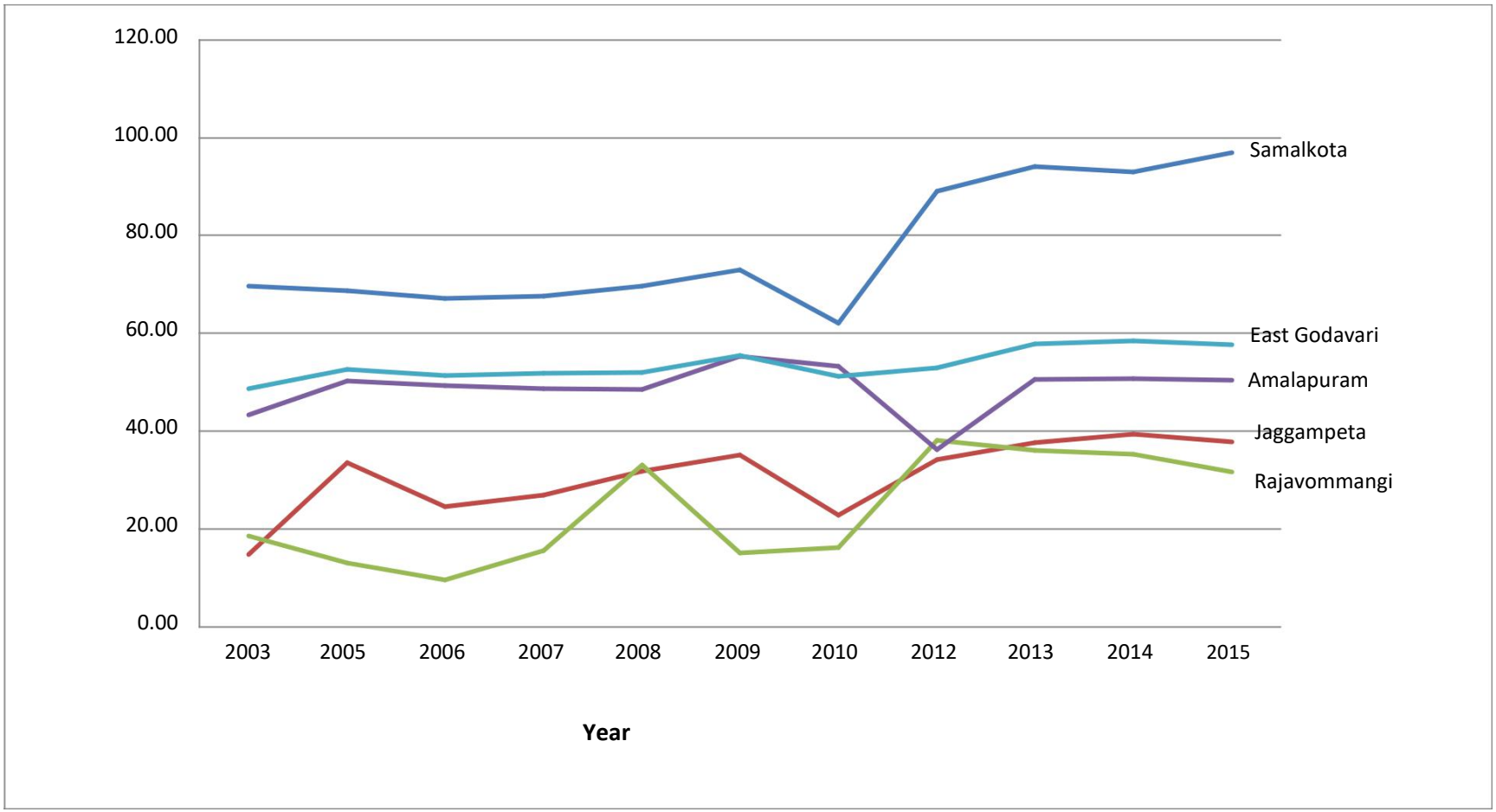
both the years followed by oil seeds. Except in Amalapuram, all other selected mandals growth rate was higher in cereals and millets compared to other crop groups.

In Samalkota and Amalapuram, growth rate of paddy was similar to growth rate of cereals and millets because paddy constituted almost 99.9 % share in cereals and millets. In the year 2015, except in Samalkota mandal, other selected mandals share of cereals and millets was lower than share of cereals and millets in East Godavari district. Between 2003 and 2015 years, growth rate of cereals and millets in Samalkota and Amalapuram mandals was lower than growth rate at district level. In the year 2015, out of four selected mandals, only in two mandals i.e; Samalkota and Amalapuram share of fruits and vegetables was lower than fruits and vegetables share at district level. Growth rate of fruits and vegetables between 2003 and 2015 was positive only in case of Rajavommangi and Amalapuram. However, only in Amalapuram growth rate of fruits and vegetables (11.72%) was higher than district level growth rate (2.55%).

4.1.4 Paddy area share in GSA

Trend of paddy area share in Gross Sown Area (GSA) for the period from 2002-03 to 2014-15 is presented in Figure 4.1. In East Godavari share of paddy area increased from 49 % to 58 % over the years. In the selected four mandals also area of paddy share increased over the years. Across selected mandals greater change was observed in Samalkota i.e; increase in share of paddy area by 27 points during the years 2003-15. This indicates increasing specialization towards paddy in the mandals as well as district.

Figure 4.1 Trend of Paddy area share in GSA in selected mandals of East Godavari (%)



Source: Hand Book of Statistics, East Godavari.

4.1.5 Top 3 crops grown in East Godavari

In order to understand mobility pattern in top 3 crops grown in East Godavari district and selected mandals, the details of top 3 crops in terms of area in the years of 2003 and 2015 was analyzed (Table 4.4). In East Godavari, top 1 crop was paddy in both the years 2003 & 2015. 2nd major crop was Black gram in 2003 but in 2015 2nd major crop was fruits. In 2003, 3rd major crop was Green gram but in 2015 3rd major crop was coconut. In Samalkota and Amalapuram, paddy was the 1st major crop in both the years. In Samalkota in the year 2003, black gram was the 2nd major crop and was replaced by sugarcane due to presence of sugar factory. In Jaggampeta, tapioca was the top 1 crop in the year 2003 but in the year 2015 paddy became the major crop. Similarly in Rajavommangi mandal, cashew nut was the 1st major crop and was replaced by paddy in the year 2015. In the year 2003, among selected mandals only in Samalkota paddy was the top 1 crop but in the year 2015, in all the selected mandals as well as at district level paddy became the top 1 crop.

Table 4.4 Top 3 crops grown in selected mandals of East Godavari

Particulars		2003	2015
Samalkota	1	Paddy	Paddy
	2	Black gram	Sugarcane
	3	Green gram	Green gram
Jaggampeta	1	Tapioca	Paddy
	2	Paddy	Maize
	3	Mango	Bajra
Rajavommangi	1	Cashew nut	Paddy
	2	Tobacco	Bajra
	3	Paddy	Horse gram
Amalapuram	1	Paddy	Paddy
	2	Coconut	Cotton
	3	Black gram	Bajra
East Godavari	1	Paddy	Paddy
	2	Black gram	Fruits
	3	Green gram	Coconut

Source: Hand Book of Statistics, East Godavari.

4.1.6 Mobility of mandals of East Godavari district in crop diversification

After analysing mobility of top 3 crops, Herfindahl Index (HI) was calculated to know the overall diversification for all the mandals of East Godavari district for the selected years. All the mandals were grouped into 4 groups according to their HI values in selected years and the details are furnished in Table 4.5. In the years 2003 & 2008, there were no mandals coming under 4^{th} group i.e; there was no mandal with complete specialization. Due to increased specialization, some of the mandals moved into 4^{th} group in recent years. Jaggampeta and Rajavommangi were in 1^{st} group in all the years indicating consistent diversification. Amalapuram was in 2^{nd} group in all the years. But Samalkota which was in 3^{rd} group during the years 2003 & 2008 moved into 4^{th} group in the years 2013 & 2015 due to increase in paddy area resulting in increased specialization. In the year 2013, high diversified and low diversified mandals were Rangampeta (0.167) and Rayavaram (0.930) whereas in the year 2015 kunavaram (0.123) was highly diversified mandal and karapa (0.963) was the low diversified mandal.

Table 4.5 Mobility of mandals of the district in crop diversification

HI Value	2003	2008	2013	2015
0.001 - 0.250	19	19	12	19
0.251 - 0.500	30	29	28	24
0.501 - 0.750	8	10	8	5
0.751 - 1.000	0	0	10	14

Source: Hand Book of Statistics, East Godavari.

4.1.7 Nature and extent of crop diversification in selected mandals of East Godavari district.

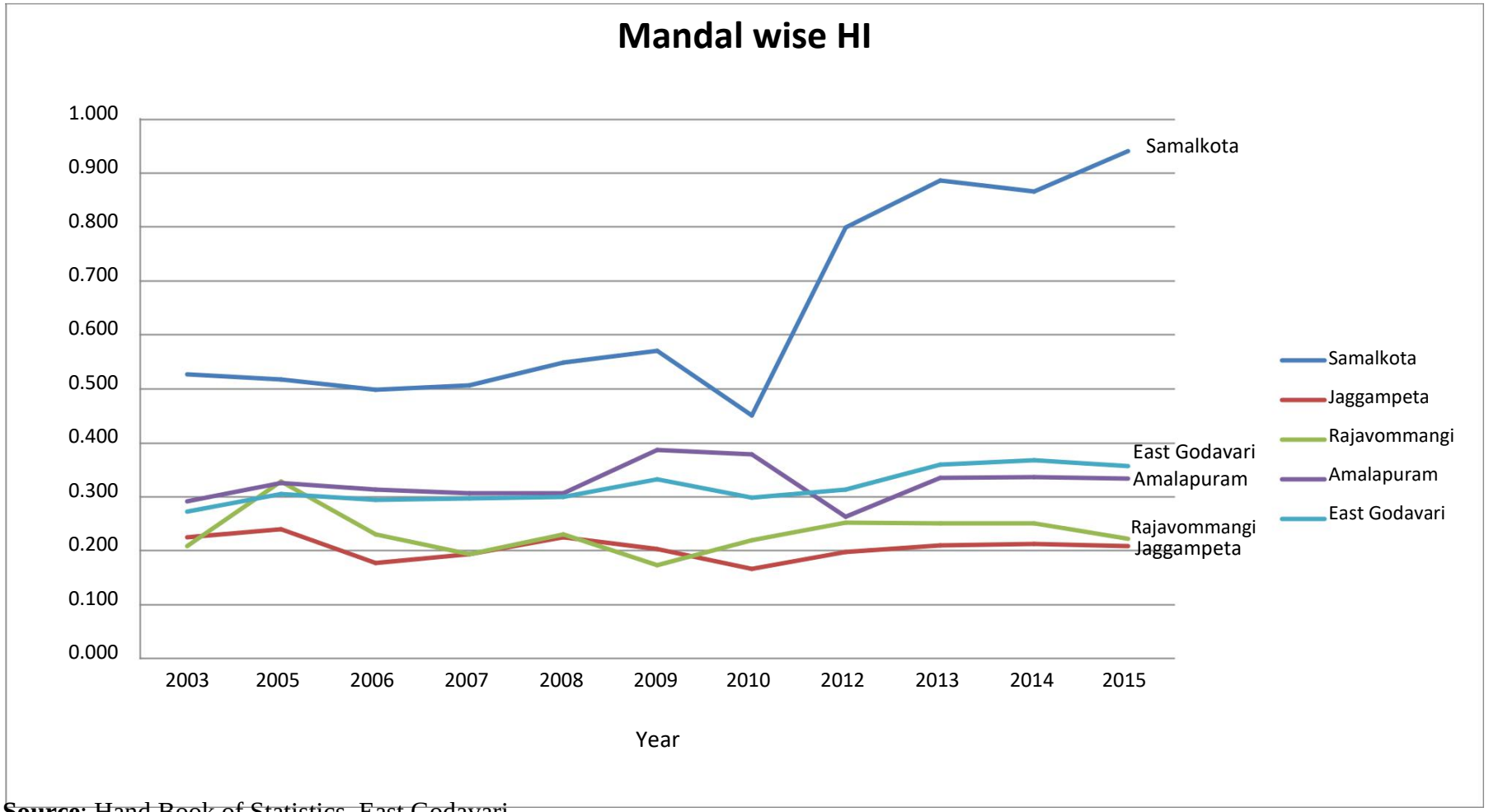
To know the diversification trend continuously, in selected mandals of East Godavari district Herfindahl Index (HI) was calculated for the period from 2002-03 to 2014-15. The results of HI are presented in Fig. 4.2. In East Godavari, HI value increased in the year 2003 (0.273) to the year 2015 (0.357). In Samalkota

mandal, HI value increased from 0.527 to 0.941 indicating increased specialization. In Jaggampeta mandal, HI value decreased from 0.225 to 0.208 (indicating movement towards diversification) whereas in Rajavommangi mandal HI value increased from 0.208 to 0.222 (indicating movement towards specialization). In Amalapuram HI value increased from 0.291 to 0.334. Hence, among selected four mandals only in the case of Jaggampeta, HI decreased in the 2014-15 compared to the year 2002-03.

4.1.8 Diversification pattern in selected mandals & corresponding zones

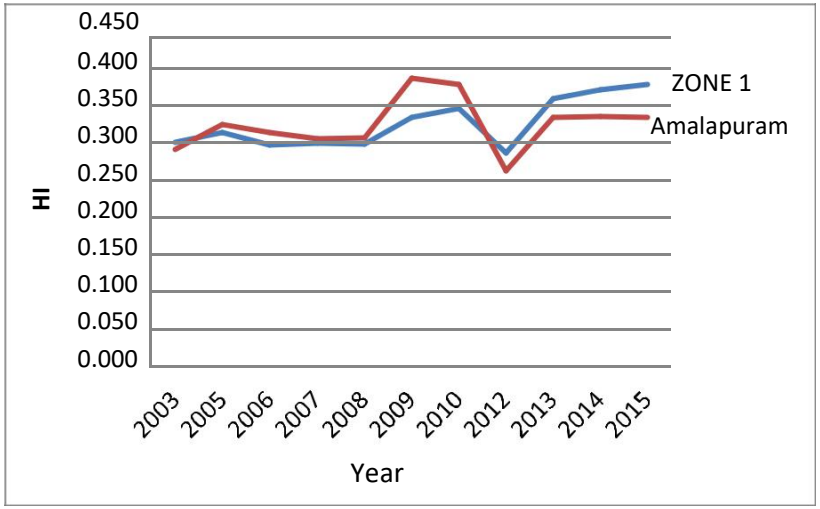
Selected mandals and their respective zone wise Herfindahl index (HI) values over the years are presented in Fig. 4.3. From zone 1, Amalapuram was selected as discussed earlier in chapter 3. Compared to zone 1, Amalpuram has low HI value which shows increasing diversification. In contrast, remaining selected mandals show higher HI compared to corresponding zones which shows increasing specialization.

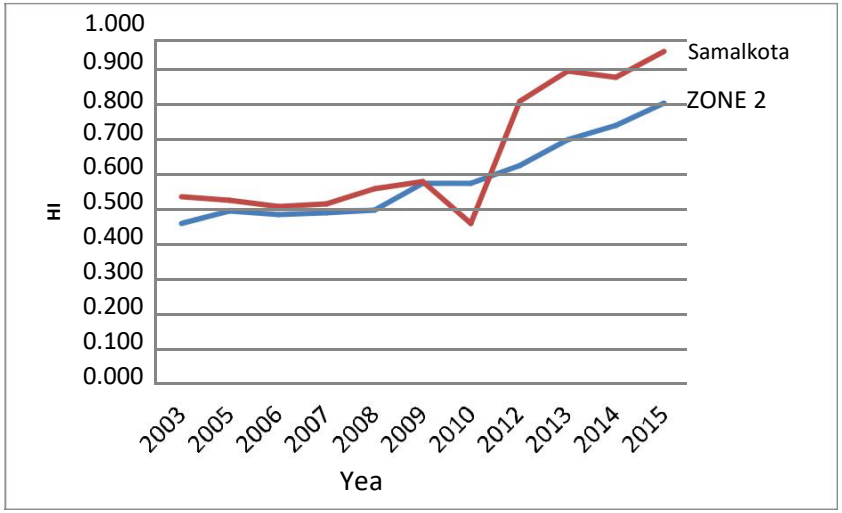
Figure 4.2 Nature and extent of crop diversification in selected mandals of East Godavari district.

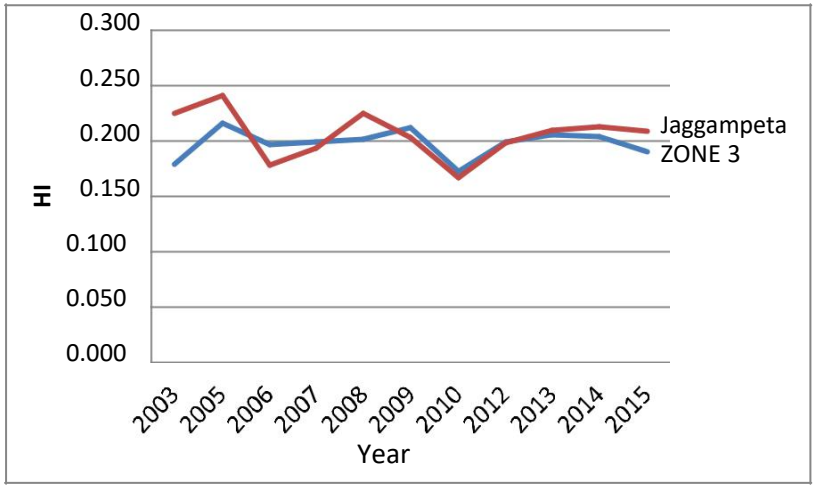


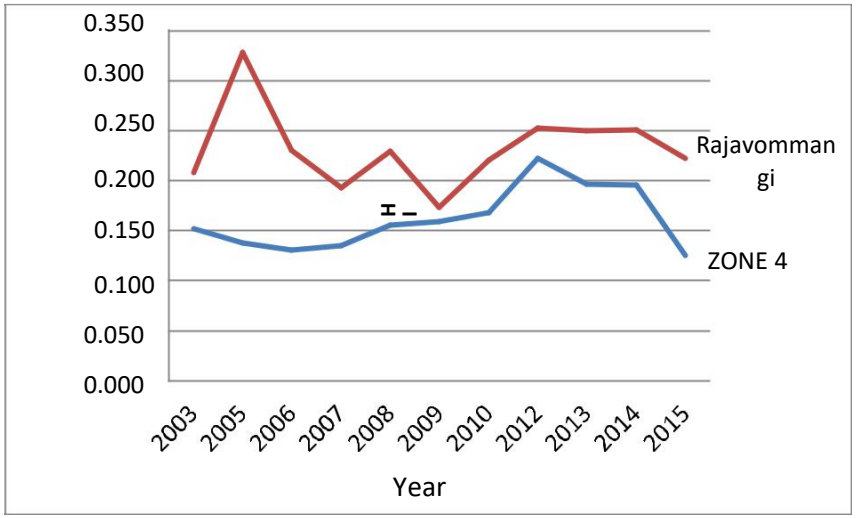
Source: Hand Book of Statistics, East Godavari.

Figure 4.3 Diversification pattern in selected mandals & corresponding zones









4.2 Determinants of crop diversification

Diversification offers a wider choice in the production of crops in the given area. The shift in cultivation from traditional, less-remunerative crops to higher-value crops leads to higher incomes for the producer. At the same time, cultivation of a variety of crops reduces risk. Several quantitative and qualitative factors can induce a shift in the crops grown. Using both primary and secondary data, an attempt was made to identify and to test the effect of different socio-economic variables on diversification towards high-value crops.

4.2.1General characteristics of sampled farmers

As stated in methodology chapter sampled farmers were post stratified into four groups based on farm size. Hence general and other characteristics of farmers were analysed and discussed according to this classification only. Details of general characteristics of sample farmers are examined in Table 4.6 and are discussed here. The average family size of sampled farmer households is 6. Among sampled farmers, most of the farmers (30% of total farmers) belonged to the age category of between 36-45 years. However in marginal and medium category farmers, share of farmers aged above 55 years was highest. Share of farmers aged above 55 years ranged from 22.64% to 33.33% across different category farmers. 50.63% of farmers were illiterates followed by farmers with secondary education i.e., 6^{th} class to 10^{th} class (36.25%). In three categories i.e., marginal, small and semi medium some farmers completed intermediate, their share ranged from 1.8 to 2.5 percent. In none of the categories farmers with graduation & above qualification were observed.

Table 4.6 General characteristics of sampled farmers

Particulars	Farm size category				**All**
	Marginal	**Small**	**Semi medium**	**Medium**	
Sample size	40 (25)	55 (34.38)	53 (33.13)	12 (7.5)	160
Average family size	5.3	5.5	5.7	5.8	5.5
	Age wise distribution				
<35 years	10 (25)	12 (21.82)	10 (18.87)	3 (25)	35 (21.88)
36-45 years	11 (27.5)	18 (32.73)	16 (30.19)	3 (25)	48 (30.00)
46-55 years	7 (17.5)	11 (20)	15 (28.30)	2 (16.67)	35 (21.88)
>55 years	12 (30)	14 (25.45)	12 (22.64)	4 (33.33)	42 (26.25)
	Distribution of farmers based on education				
Illiterate	18 (45)	28 (50.91)	28 (52.83)	7 (58.33)	81 (50.63)
Primary	8 (20)	4 (7.27)	5 (9.43)	1 (8.33)	18 (11.25)
6th class to 10th class	13 (32.5)	22 (40)	19 (35.85)	4 (33.33	58 (36.25)
Intermediate (10+2)	1 (2.5)	1 (1.82)	1 (1.89)	0 (0.00)	3 (1.88)
Graduation &above	0	0	0	0	0

Note: Figures in parentheses indicate percentage to total

4.2.2 Land ownership details of sampled farmers

Details of land ownership of sampled farmers are presented in Table 4.7.

Out of 160 farmers, 72 were pure tenant farmers i.e., 45% of sampled farmers were pure tenants. Share of tenant farmers ranged from 39.6 % to 52.7 % across farm size categories. Share of tenant farmers was maximum (52.7%) in case of small farmers and minimum in case of semi medium farmers. The average size of holding was 1.77 ha amongst the respondents. It varied from 0.62 ha on marginal farms to 4.15 ha on medium farms.

Table 4.7 Land ownership details of sampled farmers (ha)

Particulars	Farm size category				**All**
	Marginal	**Small**	**Semi medium**	**Medium**	
Number of fully owned farmers	21	16	23	6	66
Number of tenant/ leased in farmers	16	29	21	6	72
Number of partially owned farmers (owned+ tenant)	3	10	9	0	22
Share of pure tenant farmers (%)	40.0	52.7	39.6	50.0	45.0
Average size of Owned farms	0.57	1.31	2.46	4.25	1.74
Average size of tenant farms	0.66	1.38	2.43	4.05	1.76
Average size of partially owned farms	0.81	1.42	2.88	NA	1.91
Average farm size	0.62	1.37	2.52	4.15	1.77

NA – Not Available

4.2.3 Cropping pattern of sampled farmers

Details of cropping pattern of sampled farmers are given in Table 4.8. In aggregate level & in all farm size categories major crop was paddy, its share ranged from 72.83% to 78.86%. In marginal and medium farmers tapioca followed paddy. Second major crop in case of small, semi medium farmers and also at aggregate level was cotton. Share of fruits and vegetables (i.e., tapioca and banana) ranged from 2.72% to 12.38% across different farm size categories. It was highest in small category farms and lowest on semi medium farms. Out of 160 farmers, 145 farmers cultivate paddy whereas 21 farmers have high value crops.

Table 4.8 Details of cropping pattern of sampled farmers in 2015-16 (in ha.)

Particulars	Marginal	Small	Semi medium	Medium	Total
Paddy	**18.42 (73.98)**	**54.80 (72.83)**	**97.98 (73.34)**	**39.27 (78.86)**	**210.47 (74.23)**
Tapioca	**2.02 (8.13)**	6.48 (8.61)	3.24 (2.42)	**6.07 (12.19)**	17.81 (6.28)
Black gram	1.21 (4.88)	2.43 (3.23)	0.81 (0.61)	2.02 (4.06)	6.48 (2.28)
Cotton	1.62 (6.50)	**7.49 (9.95)**	**25.10 (18.79)**	2.02 (4.06)	**36.23 (12.78)**
Sugarcane	1.21 (4.88)	0.00 (0.00)	4.05 (3.03)	0.00 (0.00)	5.26 (1.86)
Banana	0.40 (1.63)	2.83 (3.77)	0.40 (0.30)	0.00 (0.00)	3.64 (1.29)
Coconut	0.00 (0.00)	1.21 (1.61)	2.02 (1.52)	0.40 (0.81)	3.64 (1.29)
All crops	24.9 (100)	75.24 (100)	133.60 (100)	49.80 (100)	283.54 (100)

Figures in the parenthesis represent percentage to total.

4.2.4 Diversification and farm income of sampled farmers

For analyzing overall diversification level of sampled farmers, HI value was calculated for each farmer and also different farm groups. HI value of sampled farmers was lower in case of owned farmers compared to pure tenant farmers across all farm size categories, which means owned farmers were more diversified than tenant farmers (Table 4.9). HI value on partially owned farms across all size categories was lower than pure tenant category indicating that partially owned farms were more diversified than pure tenant farms.

In medium category farms all farms were either owned farms or purely tenant farms i.e., there was no partially owned farm in this category. On marginal and small farms partially owned farms were more diversified than owned farms. But in the category of semi medium farms owned farms were more diversified than partially owned farms. Diversification was highest on small farms in tenant category, partially owned category and pooled farms. Among owned farms diversification was highest in semi medium category farms.

Table 4.9 Details of diversification and farm income of sampled farmers (2015-16)

Particulars	Ownership	Farm size category				All
		Marginal	**Small**	**Semi medium**	**Medium**	
Herfindahl Index (HI)	Owned	0.58	0.58	0.43	0.58	0.48
	Tenant	0.63	0.61	0.80	0.72	0.70
	Partially Owned	0.39	0.38	0.60	NA	0.50
	Pooled	0.56	0.55	0.57	0.64	0.57
Average gross income/ ha (Rs.)	Owned	88694.27	80537.72	93355.68	78851.42	87321.25
	Tenant	101542.7	81534.95	79446.67	81699.37	82393.28
	Partially Owned	68042.33	109808.08	83990.99	NA	91685.34
	Pooled	92111.28	86581.24	86228.79	80240.66	86290.49

Average gross income ranged from Rs. 68042.33 to Rs. 109808.08 across farm size categories and across tenancy categories. At aggregate level, average gross income of sampled farmers was lower in case of tenant farmers (Rs. 82393.28) compared to owned farms. This pattern is correlating with diversification i.e., specialization of crops yielded low income. Among small farmers especially partially owned farmers have lower HI value (0.38) resulted in higher average gross income (Rs. 109808.08). Gross income per ha was inversely related with farm size as reported in Maila lama (2016).

4.2.5 Determinants of crop diversification using primary data

In order to identify determinants of crop diversification, linear regression analysis was carried out using primary data and the results are presented in Table 4.10. 1-Herfindahl index (1-HI) was taken as dependent variable.

Based on insights drawn from review of literature, the following factors were considered as explanatory variables in the study i.e., farming experience, age, education, total land of farmer, number of family members participating in agriculture, market distance from village, and share of irrigated area. The expected relation between farming experience and diversification is empirical; similarly the expected relation between age and diversification, education and diversification is also empirical. Many studies indicated that farm size influenced diversification (Birthal *et al.,* 2006 and Monika *et al.,* 2017). To analyze the effect of farm size on diversification in the present study, total land in ha was considered as an explanatory variable. Some studies indicated that higher labour availability in terms of more family labour participation leads to more diversification towards crops like vegetables i.e., labour intensive crops (Birthal *et al.,* 2006). Some studies indicated lower is the market distance higher is the diversification towards fruits and vegetables as there is more demand for these commodities in urban centres and also quick transferability. So market distance variable was considered as one of the explanatory variable. Many studies indicated diversification is more in rainfed areas, hence share of irrigated area in total cropped area was considered as explanatory variable in the current study (Joshi *et al.,* 2003; Mithiya *et al.,* 2018).

Table 4.10 Determinants of crop diversification using primary data (2015-16).

	Dependent variable : 1-HI		
	Coefficients	Standard Error	P-value
Intercept	-0.020	0.153	0.896
Farming experience (years)	-0.001	0.003	0.852
Age (years)	0.001	0.003	0.867
Participation in agriculture (years)	0.044	0.036	0.232
Education(years)	0.001	0.003	0.815
Total land in ha	0.029	0.012	0.015
Market distance (km)	0.000	0.005	0.936
Share of irrigated area (%)	-0.001	0.000	0.145
Partially owned (dummy)	0.214	0.043	0.000
Owned (dummy)	0.081	0.035	0.021
Institutional credit (dummy)	-0.031	0.036	0.401
Non-institutional credit (dummy)	-0.052	0.032	0.098
MD1 (dummy)	-0.037	0.067	0.577
MD2 (dummy)	0.193	0.090	0.034
MD3 (dummy)	0.135	0.055	0.015
Observations		160	
R Square		0.50	
Adjusted R Square		0.45	
Standard Error		0.16	

To capture the effect of agro ecological diversity on diversification, mandal dummies (MD1, MD2, MD3) were used. Murali and Vijay (2017) reported that tenancy is constraining diversification. Keeping this in view in the present study effect of tenancy on diversification was analyzed using dummy variables. An attempt has been made in the present study to examine the influence of credit on diversification using dummies. Further the farmers who have taken credit were categorized into farmers taking credit from institutional sources and farmers taking credit from non institutional sources. Accordingly dummies were introduced in the

model, one is for taking loans from institutions, other is for taking loans from private lenders (non institutional credit).

Among the variables considered in the study five variables were influencing diversification negatively they are farming experience, share of irrigated area, non institutional credit, institutional credit and one mandal dummy. Total land was positively influencing diversification and was significant. Education showed a positive influence on crop diversification but it was not significant. This is in line with expectation that education helps the farmers in taking conscientious decisions and enables them in accessing several facilities which are required for crop diversification. Number of family members participating in agriculture, which represents the assured labour availability, was positively influencing overall crop diversification. This indicates that availability of more family labour induces the farmers to diversify crops.

It is observed that ownership of land both complete and partial were having positive influence on diversification compared to pure tenants. Non institutional credit was influencing diversification negatively compared to farmers who have not taken any loan. Among dummy variables, only in case of Jaggampeta (MD2) and Rajavommangi mandal (MD3), the mandal dummy effect positive and significant. In the case of Samalkota mandal (MD1), the effect of dummy was negative as the mandal was the highest specialized mandal among the selected four mandals. Age and market distance influenced crop diversification positively but both the variables observed to be non significant. In contrast farming experience and share of irrigated area negatively influenced crop diversification. Overall the model was able to explain 50% of variation in crop diversification.

For analyzing determinants of diversification towards high value crops namely fruits and vegetables using primary data, Linear Probability Model (LPM) was carried out (Table 4.11). Since some of the farmers don’t have the area under high value crops, hence LPM was used by taking binary values as dependent variable i.e., 1 for presence of high value crops and 0 for absence of high value crops.

Among the variables only farming experience, tenancy dummies, non institutional credit dummy and MD2 had positive influence on high value crops. It means if increase in above variables leads to probability of increase in area under high value crops. But none of them were statistically significant. Only share of irrigated area and partially owned dummy were statistically significant. Overall this model is able to explain 31 % of variation in high value crops.

Table 4.11 Determinants of diversification towards fruits and vegetables.

Dependent variable : Binary values (0/1)			
	Coefficients	**Standard Error**	**P-value**
Intercept	0.617	0.288	0.034
Farming experience (years)	0.000	0.006	0.940
Age (years)	-0.002	0.006	0.784
Participation in agriculture (years)	-0.061	0.068	0.372
Education(years)	-0.003	0.006	0.599
Total land in ha	-0.009	0.022	0.687
Market distance (km)	-0.005	0.009	0.543
Share of irrigated area (%)	-0.004	0.001	0.000
Partially owned (dummy)	0.148	0.081	0.068
Owned (dummy)	0.000	0.066	1.000
Institutional credit (dummy)	-0.013	0.068	0.852
Non-institutional credit (dummy)	0.042	0.059	0.476
MD1 (dummy)	-0.043	0.125	0.733
MD2 (dummy)	0.190	0.169	0.263
MD3 (dummy)	-0.011	0.103	0.914
Observations		160	
R Square		0.314	
Adjusted R Square		0.248	
Standard Error		0.294	

4.2.6 Determinants of crop diversification using secondary data

Apart from primary data, analysis of determinants of crop diversification was also carried out using secondary data of all the mandals of East Godavari district with two alternative models (Table.4.12). In the model.1, one minus Herfindahl Index was used as the dependent variable. In the second model share of high value crops was used as dependent variable. To capture the effect of agro ecological diversity 3 zonal dummies (ZD1, ZD2, and ZD3) were used. Other explanatory variables considered in the analysis were average farm size, share of agricultural labours and cultivators in total population, actual and lagged rainfall, share of canal irrigated area, share of urban population, area available for unit agricultural labour, GIA share in GSA, land inequality ratio, share of small and marginal farmers in total farmers.

It is observed that average farm size was statistically significant in both the models, positively influenced diversification towards high value crops, but negatively influenced overall diversification. It is pertinent to note here that in East-Godavari district share of fruits is more in high value crops, and cultivation of fruits being capital intensive, might led to positive relation between average farm size and diversification towards high value crops. This observation is in line with observations made by Birthal *et al.,* 2013 and Lakshmi, 2015. Irrespective of diversification measure, GIA share in GSA and share of canal irrigated area negatively influenced diversification (Table.4.12). These results are in line with reporting by Joshi *et al.,* 2003. Both these variables observed to be statistically significant in model 1 whereas in model 2 only share of canal irrigated area was statistically significant.

Both actual and lagged rainfalls were used as explanatory variables separately. The variable which gave better fit in the model was retained. In the model 1 actual rainfall was significant and in the second model lagged rainfall was significant. The effect of rainfall on diversification was positive in both the models. Share of urban population positively influenced diversification towards high value crops and negatively influenced overall diversification but statistically non significant in both the models.

Table 4.12 Determinants of crop diversification using secondary data (2014-15).

Model 1	Dependent variable: 1-Herfindahl index		
	Coefficients	Standard Error	P-value
Intercept	3.3823	1.0742	0.0028
Average farm size (ha)	-0.5371	0.1877	0.0062
Share of agricultural labours and cultivars in total population (%)	0.0005	0.0033	0.8802
Actual rainfall (2014-15)	0.0002	0.0001	0.0697
Share of canal irrigated area (%)	-0.0035	0.0005	0.0000
Share of urban population (%)	-0.0009	0.0011	0.3881
Area available per agril. labour (ha)	-0.1752	0.0814	0.0364
GIA share in GSA	-0.0030	0.0008	0.0007
Share of marginal and small farmers in total farmers(No.)	-0.0207	0.0109	0.0631
ZD1 (dummy)	-0.1269	0.1770	0.4770
ZD2 (dummy)	-0.3446	0.1727	0.0517
ZD3(dummy)	-0.0206	0.1574	0.8966
Observations		60	
R Square		0.91	
Adjusted R Square		0.89	
Standard Error		0.09	
Model 2	**Dependent variable: Share of high value crops**		
	Coefficients	Standard Error	P-value
Intercept	2.5458	28.9563	0.9303
Average farm size (ha)	21.4093	10.0758	0.0388
Share of agricultural labours and cultivars in total population (%)	0.5680	0.3278	0.0895
Lagged rainfall (2013-14)	0.0118	0.0070	0.0997
Share of canal irrigated area (%)	-0.2858	0.0523	0.0000
Share of urban population (%)	0.0573	0.1056	0.5895
Area available per agril. labour (ha)	-26.8521	8.1684	0.0019
GIA share in GSA	-0.1361	0.0871	0.1246
Land inequality (Gini ratio)	-28.0597	35.5179	0.4334
ZD1 (dummy)	20.0433	15.9374	0.2146
ZD2 (dummy)	16.5029	15.3284	0.2870
ZD3(dummy)	16.2930	13.6418	0.2382
Observations		60	
R Square		0.75	
Adjusted R Square		0.69	
Standard Error		9.07	

Both in the case of overall diversification and diversification towards high value crops the variables (i) share of cultivators and agricultural labours in total population had positive influence and (ii) area available per agricultural labour which was statistically significant, had negative influence. This is indicating higher is the share of population engaged in agriculture more is diversification. It is also observed that land inequity negatively influenced diversification towards high value crops, whereas share of small and marginal farmers in total farmers was statistically significant and negatively influenced overall crop diversification. Coming to zonal dummies, all the three zone dummies negatively influenced overall diversification and positively influenced diversification towards high value crops. This indicates compared to Agency area zone (zone 4), in other three zones diversification towards high value crops was more and overall diversification was less. Overall the model 1 is able to explain 91% of variation in overall crop diversification whereas model 2 was able to explain 75 % of variation in share of high value crops.

4.3 Impact of crop diversification on farm income

4.3.1 Costs and returns of crops grown by farmers

Before discussing the impact of crop diversification on farm income, the economics of crops grown by the sampled farmers is presented in Table 4.13. From the table it is evident that the total cost of cultivation per hectare was highest on coconut and lowest in black gram. Gross returns were highest in case of banana (Rs.336194.44) followed by sugarcane (Rs.285000). Returns over variable cost were positive in all the crops. On the contrary, returns over total cost were negative in all the crops except in sugarcane and banana. Though these costs and returns are not comparable due to different durations of crops, this attempt was made to give a broader sense about the cost of cultivation of different crops growing in East Godavari district.

Table 4.13 Costs and returns of crops grown by farmers in 2015-16 (Rs/ha)

Particulars	Crops						
	Paddy	**Cotton**	**Banana**	**Sugarcane**	**Tapioca**	**Black gram**	**Coconut**
Operational cost	63740.79	60516.10	129957.68	108121.40	56301.97	18847.75	139384.84
Interest on working capital	929.55	882.53	4548.52	3784.25	1149.50	164.92	9756.94
Total variable cost	64670.35	61398.63	134506.20	111905.65	57451.46	19012.66	149141.78
Total fixed cost	32736.58	28041.20	26973.77	12728.10	35078.03	37512.10	26825.44
Total cost	97406.93	89439.83	161479.97	124633.75	92529.49	56524.76	175967.22
Gross returns	79388.39	72789.11	336194.44	285000.00	77355.91	49400.00	148694.00
Returns over variable cost	14718.04	11390.48	206236.77	176878.60	21053.94	30552.25	9309.16
Returns over total cost	-18018.54	-16650.72	174714.48	160366.25	-15173.58	-7124.76	-27273.22

4.3.2 Impact of crop diversification on farm income using primary data

To know the impact of diversification on farm income, linear regression analysis was carried out using primary data with Gross returns/ha as a dependent variable (Table.4.14). For this analysis, gross returns were computed from all the crops grown by each farmer. Analysis clearly showed that gross returns per hectare increased with increase in crop diversification (1-HI). Crop diversification was observed to be statistically significant.

Table 4.14 Impact of crop diversification on farm income using primary data (2015-16).

Dependent variable : Gross returns/ha			
	Coefficients	Standard Error	P-value
Intercept	-29598.15	8463.08	0.00
1-HI	16226.82	9606.23	0.09
Total land (ha)	2361.11	1408.64	0.10
Share of irrigated area (%)	216.41	59.13	0.00
Fertilizer (kg/ha)	232.59	9.61	0.00
Farming experience (years)	182.92	126.69	0.15
Education(in years)	-19.94	374.28	0.96
Partially owned (dummy)	-3798.87	5380.12	0.48
Owned (dummy)	2631.76	4103.26	0.52
Institutional credit (dummy)	-2937.82	4212.32	0.49
Non-institutional credit (dummy)	5357.44	3683.09	0.15
MD1 (dummy)	833.75	4278.31	0.85
MD2 (dummy)	-6212.54	5079.89	0.22
MD3 (dummy)	11367.23	5201.83	0.03
Observations		160	
R Square		0.84	
Adjusted R Square		0.82	
Standard Error		18060.68	

Thus both tabular analysis (Table 4.9) and regression analysis (Table 4.14) showed positive effect of crop diversification on gross income of farmers. These observed results corroborate with expected hypothesis that diversification increases income from crops. Gross income per ha was inversely related to education of the farmer but was not statistically significant. Total land in ha, share of irrigated area, fertilizer consumption/ha, farming experience positively influenced gross returns/ha. Out of all these variables except farming experience, remaining were statistically significant. Among dummy variables, only in case of Samalkota (MD1) and Rajavommangi (MD3) mandal, the mandal dummy effect positive. In the case of Jaggampeta mandal (MD2), the effect of dummy was negative. Among mandal dummies only MD3 was statistically significant. Among credit dummies, institutional credit dummy influence was negative and credit from non institutional sources was positive on gross returns compared to farmers who have not taken loan. Partial ownership of land negatively influenced gross returns whereas complete ownership of land positively influenced gross returns. The values of R-square and adjusted R-square were found to be 0.84 and 0.82 respectively which are fairly high indicating good explanatory power of the variables included in the model.

4.3.3 Impact of diversification on farm income using secondary data.

Analysis of impact of diversification on farm income using secondary data was carried out in two models and presented in Table 4.15.

It is clear from the table that GVA from crops per hectare increased with increase in share of high value crops and decreased with increase in diversification. Both these variables were observed to be statistically significant. These observed results corroborate with expected hypothesis that diversification towards high value crops increases income from crops. Rice area share had negative influence on GVA/ha. The negative influence of share of rice area on GVA can be due to paddy glut and other market related issues with paddy as reported by Ramanamurthy (2011). Crop income per ha was positively related to both farm size and land inequality. But both of them were statistically non significant. Ratio of non-agriculture to

agriculture GVA a indicative measure of terms of trade, influenced GVA from agriculture positively. Fertilizer consumption per hectare positively influenced GVA whereas GIA share in GSA negatively influenced GVA but only GIA share in GSA was statistically significant. All the zonal dummies positively influenced GVA/ha but only ZD1 and ZD2 were statistically significant. Overall the model was able to explain 90 % of variation in GVA per ha.

Table 4.15 Impact of diversification on farm income using secondary data (2014-15).

	Dependent variable : GVA/ ha		
	Coefficients	Standard Error	P-value
Intercept	115426.01	30188.08	0.00
Land inequality (Gini ratio)	75154.60	47821.95	0.12
Average farm size (ha)	6534.21	13709.71	0.64
High value crops (%)	533.52	194.11	0.01
Rice area share (%)	-536.75	177.26	0.00
Ratio of non agril GVA to agril GVA	35.56	13.12	0.01
Fertilizer consumption (kg/ha)	8.28	8.38	0.33
GIA share in GSA	-635.71	131.13	0.00
ZD1 (dummy)	59235.53	20501.73	0.01
ZD2 (dummy)	49801.92	20715.02	0.02
ZD3 (dummy)	20958.13	17203.99	0.23
Observations		60	
R Square		0.90	
Adjusted R Square		0.88	
Standard Error		11522.61	

4.4 Problems and prospects of crop diversification:

An opinion survey of selected 160 farmers was conducted on aspects such as motives behind crop diversification and constraints in crop diversification. The responses were analyzed and discussed in this section.

4.4.1 Reasons for crop diversification

Out of 160 farmers only 57 farmers were diversified (Table 4.16). Among diversified farmers, 45.6 percent farmers have diversified with the view of increasing income whereas 31.5 % farmers were diversified with the motive of mitigating risk. For satisfying their family food needs 14% farmers have diversified and due to presence to large size of farm 8.7 % were diversified.

Table 4.16 Reasons for crop diversification

Diversified reasons	Number	%
Increasing income	26	45.61
Mitigating risk	18	31.58
Family food needs	8	14.04
Large size of farm	5	8.77
Total	57	100.00

4.4.2 Reasons for non diversification

From Table 4.17 it is clear that out of 160 farmers, 103 (64%) farmers were not diversified, i.e., they cultivated only single crop. Out of 103 farmers, 86 percent of farmers cultivated paddy crop followed by cotton (5 percent) and tapioca (4 percent) among non diversified farmers. Remaining 5 percent non diversified farmers cultivated banana, black gram and sugarcane.

Table 4.17 Reasons for non diversification

Non diversified reasons	Number	%
Land is suitable for particular crop only	46	44.66
No awareness about benefits of crop diversification	35	33.98
Small size of farm	18	17.48
Unavailability of adequate labour	3	2.91
Others	1	0.97
Total	103	100

Majority of farmers were (44.66%) not diversified because of the land suitability to the particular crop only. This was the major problem faced by all the sample

farmers irrespective of the size of the farm holdings. According to the survey conducted on the study area, it is observed that about 50 per cent farmers faced the problem of illiteracy (Table 4.6). Due to this illiteracy, lack of awareness about the benefits of crop diversification was another reason for farmer's not practising diversification (33.98 per cent among non diversified farmers). Small size of farm was also felt as the problems in crop diversification by 17.48 % of non diversified farmers.

It is then concluded that even though diversification showed positive influence on farm income, due to the reasons discussed above in table 4.17 farmers were not able to diversify crops. There are several other constraints like lack of capital, interlocking of capital etc., also felt by the farmers. Some of them are related with the extension agencies and therefore it should be strengthened.

CHAPTER - V
SUMMARY AND CONCLUSIONS

5.1 Summary

Crop diversification represents the growing of a variety of agricultural crops that are commercially viable and locally acceptable. It means moving away from growing a single crop to a number of crops. With the increase of population traditional agriculture could not meet the food requirements and therefore diversification was desirable. Crop diversification is a popular strategy to maximize the use of land, water and other resources. It can meet different requirements of people's food and nutritional demand and can generate earnings for farmers. The diversification in agriculture is also practiced with a view to avoiding risk and uncertainty due to climatic and biological vagaries. Some studies have showed that crop diversification can aid in improving farmers income. Hence crop diversification is an important strategy for overall agriculture development in the country.

In this backdrop the present study has been conducted with the following specific objectives:

1. To examine the trend and pattern of crop diversification in East Godavari district.
2. To identify determinants of crop diversification in East Godavari district.
3. To evaluate the impact of crop diversification on farm income in East Godavari district.
4. To identify the problems and prospects in crop diversification.

Andhra Pradesh (A.P.) state was selected purposively for the present study. From the A.P State, East Godavari district was selected purposely because it stood at 4^{th} rank in District wise and sub sector wise Gross Value Added (GVA) in agriculture in 2014-15 & 2015-16 also. HI was calculated for all the mandals of East Godavari district based on area under different crops in 2014-15. Then four mandals were selected, Samalkota from low diversified group, Amalapuram from

medium diversified group and Jaggampeta, Rajavommmangi from high diversified group so as to have representation from all four agro-climatic zones of the district. From each selected mandal, two villages were selected. A sample of 20 farmers from each of the selected village were selected randomly. Thus a total 160 farmers constituted sample for primary data in present study. Primary data was collected using separate specifically designed and pretested schedules for farmers. For further analysis farmers were post stratified into marginal (<1 ha), Small (1-2 ha), semi medium (2-4 ha) and medium (4-10 ha) categories based on the size of their operational land holdings. Primary data was collected from farmers regarding costs and returns of different crops in the year 2015-16.

The study is based on both primary as well as secondary data. Secondary data was collected from review of literatures and from various government publication sources including the various departments such as Directorate of Economics and Statistics, Government of Andhra Pradesh, Department of Horticulture other authentic sources.

Both tabular and functional analysis was carried out in the study for getting insights. The concept used in the study for measuring the extent of diversification was Herfindahl Index (HI). Gini ratio was used for measuring the land inequality. For analysing extent of influence of different socio-economic factors on diversification, linear regression analysis and linear probability model were carried out.

Examination of general characteristics and socio- economic features of the district and selected mandals revealed the following facts. The per capita income at current price in 2015 - 16 was Rs.105000 in East Godavari. The GVA from agriculture and allied sectors in 2015-16 was Rs.16396 crores which accounted for 27 % to total GVA of district. In East Godavari 75% of population live in rural areas. Rural population was 100 % in case of Jaggampeta and Rajavommangi mandals. But the share of cultivators in agricultural workers was highest in Rajavommangi mandal. Literacy rate was higher in Amalapuram mandal (84.22%) compared to other selected mandals.

It was observed that in East Godavari Gross Sown Area (GSA) increased in year 2008 compared to year 2003. In the years 2013 and 2015, GSA at district level was more than GSA of year 2003 but lesser than GSA in year 2008. Similarly in the years 2013 and 2015, NSA at district level was more than NSA of year 2003 but lesser than NSA in year 2008. In East Godavari both NIA and GIA increased during the years 2003 to 2008 and then declined.

In 2003, paddy constituted 48.62 % of GSA followed by fruits (10.33%) and black gram (9.45%). In 2015 paddy (57.63%) occupied the major share of GSA followed by fruits (11.44%) and coconut (7.36%). Gross sown area of East Godavari showed a growth rate of 0.85%.

In the year 2003 in Samalkota cereals occupied major share in GSA (69.69 %) followed by pulses (27.64 %). In 2015 pulses share was drastically decreased to 1 % which was replaced with paddy leading to increased paddy share (97%) in the mandal. Results showed that, in Jaggampeta and Rajavommangi mandals fruits and vegetables constituted major share in GSA in the year 2003 but it was reduced in the year 2015. In Amalapuram paddy occupied major share in both the years followed by oil seeds.

In East Godavari paddy area share increased from 49 % to 58 % over the years. Across selected mandals greater change was observed in Samalkota i.e., increase in share of paddy area by 27 points during the years 2003-15. It was observed that top 1 crop in East Godavari was paddy in both the years 2003 & 2015. 2^{nd} major crop was black gram in 2003 but in 2015 2^{nd} major crop was fruits. In the year 2003 among selected mandals only in Samalkota paddy was the top 1 crop but in the year 2015 in all the selected mandals as well as at district level paddy became the top 1 crop. From 2003 to 2015 growth rate of paddy was 2.55 % in East Godavari whereas in selected mandals ranged from 1.20% in Amalapuram to 37.85% in Jaggampeta.

Results indicated that HI value in East Godavari increased in the year 2003 (0.273) to the year 2015 (0.357). In Samalkota mandal HI value increased from 0.527 to 0.941 indicating increased specialization. In Jaggampeta mandal, HI value

decreased from 0.225 to 0.208 (indicating movement towards diversification) whereas in Rajavommangi mandal HI value increased from 0.208 to 0.222 (indicating movement towards specialization). In Amalapuram HI value increased from 0.291 to 0.334. Hence among selected four mandals only in the case of Jaggampeta, HI decreased in the 2014-15 compared to the year 2002-03.

- Among sampled farmers, most of the farmers (30% of total farmers) belonged to the age category of between 36-45 years.
- Out of 160 farmers, 72 were pure tenant farmers i.e., 45% of sampled farmers were pure tenants. Share of tenant farmers ranged from 39.6 % to 52.7 % across farm size categories. Share of tenant farmers was maximum (52.7%) in case of small farmers and minimum in case of semi medium farmers.
- It was observed that the average size of holding was 1.77 ha amongst the respondents. It varied from 0.62 ha on marginal farms to 4.15 ha on medium farms.
- In aggregate level and across all farm size categories of sampled farmers major crop was paddy, its share ranged from 72.83% to 78.86%.
- Results indicated that share of fruits and vegetables in case of sampled farmers ranged from 2.72% to 12.38% across different farm size categories. It was highest in small category farms and lowest on semi medium farms.
- It was observed that average gross income ranged from Rs. 68042.33 to Rs. 109808.08 across farm size categories and across tenancy categories. At aggregate level, average gross income of sampled farmers was lower in case of tenant farmers (Rs. 82393.28) compared to owned farms(Rs.87321.25).
- Analysis of determinants of crop diversification using primary data with 1-HI as dependent variable was carried out. It revealed that age, number of family members participating in agriculture, education of farmer, total land in ha, market distance, ownership dummies, mandal dummies MD 2 and MD 3 had positive influence towards overall diversification.
- Analysis of determinants of crop diversification using primary data with high value crops as dependent variable was carried out. It showed that farmig experience, ownership dummies, non institutional credit dummy and MD 2

were having positive influence towards probability of cultivating high value crops.

- Analysis of determinants of crop diversification using secondary data with 1-HI as dependent variable was carried out. It revealed that only share of agricultural labours and cultivators in total population and actual rainfall had positive influence towards overall crop diversification.
- Analysis of determinants of crop diversification using secondary data with high value crops as dependent variable was carried out. It showed that average farm size, share of agricultural labours and cultivators in total population, actual rainfall, share of urban population, and three zonal dummies had positive influence towards share of high value crops.
- Analysis of impact of crop diversification on farm income using primary data with gross returns/ha as dependent variable was carried. It showed that 1-HI, total land, share of irrigated area, fertilizer consumption, education, owned land dummy, non- institutional credit dummy, MD 1 and MD 3 had positive influence towards gross returns/ha.
- Analysis of impact of crop diversification using secondary data with GVA/ha as dependent variable was carried out. It showed that high value crop share, ratio of non agril GVA to agril GVA had positive influence with GVA/ha.

The major constraints reported by the farmers for not diversifying crops were land is suitable for particuar crop only (47%), no awareness about benefits of crop diversification(34%), small size of farm (17%) and unavailability of labour etc,.

5.2 Conclusions:

The following conclusions were derived from the analysis of the collected data under study.

1. Over the years, diversification decreased in district as well as in the selected mandals except in Jaggampeta.
2. Diversification showed positive influence on farm income, due to the constraints discussed above; farmers were not able to diversify crops.
3. In the years 2003 & 2008 there were no mandals coming under 4^{th} group i.e., HI more than 0.75. Due to increased specialization, some of the mandals moved into 4^{th} group in recent years.

4. In irrigated areas, diversification is less.
5. Soil suitability and tenancy were restricting diversification.

5.3 Policy implications

1. As market distance showed positive influence towards crop diversification, infrastructure plays an important role in the process of diversification. It is suggesting the need for increased public investment in the development of markets and roads to help accelerate the pace of diversification.
2. Even though diversification showed positive influence on farm income, due to the constraints, farmers were not able to diversify crops. Hence one option is to promote optimum use of resources in existing cropping pattern on sustainable basis.
3. According to the survey, it is observed that about 50 per cent farmers faced the problem of illiteracy. Due to this illiteracy, lack of awareness about the benefits of crop diversification was another reason for farmer's not practising diversification. The adequately trained human resources is the need of the hour in agricultural sector. Therefore, the provision of training and skill-formation should be arranged on a larger scale for the agriculturalists.
4. Land size showed positive influence on diversification and also on gross returns. Apart from this small size of farm is one of constraint for non diversification, hence pooling of land is recommended.
5. As tenancy is a problem land policies in should be formulated to enhance efficient utilization of land while protecting the land rights of the poor.

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Appendix A

Descriptive statistics of variables used in regression analysis of primary data

	Mean	Standard Error	Median	Mode	Standard Deviation	Sample Variance	Range	Minimum	Maximum	Count
1-HI	0.15	0.02	0.00	0.00	0.21	0.04	0.50	0.00	0.50	160
Total land in ha	1.77	0.09	1.62	1.21	1.08	1.17	5.87	0.20	6.07	160
Age	47.46	0.99	45.00	45.00	12.46	155.36	60.00	20.00	80.00	160
Education(in years)	3.92	0.34	0.00	0.00	4.33	18.77	12.00	0.00	12.00	160
Farming experience	24.73	1.01	22.50	15.00	12.80	163.73	59.00	1.00	60.00	160
Participation in agriculture	1.14	0.03	1.00	1.00	0.37	0.14	2.00	1.00	3.00	160
Share of irrigated area	83.61	2.47	100.00	100.00	31.19	972.66	100.00	0.00	100.00	160
Fertilizer kg/ha	370.79	12.90	330.05	308.75	163.18	26627.01	1160.90	148.20	1309.10	160
market distance	12.38	0.53	13.00	5.00	6.67	44.51	18.00	4.00	22.00	160
Partially owned	0.14	0.03	0.00	0.00	0.35	0.12	1.00	0.00	1.00	160
Owned	0.41	0.04	0.00	0.00	0.49	0.24	1.00	0.00	1.00	160
Institutional credit	0.33	0.04	0.00	0.00	0.47	0.22	1.00	0.00	1.00	160
Non-Institutional credit	0.28	0.04	0.00	0.00	0.45	0.20	1.00	0.00	1.00	160

Appendix B

Descriptive statistics of variables used in regression analysis of secondary data

	Mean	Standard Error	Median	Mode	Standard Deviation	Sample Variance	Range	Minimum	Maximum	Count
Average farm size	0.83	0.07	0.62	#N/A	0.53	0.28	2.16	0.38	2.54	60
Share of agricultural labours and cultivars in total population	30.66	1.41	31.05	#N/A	10.89	118.69	58.69	0.76	59.46	60
Share of Canal irrigated area	58.46	4.66	63.17	0.00	36.12	1305.00	100.00	0.00	100.00	60
Share of urban population	11.31	3.24	0.00	0.00	25.09	629.34	100.00	0.00	100.00	60
GIA share inGSA	69.14	3.53	72.32	#N/A	27.37	749.34	96.49	3.51	100.00	60
Area available per agricultural labour	0.47	0.04	0.39	#N/A	0.30	0.09	1.95	0.06	2.01	60
Lagged Rainfall (2013-14)	1086.99	23.94	1081.10	#N/A	185.45	34390.22	885.60	661.40	1547.00	60
Actual Rainfall (2014-15)	623.93	18.60	612.18	#N/A	144.07	20756.34	704.71	370.79	1075.50	60
Gini ratio	0.38	0.01	0.38	#N/A	0.06	0.00	0.32	0.27	0.59	60
Share of marginal and small farmers in total farmers(No.)	90.74	1.41	95.20	#N/A	10.94	119.58	45.63	52.30	97.93	60
Z1	0.28	0.06	0.00	0.00	0.45	0.21	1.00	0.00	1.00	60
Z2	0.30	0.06	0.00	0.00	0.46	0.21	1.00	0.00	1.00	60
Z3	0.30	0.06	0.00	0.00	0.46	0.21	1.00	0.00	1.00	60

Appendix C

Impact of Crop Diversification on Farm Income in East Godavari District of Andhra Pradesh

Date:

Name of the farmer: Phone no:

Address: S/o

Village name: Mandal name:

Age of farmer:

Education of farmer:

Gender of farmer: Male/ Female Experience in farming:

Main Occupation: Subsidary Occupation:

Details of Family: Total Participation in Agriculture

No of males:

No of females:

No of children:

No of dependents:(>60)

(<18)

Details of Holding:

Item (in acres)	Unirrigated	Irrigated	Total Area (acres)
Owned			
Leased – in			
Leased-out			
Present value/ acre			
Land revenue/cess/acre			

Crops grown:

Sno.	Crop	Variety	Acreage(acres)
	Kharif(July-October)		
1			
2			
3			
4			
	Rabi(October-March)		
1			
2			
3			
	Summer(March-June)		
1			
2			

Sources of Irrigation: (Tanks/ Canals/ Tubewells/ Dugwells/ Borewells)

Sno.	**Source**	**Area irrigated (acres)**	**Charges/ Unit**
1			
2			
3			

Location and Approach:

Sno.	**Item**	**Location**	**Distance from village (kms)**
1	Mandal headquarters		
2	District headquarters		
3	Railway/ Bus station		
4	Godown/ Warehouse		
5	Banks		
6	Wholesale/Retail Market		
7	Regulated Market		

Whether he has taken Credit ? Yes or No

If Yes what are the sources of credit?

	Item	Source	Distance	Total Amount (Rs.)	% of interest
Short term loans					
Medium term loans					
Long term loans					

Whether he has owned machinery or not? If yes

Name	Year of purchase	Purchase rate (Rs.)	Life expectancy

Whether owns Livestock or not? if yes

Sno.	Kind of livestock	Number
1	Cow	
2	Buffalo	
3		
4		

Cost of cultivation: **Crop: Rice** **Acreage:**

Sno	Operation	(A) Labour cost							(B) Material cost			
		Human (units)		Machine (hr)		wage rate(Rs.)		Amount (Rs.)	Quantity		Source of purchase (km)	Amount (Rs.)
		owned	purchased	owned	Purchased	Human day	Machine hr		Owned	Purchased		
Nursery												
1	Land ploughing											
2	Sowing											
3	Fertilizer											
	i.											
	Ii											
4	Irrigation											
Main land												
5	Application of manures											
6	Transplanting											
7	Fertilizer application											
	i.											
	ii.											
	iii.											
8	Intercultural operations/Weeding											
9	Irrigation											
10	Plant protection chemical											
	i.											
	ii.											
	iii.											
11	Harvesting											
12	Post harvesting costs											
13	Total											

Cost of cultivation: **Crop:** **Acreage:**

Variety: **Duration:**

Sno	Operation	(A) Labour cost							(B) Material cost			
		Human(units)		Machine (hr)		wage rate(Rs.)		Amount (Rs.)	Quantity		Source of purchase (km)	Amount (Rs.)
		owned	purchased	owned	Purchased	Human day	Machine hr		Owned	Purchased		
1	Land ploughing											
2	Application of manures											
3	Planting											
4	Fertilizer application											
	I											
	Ii											
	Iii											
	Iv											
5	Irrigation											
6	Intercultural operations/ weeding											
7	Plant protection chemicals											
	I											
	Ii											
	Iii											
8	Harvesting											
9	Post harvesting costs											
	Total											

C) Interest on working Capital

D) Fixed costs

i. Land revenue/ acre

ii. Depreciation

iii. Rental value of land /acre

iv. Interest on fixed capital

Total cost (A+B+C+D)

Returns from crop enterprise:

Sno.	Name of the crop	Main product			By product			Total value (Rs.)	Place of disposal	Distance(km)	Mode of transport	Marketing Costs(Rs.)
		Quantity(Kg)		Value(Rs)	Quantity(kg)		Value (Rs)					
		Own purpose	sold		Own purpose	sold						
1												
2												
3												
4												
5												
6												

Whether the farmer is diversified or not ? Yes/ No

If he is diversified, reasons for diversification

i. Mitigating risk
ii. Increasing farm income
iii. Large size of farm
iv. Limited irrigation availability
Livestock feed needs
Family food needs
Labour availability

Others if any

If he is not diversified, reasons for not diversifying

i. Land is suitable for particular crop
ii. No awareness about benefits of diversification
iii. Small size of farm
iv. Labour availability

Others if any

Are you aware of crop holiday 2011, 2016?

Why people have gone for crop holiday?

Reasons i.

ii.

iii.

why farmers opted for crop holiday rather than going for crop diversification ?

Opinion about crop holiday:

General perceptions

1. Whether agriculture is profitable or not?

2. If not what are the reasons?

3. What are the constraints in agriculture?

4. What measures need to be taken to make agriculture profitable?

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