SHORT DURATION CHICKPEA CULTIVARS ADOPTION AND DIFFUSION PATTERN IN ANDHRA PRADESH

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INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

By

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To Whomsoever It May Concern

This is to certify that this project report on "**Short Duration Chickpea Cultivars Adoption and Diffusion Pattern in Andhra Pradesh**" is a bonafide record of work done by Ms. Komal Shah under my supervision and submitted to International Crop Research Institute for the Semi-Arid tropics.

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DECLARATION

I do hereby declare that the dissertation entitled upon **"Short Duration Chickpea Cultivars Adoption and Diffusion Pattern in Andhra Pradesh"** is an original and independent record of project work undertaken by me under the supervision of Dr. MCS Bantilan, Research Programme Director MIP (Markets, Institutions and Policies), Dr. D Kumara Charyulu, Scientist, Agricultural Economist, (MIP) and Dr. D Moses Shyam, Special Project Scientist-Economics, MIP, at International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India, during the period of my study as a part of curriculum of Masters in Agri-Business Economics.

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Abstract

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Abstract

Chickpea is the third largest food legume crop and is grown in around 52 countries of the world and accounts for 15% of the total pulse area. South and South-East Asia (SSEA) alone contribute to about 86% of the global production wherein India's share is 80% and nearly 70% of world production is consumed in India.

Chickpea area in the non-traditional region has increased substantially since the 1990's, while back in the 1960's Andhra Pradesh's contribution to chickpea area and production was 0.99% of the area share and 0.40% of the production share, today the same is 7.27% of the area share and 10.64% of the production. Which despite being extremely low, yields the highest productivity all over India with 1317 kg/ha. With the introduction of improved cultivars and changes in the pattern of area expansion; this paper tries to understand the pattern of area expansion with respect to the pattern of first adoption of chickpea improved cultivars in the sample districts and tracking their adoption. We also try to understand the dynamics of varietal replacement across sample farmers and document the perceived behavioural changes of sample farmers in relation to technology adoption while studying the socio-economic factors influencing the chickpea adoption.

CONTENTS

"Short Duration Chickpea Cultivars Adoption and Diffusion Pattern in Andhra Pradesh"

CHAPTER I

1.1 INTRODUCTION:

Chickpea is the third largest food legume crop and is grown in around 52 countries of the world constituting 15 per cent of the total pulse area. South and South-East Asia (SSEA) alone contribute about 86 per cent of the global production, wherein India's share is 80 per cent and nearly 70% of world production is consumed in India.

India is a primarily agrarian economy, with over 15 different agro-climatic zones. A number of varied agro-climatic zones promote the cultivation of different crops as per region for the best results. As the Green Revolution[1], has demonstrated improved technology adoption promotes agricultural transformation as well as intensification, both of which have received much interest and have seen phenomenal growth. The Green Revolution which focused entirely on rice and wheat ignored almost wholly the growth, research and development of the pulses sector within India.

As pulses, once again are coming back to the forefront of research and development, various states and private players are investing towards research and development of various pulses. In recent times, chickpea (red gram) has received much interest and there has been exponential growth in the area under chickpea cultivation as well. The focus of cultivating pulses shifted towards the southern part of India after northern India experienced significant growth with the introduction of the Green Revolution.

Chickpea is an important source of protein for millions of people in the developing countries. Andhra Pradesh primarily cultivates traditional crops, as rice, sunflower, and pulses such as Sorghum, Pearl Millet, Millet as well as cash crops as tobacco. However, after the "tobacco holiday" in the state of Andhra Pradesh, the Andhra government changed tracks and started investing heavily in pulses, as there was potential in the development and growth of pulses. Besides, majority of Andhra Pradesh is under the

[1] Empirical literature on Green Revolution – Datt and Ravallion, 1998a, 1998b; Evenson and Gollin, 2003.

semi-arid tropic belt and thus the soil and climatic conditions are very favourable for the cultivation of the chickpea crop. Since, the chickpea crop requires similar climatic and soil conditions.

Thus, chickpea gradually started dominating the farming system in Andhra Pradesh. And a farming system becomes successful with the introduction of new and improved technology and the knowledge to innovate with it. The country's ability to fully utilise its agricultural production potential depends on the innovativeness of actors in the agricultural sector, particularly farmers. The capacity of farmers and actors along the agricultural value chain to innovate in their production activities is contingent on the availability of technology (Mamudu 2012).

There are various factors that drive agricultural productivity growth such as improved farm practices and improved seeds. Along with the introduction and generation of technological innovations there is also need to promote these to the farmers through dissemination, which plays an extremely important role in boosting agricultural productivity.

Farmers learn about new technologies through various sources, be it their next-door neighbours, their relatives, or a Research Hub situated near their farmland. These Research Hubs promote various new technologies through on-farm trials or through free distribution of seed. Thus the availability of modern agricultural production technologies to the farmers, and their capacities to adopt and utilise these technologies is also important. Likewise, it will be very interesting to observe the dissemination of these new technologies; whether it is scattered or concentrated and what kinds of trends it followed.

The study therefore examines the diffusion process and factors that influence the adoption of modern agricultural production technologies among farmers in select districts of Andhra Pradesh with special reference to chickpea short-duration improved cultivars. Apart from the background, the paper presents the literature review in section 2; the methodology employed for the analysis in section 3; the results and discussions in section

4; and finally, the conclusions drawn from the findings and recommendations made in section 5.

The study is a small component of the recent data collected for Chickpea Technology Adoption and Impact Study in Andhra Pradesh under RP- Markets, Institutions and Policies. However, this data was collected with many different objectives, but, for the duration of the internship, work has been done only on certain modules of this study, which will be presented herewith.

1.2 OBJECTIVE:

To discuss changes in cropping patterns, behavioural adoption patterns and investment patterns due to discernible growth in technological diffusion and adoption.

1.3 SPECIFIC STUDY OBJECTIVES:

1. To understand the pattern of first adoption of chickpea improved cultivars over study period – across districts (Area and no. of farmers)

2. Tracking diffusion of technology and adoption of new varieties in Andhra Pradesh

3. To understand the dynamics of varietal replacement across sample farmers

4. To document the perceived behavioural changes of farmers in relation to technology adoption

5. Socio-economic factors influencing the chickpea adoption.

CHAPTER II

REVIEW OF LITERATURE

2.1 UNDERSTANDING CHICKPEA: CROP SITUATION

Chickpea (*Cicer arietinum L.*), a pulse, is the largest produced food legume in South Asia and is the world's third most important food legume and is grown on about 11.5 million ha, with 96% of the area in developing countries[2]. Apart from India, the other major chickpea producing countries include Pakistan, Turkey, Iran, Myanmar, Australia, Ethiopia, Canada, Mexico and Iraq.

A legume that originates from Turkey but is consumed most widely all over India, accounts for about 35% of area and 45% of total production of pulses in India, according to the All India Coordinated Research Project (AICRP, 2000). Studies show that since 1971, chickpea has experienced increase in growth in terms of production, area and yield in the state of Andhra Pradesh[3].

As the population of a country grows, ensuring the nutritional security becomes vital. As pulses play a key role in ensuring the nutritional security, among the pulses too, chickpea is the most important crop with high acceptability and wider use. Chickpea is an important source of protein for millions of people in the developing countries, particularly in South Asia, who are largely vegetarian either by choice or because of economic reasons. In addition to having high protein content (20-22%), chickpea is rich in fiber, minerals (phosphorus, calcium, magnesium, iron and zinc) and *β-carotene*. Its lipid fraction is high in unsaturated fatty acids[4].

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[2] http://www.icrisat.org/crop-chickpea.htm

[3] Suhasini P, Kiresur VR, Rao GDN and Bantilan MCS, in "Adoption of chickpea cultivars in Andhra Pradesh: Pattern, trends and constraints" 2009, ICRISAT Baseline Report for the Tropical Legumes - II

[4] Gaur PM, Tripathi S, Gowda CLL, Ranga Rao GV, Sharma HC, Pande S and Sharma M. 2010. Chickpea Seed Production Manual. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 28 pp.

Apart from its nutritive value, chickpea plays a significant role in improving soil fertility by fixing the atmospheric nitrogen. Chickpea meets 80% of its nitrogen (N) requirement from symbiotic nitrogen fixation and can fi x up to 140 kg N ha-1 from air. It leaves substantial amount of residual nitrogen for subsequent crops and adds plenty of organic matter to maintain and improve soil health and fertility. Because of its deep tap root system, chickpea can withstand drought conditions by extracting water from deeper layers in the soil profile[5].

TYPES OF CHICKPEA

There are two distinct types of chickpea that have been recognized and which are conspicuously included in our study.

a. *Desi* chickpea: Chickpeas with coloured and thick seed coat are called *desi* type. The common seed colours include various shades and combinations of brown, yellow, green and black. The *desi* types account for 80-85% of the chickpea area. The splits (dal) and flour (besan) are invariably made from *desi* type.

b. *Kabuli* chickpea: The *kabuli* type chickpeas are characterized by white or beige-colored seed with ram's head shape, thin seed coat and a smooth seed surface. As compared to *desi* types, the *kabuli* types have higher levels of sucrose and lower levels of fiber. The *kabuli* types generally have large sized seeds and receive higher market price than *desi* types. The price premium in *kabuli* types generally increases as the seed size increases.

2.2 UNDERSTANDING TECHNOLOGY ADOPTION AND DIFFUSION:

Technology is assumed to mean a new, scientifically derived, an often complex input supplied to farmers by organizations with deep technical expertise. Gershon and Umali define technology as "*... a factor that changes the production function and regarding*

[5] Gaur PM, Tripathi S, Gowda CLL, Ranga Rao GV, Sharma HC, Pande S and Sharma M. 2010. Chickpea Seed Production Manual. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 28 pp.

which there exists some uncertainty, whether perceived or objective (or both). The uncertainty diminishes over time through the acquisition of experience and information, and the production function itself may change as adopters become more efficient in the application of the technology."[6]

Davis et al. state that agricultural technology adoption and success depends on the similarity of environmental factors. In the districts of Kurnool, Anantapur and Mahabubnagar, it can be noted that the adoption of technology and its eventual diffusion has been very successful. As the adopters of new technology get accustomed to reaping a good harvest; which results in receiving a good market as well, the adopters become more efficient over time. In the process they promote the adoption of technology amongst others as well.

The districts of Kurnool, Anantapur and Mahabubnagar have been grouped together since they are located around each other. Each district is rich in red and black soil and has a semi-arid climate. Drought is an ever persistent problem as well. Mahabubnagar has been identified as one of India's most backward districts and efforts are being made to change that. Rainfall patterns are also similar, since they are all part of the semi-arid tropics, and fall under the dryland regions, the average annual rainfall received is below 750mm.

Apart from that the districts of Kurnool and Anantapur have been very successful in the cultivation of the chickpea crop. Within this study, we are trying to apply the same success principles to the district of Mahabubnagar as well.

Besides, there are various factors that have been affecting the adoption of new and improved technology. The factors that would be affecting the adoption of technology would be primarily the demographics.

[6] Gershon Feder and Dina L. Umali, "*The Adoption of Agricultural Innovations: A Review,*" in Technological Forecasting and Social Change, (Iss. 43, 1993), pg 215-239.

Most empirical literature so far has denoted that farm size, risk exposure and capacity to bear risk, labour availability, age, education, income, family size, tenure status, credit requirement and access to credit are all positively related to adoption. However, these factors along with the various biophysical factors such as location, rainfall distribution, soil type and availability of resources as well as basic infrastructure requirements such as roads, markets, transportation, and product price have all influenced the adoption and diffusion process either positively or negatively. Some of the factors that affect adoption as defined by Feder, Just and Zilberman (1985) are specified below.

Farm size:

Most of the times, one of the first factors that is taken into consideration when studying an adoption process is the farm size. The farm size may not necessarily always affect the adoption process, but as a lot of literature points out the effects of farm size on adoption varies depending on the type of technology that is being implemented.

Risk and Uncertainty:

Every technology adoption decision would carry with it some notion of risk. Risks may be relating to variations in rainfall, pests, droughts and diseases and credit. And till date as literature has proven, the observed patterns of technology adoption are typically influenced by the farmers' individual risk preferences and their ability to bear the risk of a new uncertainty. Not being aware of uncertainties or without having some level of assurance to access future benefits without being at risk delays the technology adoption decision making as farmers have little incentive to invest their time, labour and capital into technology adoption.

Human Capital:

This comprises of characteristics such as education, human health indicators, age and gender demographics, and their relationship to technology adoption. According to Fuglie and Kascak human capital is positively correlated with innovators or early adopters.

Labour Availability:

The availability of labour would also affect the adoption of technology with respect to the fact whether the technology in question requires labour regularly or only seasonally.

Another consideration is whether the proposed technology is labour-saving or labour-intensive. Higher labour supply is associated with higher rates of adoption of labour-intensive technologies the inverse is also true.

Credit Constraints:

Easy accessibility to credit also acts as an important factor after farm size, human capital and tenure. In fact credit is interrelated with farm size, human capital and tenure too. The larger the farm size, the more is the ability of the farmer to loan against his land and invest in the adoption of a new technology.

Tenure:

If farmers are likely to have insecure tenure rights, they are likely to be more risk-averse and thus there is little or no room for technology adoption. Poverty too, is another factor that affects the tenancy status and thus the rate of adoption.

From the aforementioned factors affecting adoption, some of them have been discussed in the results and discussion section with regard to its impact on the rate of adoption in Andhra Pradesh with respect to chickpea.

Since the decision to adopt technology depends on the way a farmer perceives the technology, it is important to understand how to make technology adoption as simple and fruitful as possible.

Therefore it is important to recognize where a newly developed technology is likely to be applicable as the technologies developed generates new knowledge which could disseminate far beyond the location where the research is conducted and even beyond the location the research targeted through a spillover effect.

A spillover effect refers to a situation in which a technology that is generated for a specific target zone or product is also applicable to other locations or products that are not targeted during the research process. (Deb and Bantilan, 2001)

A spillover effect could refer largely to the diffusion of technology since diffusion is the process by which an innovation is communicated through various channels. Thus, the diffusion of a technology forms the crux of any adoption survey.

As Sunding and Zilberman (2000) have shown that diffusion can also be termed as aggregate adoption, there can thus be indicators that affect the diffusion process as well. For example, the percentage of the farming population that adopts new innovations or the land share in total land on which innovations can be utilized.

Diffusion of chickpea technology too has been elaborated in detail in the results and discussion section.

2.3 SOCIO-DEMOGRAPHIC FACTORS AFFECTING ADOPTION AND DIFFUSION:

There are also various socio-demographic factors that need to be taken into consideration while studying the many factors that influence an innovators decision to adopt. Some of these have been discussed briefly below, and results from the same have been included in the results and discussion section.

AGE:

Age is considered a major factor for adoption, since the younger generation farmers, learn initially from the previous generation and then with the inputs of various research institutions, extension services and other informal activities. The younger farmer with more inputs from the older generation can ultimately combine their ideas at an earlier stage and become innovators much sooner.

EDUCATION:

A lot of literature categorizes education into formal, non-formal and informal education, each of which plays a different role in the farmer's process of decision making. All three types of education are important in the diffusion of innovations[7]. It can be said that formally educated farmers may take the initiative in the adoption of innovations. Other farmers may observe the practices of formally or non-formally educated farmers and copy them, constituting a type of informal education. However, informal learning that occurs as farmers copy their more productive (and perhaps more educated) neighbours (Weir & Knight, 2000) is an area of increasing interest to researchers.

In India, where literacy rates are very low, and the lowest level of education that can be received by farmers is up to class 7, how education can be used as a major factor affecting adoption is extremely interesting. Besides, as new growth theory literature suggests (Weir & Knight, 2000) each generation benefits from the stock of knowledge left by previous generations, which suggests that economic growth arises as a result of knowledge spillovers. Whereas, it is also commonplace to see "herd behavior" as a part of farming practices, wherein learning from experienced neighbours would be profitable. Thus, this could suggest that the educated are early adopters but as has been discussed in the Results and Discussion Section, we can try to understand if the uneducated farmers are likely to copy the innovative behavior of the educated farmers, or whether they are innovators themselves.

2.4 ROLE OF PRICES AND AREA IN ADOPTION:

As Joshi, Asokan and Bantialan (2005) suggest, chickpea is a non-traditional crop that is flourishing in the state of Andhra Pradesh. It is interesting to note that their study focused on the availability of improved technology (e.g. new varieties) that facilitated area expansion. Besides, with the easy availability of the improved varieties that endorse

[7] Cotlear, Daniel (1990) "*The effects of education on farm productivity*", in Keith Griffin and John Knight, eds., Human Development and the International Development Strategy for the 1990s (London: MacMillan).

lesser input requirement and are highly resistant to drought and pests, the improved varieties are extremely popular among the farmers.

Another noteworthy point is the prices, the price of any crop acts as a proxy for price policy, similar is the case of chickpea. With better prices being offered for chickpea, the farmers will obviously move from lower paying crops to crops with higher returns. Although, here in the state of Andhra Pradesh there are some catches with the adoption of *desi* and *kabuli* varieties, despite, the *kabuli* variety paying higher returns, farmers prefer to adopt the *desi* varieties.

2.5 UNDERSTANDING INTENSIFICATION:

Intensification refers to a constant growing process that encompasses all spheres of agriculture.

Brookfield (1993) describes intensification as 'in relation to constant land, the substitution of labor, capital or technology for land, in any combination, so as to obtain higher long-term production from the same area'.

Turner (1993) and Netting (1993) use the formulation that intensification is 'a process of increasing the utilization or productivity of land currently under production, and it contrasts with expansion, that is, the extension of land under cultivation.'

Shriar (2000) uses the formulation that 'agricultural intensification is a process of raising land productivity over time through increases in inputs of one form or another on a per unit area basis.'

Therefore: (1) intensification means increases in productivity and (2) intensification can be achieved by a broad spectrum of options which are all induced by humans. (Dietrich et al)

It is also necessary to understand the variables that would sufficiently indicate intensification. These have been highlighted by Keys and McConnell (2005), these variables included:

- Size of landholdings,
- Type of land used (e.g., upland, bottom land/swamp),
- production (qualitative),
- production amount (quantitative),
- Land intensity, or the frequency with which parcels are cultivated,
- Production mix, including cultivars and livestock,
- Production techniques (e.g., intercropping),
- Mechanical technology,
- Chemical technology,
- Water management,
- Labor,
- Other capital requirements.

Some other variables highlighted through the other papers include yield, which is the most useful means of measuring intensification of agriculture based on a quantity of produce extracted per unit of area of land per year.

Thus intensification can be input based or output based.

CHAPTER III

METHODS AND MATERIALS

3.1 SAMPLING FRAMEWORK

Kurnool is one of the seed production centres in Andhra Pradesh for cotton and sunflower crops. Despite that chickpea has emerged as a well suited crop to the farming situation. In the production year 2007-08 chickpea proved to be the priority crop in terms of area allocation. The crop production in Kurnool is mainly rainfed and the only exception is paddy, which is grown under irrigation. Sole cropping is a common practice and not much intercropping persists.

In this study the technology adoption, diffusion and intensification process for Chickpea (both *desi* and *kabuli*) for the districts of Kurnool, Anantapur and Mahabubnagar has been considered.

There are 23 districts within Andhra Pradesh with a total of 612.3 thousand ha under chickpea cultivation. The overall study is based on a total of 810 farmers spread over 7 districts of Andhra Pradesh. The districts of Kurnool, Anantapur and Mahabubnagar, put together account for about 55% of the total area under chickpea cultivation. Each district is first divided into mandals and further into villages. In the sampling that follows in the table below, is a list of all the mandals within each district. As well as those mandals that have more than 3000 ha under chickpea cultivation. These mandals with more than 3000 ha have been considered for further sampling.

Table 1. List of *mandals* with chickpea area greater than 3000 ha

District	Chickpea growing mandals	No. of mandals with >3000 h	Total chickpea cropped	Area coverage of mandals with >3000 h	% covered
Anantapur	42	7	81362	64717	79.5
Kurnool	53	23	209255	172291	82.3
Kadapa	30	12	79942	68043	85.1
Nellore	18	0	10728	0	0.0
Prakasam	50	10	84004	45853	54.6
Guntur	30	0	10514	0	0.0
Mahabubnagar	31	3	27035	18438	68.2
Medak	45	3	31014	11721	37.8
Nizamabad	30	3	20705	13788	66.6
Total	**329**	**61**	**554559**	**394851**	**71.2**

A random sample of each district was taken further, and from the aforementioned results we have drawn out the final sample that will be studied in the course of this study.

Below is the list of all the districts along with their districts that will be studied within this study which results in 5 *mandals* from Anantapur, 13 *mandals* from Kurnool and 1 *mandal* from Mahabubnagar. I have worked on primary raw data for all my conclusions. Below are the details which summarise the number of villages and farmers treated in this survey.

Table 2. Final Sample Frame

Sl.no	Name of District	Number of Mandals	Number of Villages	No of famers
1	Kurnool	13	39	351
2	Anantapur	5	15	135
3	Mahabubnagar	1	3	27
4	Prakasam	4	12	108
5	Kadapa	5	15	135
6	Medak	1	3	27
7	Nizamabad	1	3	27

3.2 REGRESSION MODEL

The use of the Logistic Regression Function and the Odds Ratio has been made to understand the determinants of the chickpea adoption in the total study sample (N=1080) wherein, 810 of the farmers are chickpea farmers and 270 are non-chickpea farmers.

The dependent variables are adopted and non-adopted. We have assigned 1 to the adopters and 0 to the non-adopters. Results have been displayed in the Results and Discussion Section.

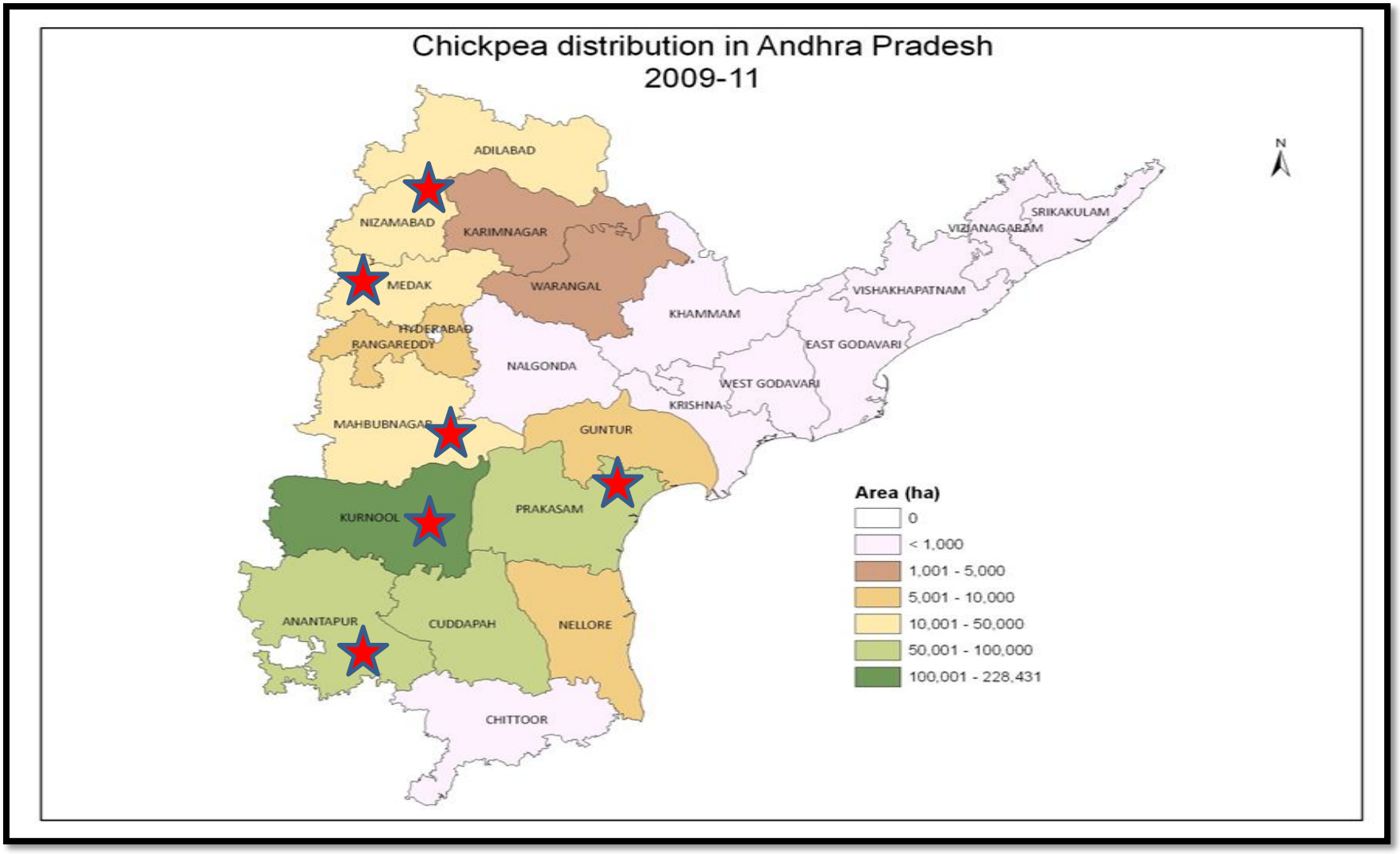


Figure 1: Map of Andhra Pradesh, with districts of study highlighted

CHAPTER IV

RESULTS AND DISCUSSION

In this section the following parameters will be included and dealt with:

- Socio-economic characteristics of sample farmers
- Pattern of first adoption of improved cultivars
- Current Adoption of cultivars (2011-12)
- Diffusion process
- Behavioral changes in relation to technology adoption
- Determinants to chickpea adoption

4.1 OVERVIEW

Chickpea is one of the most important post-rainy season pulse crops grown in the state of Andhra Pradesh in India. Chickpea is a rainfed, post-rainy winter crop predominantly grown in residual soil moisture and rarely requires irrigation or fertilization. Chickpea is sensitive to high (maximum daily temperature >35°C) as well as low (mean of maximum and minimum daily temperatures <15°C) temperatures at the reproductive stage. Both extremes of temperatures lead to flower drop and reduced pod set. With varied environments, the crop fits extremely well with the different farming systems in India. While the local seed would take about 120 days to maturity the improved cultivars on the other hand mature within a period of 90 to 120 days and minimize the risk of cultivation as well.

With the Green Revolution, there was a drastic shift of area towards the cultivation of cereals in place of pulses as the remuneration was better. Thus, there was a massive drop in the area under cultivation of pulses and notably that of chickpea. As can be seen in Figure 2., during the years 1960's to 1990's there was a drop in the area under cultivation and as a consequence that in the production and yield as well. However, after the 1990s and the introduction of various new improved cultivars, with their high yielding trait and

their early maturity induced the farmers to sow them hitherto post-rainy fallow lands and also in the marginal areas thus contributing to the area expansion, utilization of the fallow lands and control in the soil erosion and conversion of moisture.

Studies show that since 1971, chickpea has experienced increase in growth in terms of production, area and yield in the state of Andhra Pradesh. As of today, Andhra Pradesh contributes to 7.27% of the area and 10.64% of the total Chickpea production share all over India. Andhra Pradesh is the 5th largest contributor of area under chickpea. The states of Madhya Pradesh, Rajasthan, Maharashtra and Karnataka precede the state of Andhra Pradesh. What is remarkable also is that with the lowest contribution to area and production, the productivity peaks in the state of Andhra Pradesh.

The six major states of Madhya Pradesh, Rajasthan, Maharashtra, Uttar Pradesh, Karnataka and Andhra Pradesh together contribute more than 90 per cent of area and production of chickpea in India (see Table 3). However, the growth rate in area during the last three and a half decades (1970-2007) in area, production and productivity is distinctly higher in Andhra Pradesh when compared with other states.

Table 3. Performance of chickpea across major states in India

States	Area(% share)		Production(% share)		Productivity (kg/ha)	
	1966-68	2008-10	1966-68	2008-10	1966-68	2008-10
Andhra Pradesh	0.99	7.27	0.40	10.64	238	1317
Maharashtra	4.70	15.33	2.42	14.00	305	815
Madhya Pradesh	20.15	35.79	15.82	38.56	469	972
Gujarat	0.59	1.91	0.30	2.20	337	1032
Punjab	6.46	0.03	8.61	0.04	775	1197
Uttar Pradesh	29.49	6.90	29.94	7.04	607	923
Bihar	3.71	2.01	3.73	0.77	598	1042
Rajasthan	15.40	15.56	15.58	13.70	620	760
Karnataka	2.52	10.52	1.83	7.05	430	600
India	100.00	100	100.00	100.00	594	902

Source: Ministry of Agriculture and Cooperation, 2012

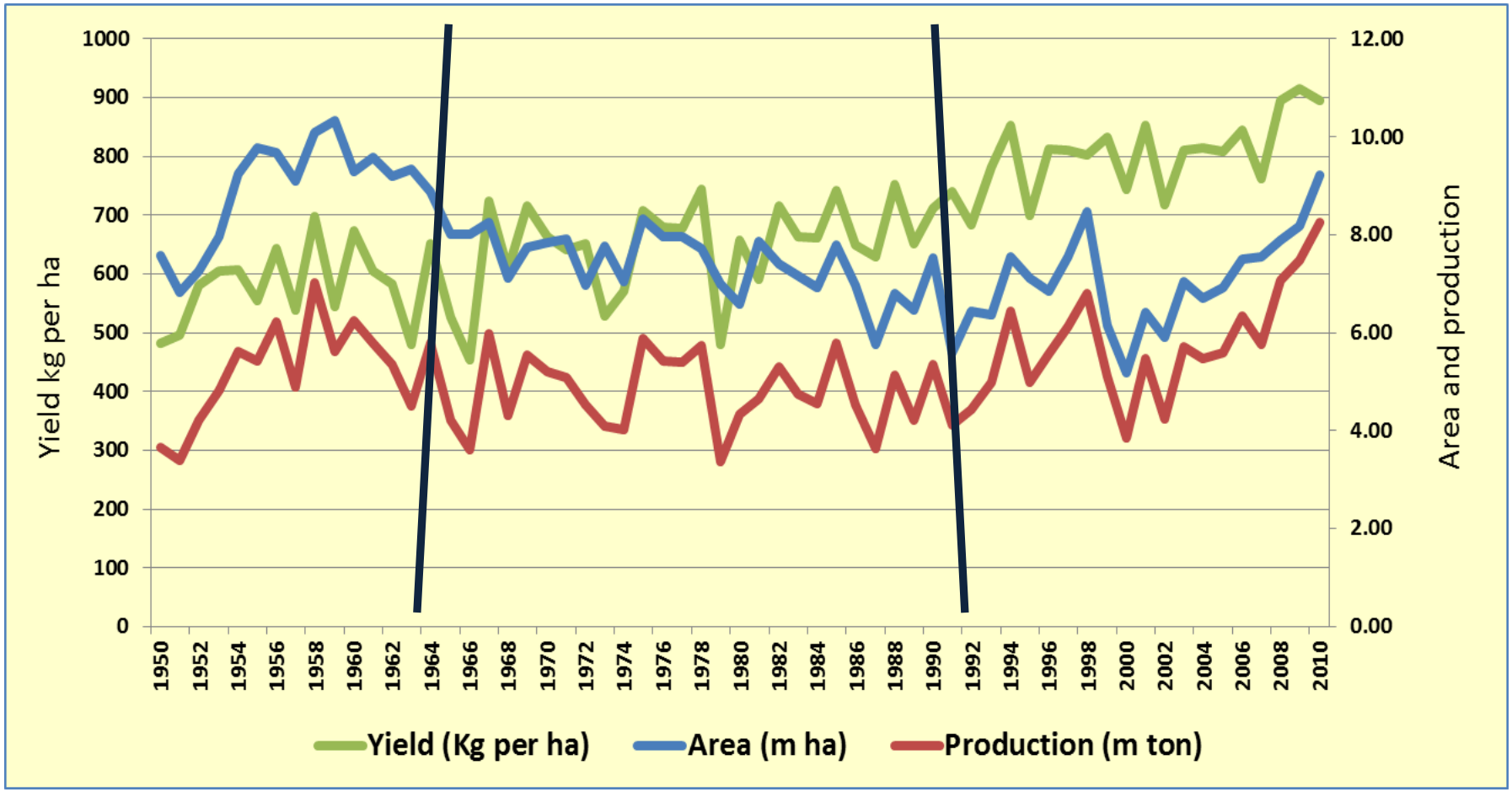


Figure 2: Area, Production, Yield figures for 1950-2010

Chickpea is emerging as a cash crop in the black cotton soils of Andhra Pradesh replacing important crops like cotton, sorghum, pearl-millet, sugarcane, groundnut and tobacco. Chickpea, a low risk crop, is found to be a suitable alternate to varied dry land agro climatic conditions of the state. Low pest and disease attack compared to other crops, storability and less price fluctuations triggered the adoption of chickpea by farmers[8].

The chickpea crop has had 113 varieties released[9] by various state, central and international institutes from 1948 to 2012. Most of the crops that have been released are short duration improved cultivars. They have been proven to be low risk, requiring low inputs, fairly priced with good and high yields.

Among the short-duration varieties, JG-11, KAK-2 and Vihar are the most popular varieties. Our study will focus only on the aforementioned improved cultivars of the *desi* variety of JG-11, and the *kabuli* varieties of KAK-2, Vihar (PHULE G – 95311).

The chickpea crop has moved very quickly from being a subsistence crop to commercial crop. In the last three years it can be noted that over 85% of the area under chickpea cultivation is dominated in the districts of this study. The productivity in the districts of Prakasam and Nizamabad has been remarkable (see table 4). Being in favourable zones, with better soil, climate, and market conditions, these districts have been able to outshine with respect to productivity despite having area lower than Kurnool district. However, it should be noted that the year during which the study was carried out in Kurnool, was a drought year and thus that has marred the best performance of that district.

Some of these districts have better soil and climatic conditions as they are situated on the coast. However, in the case of chickpea which does exceptionally well in arid zones too, the crop has performed well. As the central part of Andhra Pradesh is a part of the semi-

[8] Suhasini P, Kiresur VR, Rao GDN and Bantilan MCS, in "Adoption of chickpea cultivars in Andhra Pradesh: Pattern, trends and constraints" 2009, ICRISAT Baseline Report for the Tropical Legumes - II

[9] R. L. Shiyani P.K Joshi and M C S Bantilan, 2001, "Impact of Chickpea Research in Gujarat" in ICRISAT Impact Series no. 9

arid tropics, chickpea is the most favoured crop in that region, which has also been denoted by the high adoption and absorption of the crop in the region.

Overall also, the state of Andhra Pradesh has done exceptionally well as far as intensification of the chickpea crop is concerned as can be seen through the table. With even the lowest area under chickpea cultivation as is the case in some of the districts productivity has been significant. The farmers in Andhra Pradesh have adopted the new short duration cultivars instantaneously and their diffusion too has been significant.

The productivity in Andhra Pradesh has increased enormously from 853 kg per ha in 1996-97 to 1308 kg per ha by 2009-10 due to the widespread adoption of improved high yielding short-duration cultivars (see Table 4).

Table 4. Performance of chickpea in Andhra Pradesh, 2009-11

District	Area (000 ha)	Production (000 tons)	Yield (Kg/ha)
Kurnool	227.0 (37)	309.5 (38)	1363.3
Prakasam	87.2 (14)	150.1 (18)	1721.6
Anantapur	86.7 (14)	83.1 (10)	957.7
Kadapa	72.8 (12)	60.8 (7)	835.5
Medak	38.6 (6)	43.7 (5)	1134.0
Nizamabad	26.2 (4)	52.5 (6)	2000.5
Mahabubnagar	25.3 (4)	38.7 (5)	1525.9
Andhra Pradesh	612.3 (100)	807.7 (100)	1319.0
Figures in the parenthesis indicates percent to column total			

4.2 RESULTS FROM KURNOOL, ANANTAPUR AND MAHBUBNAGAR:

4.2.1 ADOPTION

In the districts of Kurnool, Anantapur and Mahabubnagar, various inferences have been drawn about the technology adoption, diffusion and intensification process across the drylands agriculture.

The adoption pattern illustrates the adoption over time. It is determined by three main factors, i.e. the time lag from the start of the research until adoption starts, the annual adoption increase as well as the time until the ceiling level of adoption is reached[10].

Besides that, the contribution of new technology can only be realized when it is widely diffused and used.

'Annegiri' is the initial local *desi* variety of chickpea introduced in 1978 that has now been replaced by JG-11, KAK-2, Vihar and Bold. These recently introduced improved cultivars have completely replaced 'Annegiri'. And as most of the farmers have responded positively to the improved cultivars, they have adopted the newly introduced short duration cultivars just as easily and eagerly. JG-11 has seen enormous success in all the districts of Kurnool, Anantapur and Mahabubnagar. JG-11 is a "*desi*" variety of improved cultivar. The other cultivars, KAK-2 and Vihar, both of which are of the "*kabuli*" variety have seen little success. The strategic development and diffusion of the new improved cultivars had taken into consideration the preferences of the farmers as well as the other players in the market. Thus, JG-11 and Vihar are the most adopted amongst the duly introduced improved cultivars and have seen a phenomenal rate of adoption.

[10] K Mausch, L Chiwaula, A Irshad, MCS Bantilan, S Silim and M Siambi, ICRISAT, Nairobi, Kenya, 2013 "*Strategic Breeding Investments for Legume Expansion: Lessons Learned from the Comparison of groundnut and pigeonpea*"

JG-11 is a *desi* type of improved cultivar launched in 1999 released collaboratively by the JNKVV Sehore, the PKV, Akola and ICRISAT, Hyderabad. Its maturity period is 95-100 days. The seed size is 20-22 gms, and the seed yield is 20-25 q/ha. It is preferred by the farmers due to its early maturity and ease of cultivation in irrigated as well as rainfed areas.

KAK-2 on the other hand is a *kabuli* type of improved cultivar launched in 1999 simultaneously with JG-11. It was launched by the PDKV, Akola. Like JG-11, KAK-2, also is a short duration improved cultivar, with large seed and is extremely resistant to wilt.

Vihar/(PHULE G-95311) is a *kabuli* type of improved cultivar launched in 2002 by the MPKV, Rahuri. It has similar traits as that of KAK-2.

Most farmers have enlisted their reasons for choosing these improved cultivars. Needless to restate that these improved cultivars have been designed to, in a shorter duration reap much richer benefits. All the farmers have realized this potential of the improved cultivars and are likely to continue cultivating them for a while, either by bringing in more land under cultivation or by intensifying the current land through the introduction of new agricultural technologies.

The top reasons as enumerated by the farmers for adopting the improved cultivars are that they are good and high yielding, low risk, less input required and good market price, facilities, profits recoverable. Since the chickpea crop is extremely wilt resistant, and doesn't fail in the case of drought it becomes an extremely attractive improved cultivar to adopt since the incentives are very lucrative.

Table 5. Reasons for growing improved varieties of chickpea

District	Reasons	Percentage
Kurnool	Good and High Yielding, Low Risk, Less Input Required, Good Market, Resistant to pest, drought and disease, Suitable to soil and climate conditions	**92%**
Anantapur	Good and High Yielding, Good Market, Resistant to pest, drought and disease, Wilt resistant	**94%**
Mahabubnagar	Good and High Yielding, Less Input Required, Good Market	**75%**

As of today the Figure 3., below shows the cumulative first adoption of the various improved cultivars with relation to the local Annegiri over the years. Sorting the primary raw data as per the first adoption year of Annegiri, JG-11, KAK-2, Vihar (Phule-G) which are varieties of Chickpea (*desi* and *kabuli*) we observe a trend both in the pattern of diffusion and adoption as well as concentration in the *mandals* in the districts.

FIRST AND PEAK YEAR OF ADOPTION

From Figure 3., we can also note the status of the first adoption and the extent of the area under cultivation under the various improved short duration cultivars up unto the peak year across all the 7 districts. It is interesting to note that the local variety of Annegiri had a very slow uptake and its demand plateaued almost as soon as the improved cultivars of JG-11 and KAK-2 were introduced in 1999. Although, KAK-2 has not seen a phenomenal rate of adoption it still holds important due to the higher returns it yields.

Interestingly, the first adoption started picking up from 2001-02, and 2008-09 was the peak of the adoption process in the case of JG-11. Besides, the area under cultivation under Annegiri was expanded as more area was brought under cultivation and thus the area under JG-11 was almost twice the area under Annegiri. This indicated high scope for

expansion of area under chickpea in the study area. Among the varieties, Annigeri is the older variety that is now barely under cultivation save for a few households in the districts of Medak and Nizamabad. However, overall JG-11, which is a *desi* type of improved cultivar, is being cultivated extensively by farmers in the study regions across districts and the area under the variety found to be increased almost twice in the peak year over its coverage in the first year of adoption. The farmers in all the 7 districts also showed inclination towards cultivation of other improved varieties viz., KAK-2, Vihar (PHULE-G) that are *kabuli* types, but they have not been as successfully implemented.

The farmers now grow chiefly improved cultivars as sole crops for various reasons have been discussed in the paper.

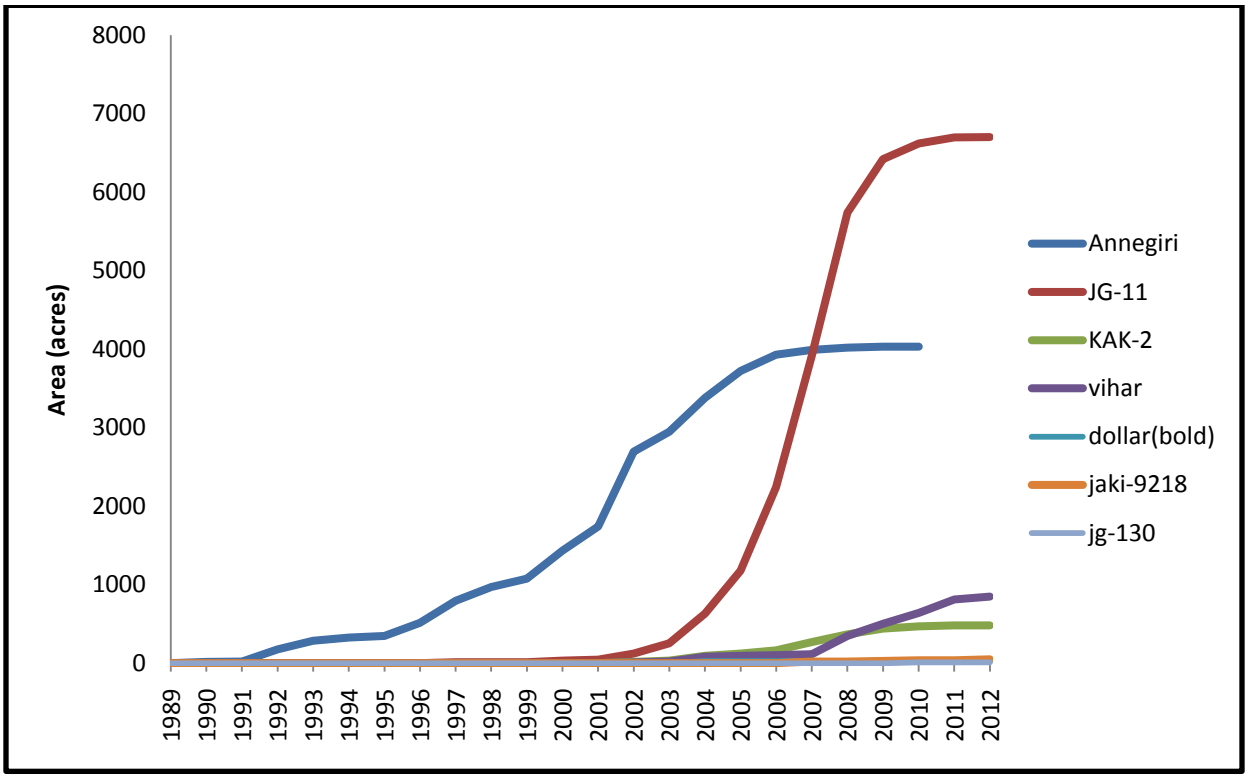


Figure 3: Cumulative First adoption area of various improved cultivars in relation to Annegiri based on first year of adoption

4.2.2 SOCIO-DEMOGRAPHIC FACTORS AFFECTING THE ADOPTION OF CHICKPEA

AGE:

The average age of the heads of the households is between 47 and 50 years (see Table 6) in all the 3 districts of study. Thus, there is not much variation in the mean ages of the adopters. The maximum decision takers lie up to the age of 40; however, in all the 3 districts of the study, it can be noted that while 40 is roughly the age under which most of the innovators lie, there is a fair distribution of innovators in the older age groups as well which indicates that these farmers have been cultivating chickpea for a long period, and continue to cultivate its improved cultivars now as they are more beneficial.

Thus, they can be considered as the most productive and innovative farmers. They can also be grouped as those that are found to be capable of making decisions on management of farm enterprises and taking risk upon making such decisions as has been proven in the studies undertaken by Kiresur VR et al., (2009)

EDUCATION:

As we have noted that education plays an important role as far as adoption and innovation is concerned, the mean level of education of the farmers in our study is up to class 5. Also the highest level of education as achieved by the various farmers is up to post graduation; however the number of farmers having reached that level is extremely low. Like in the case of Kurnool District, about 35% of the adopters and innovators are uneducated. Thus, it is interesting to note however that, there is no significant relation between the increase in adoption and the level of education. Clearly this is a case of informal education or non-formal education to a large extent.

The adoption of the improved cultivar has been solely due to its short duration and excellent yields and returns. There has been no significant influence of the overall education on the rate of adoption. Adoption continues to be exceptional.

Table 6. Socio-economic characteristics of sample farmers

District	Kurnool	Anantapur	Mahabubnagar
Average years of chickpea farming (Years)	11	11	9
Average family size (no.)	5.2	5.2	5.3
Average Education (Years)	5.95	6.60	5.93
Average Age (Years)	47.4	48.8	49.5
Avg. family members working on farm (no.)	3.08	3.04	3.03
Average land holding size (acres)	21.05	20.38	16.20
Proportion of total area under CP cultivation	92.17%	77.61%	59.3%

4.2.3 Adoption patterns for Kurnool district with respect to first adoption of Annegiri and JG-11

ANNEGIRI

Annegiri was first launched in 1978 in Karnataka but it took 10 years before it reached the Kurnool Research Centre. Adopted and launched in 1988, the initial uptake of the seed was not very significant, but over the years there has been a visible rise in the adoption of this local variety.

JG-11

First launched in 1999, we see here the first adoption in 1995 which must be due to an on-station trial. Post which a first adoption in 1999 and then there has been a gradual increase in the uptake of the seed. The actual take off point here can be noted as post 2002 and then there is a gradual/substantial climb in the first adoption of the new seed. It has reached its peak around 2006 and after which it is gradually plateauing and then veritably no new major adoption post 2010.

As can be seen in Figure 4., the time taken for Annegiri to reach its peak of adoption was almost 15 years, while in the case of JG-11 the same took a mere 7 years, thus, farmers were quicker on the uptake of the improved cultivars of JG-11 so as to replace the local vareity of Annegiri, as against adopting the local vareity of Annegiri back in 1988.

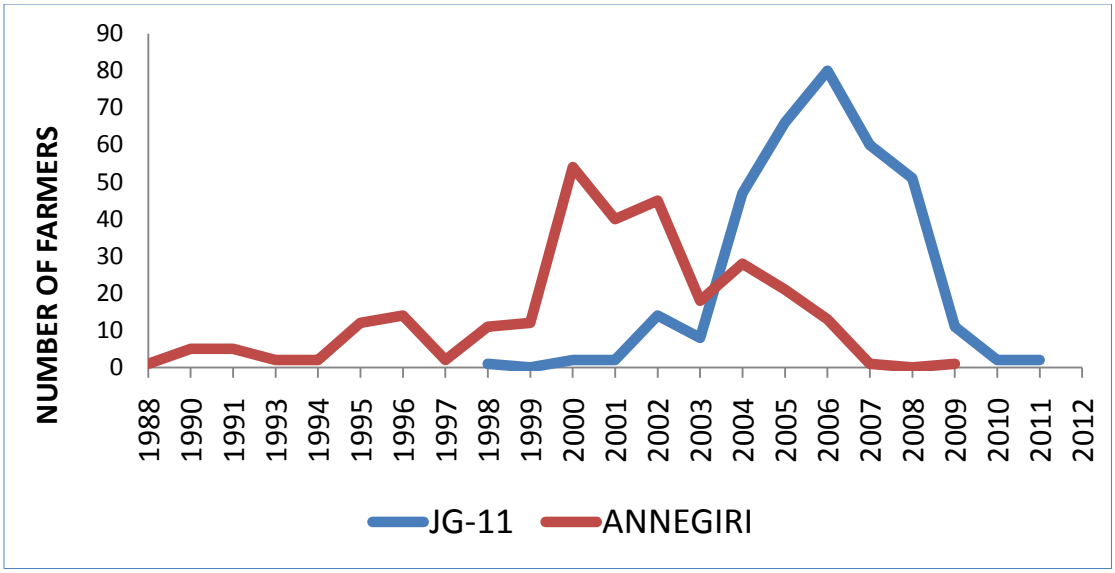


Figure 4: Comparative total number of farmers for first adoption by year

From the following graphs it can be noted that despite JG-11 being launched later than Annegiri it has seen more success than Annegiri. Below is the cumulative frequency chart for the number of adopters for both Annegiri and JG-11 which includes the first adoption of *kabuli* varieties of KAK-2 and Vihar. It can be noted here that the adoption of KAK-2 and Vihar has not been as substantial, with respect to that of JG-11.

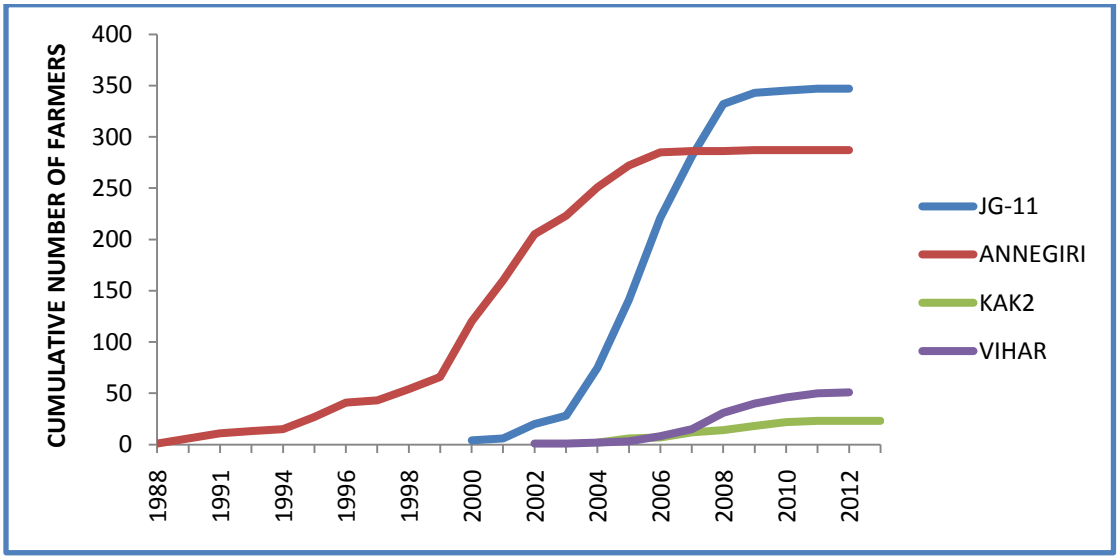


Figure 5: Cumulative total number of farmers for first adoption by year

Kurnool district is a major drought prone district. The major crops grown here are paddy, jowar, bajra, groundnut, sunflower, sorghum, cotton, tobacco and chillies. Chickpea growth happened is interesting, which is more than 150% compared to 1995 indicating

clear-cut preference of the farmers to chickpea replacing other crops[11]. The improved cultivars have shown better performance in the terms of productivity and returns per acre over the past many years which has resulted in continual adoption.

4.2.3a CURRENT ADOPTION ESTIMATES AT KURNOOL

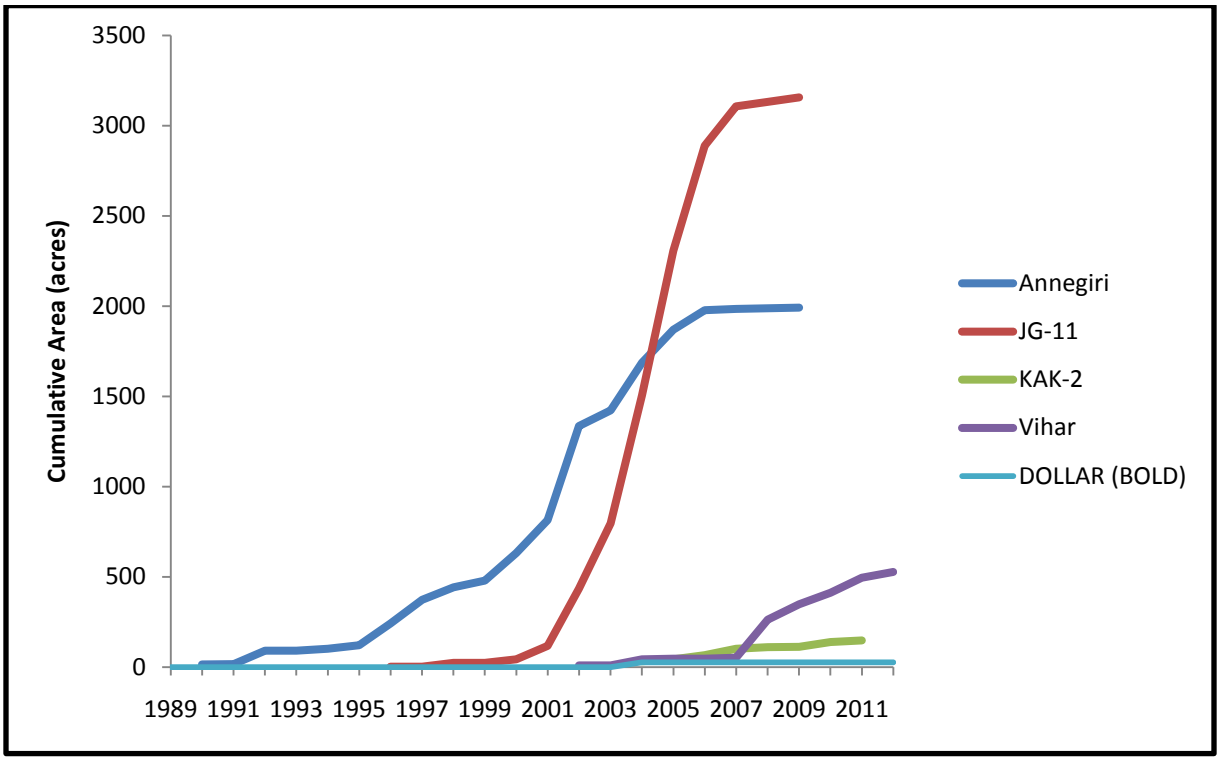


Figure 6: Cumulative Area for current adoption of improved cultivars, 2011-12

As of today, Kurnool continues to have the largest area in the entire state of Andhra Pradesh under chickpea cultivation. However, the other varieties did not see much success in relation to that what JG-11 has observed. As of today the major variety in Kurnool is JG-11, followed by a small share enjoyed each by Vihar and KAK-2. JG-11 is now the dominant crop that grows currently in Kurnool. Thus, despite the presence of better remunerating *kabuli* varieties of KAK-2 and Vihar, farmers continue to cultivate the *desi* variety of JG-11.

4.2.4 Adoption patterns for Anantapur district with respect to first adoption

<u>First and peak adoption in Anantapur</u>

As can be seen in Figure 7., a cumulative picture of first and peak adoption has been presented herewith. It follows a similar pattern as that of Kurnool, wherein the local

[11] Suhasini P, Kiresur VR, Rao GDN and Bantilan MCS, in "Adoption of chickpea cultivars in Andhra Pradesh: Pattern, trends and constraints" 2009, ICRISAT Baseline Report for the Tropical Legumes - II

variety of Annegiri has now been replaced by the improved varieties of JG-11 and KAK2. The varieties of KAK2 and JAKI-9218 along with that of Vihar, have barely seen any success and farmers continue to cultivate JG-11.

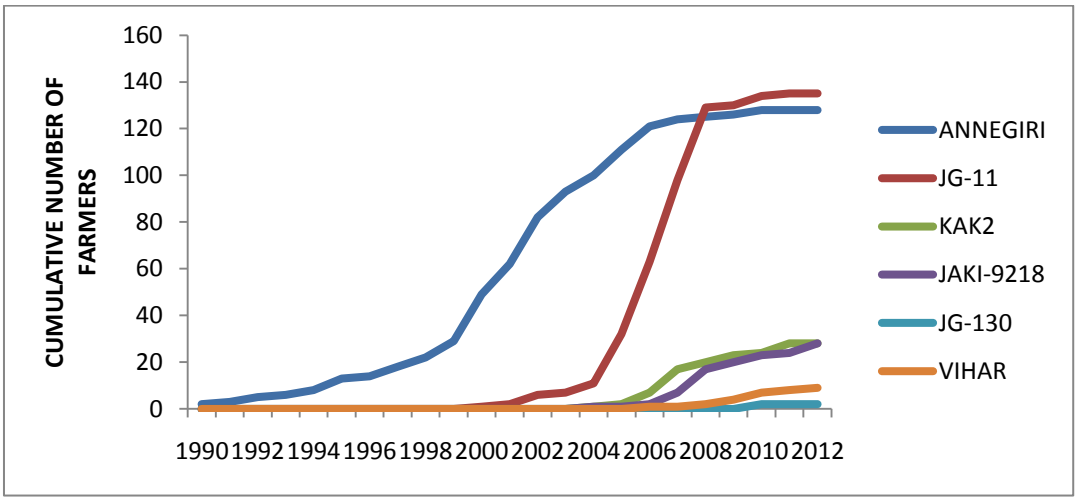


Figure 7 Cumulative total number of farmers first adoption trend in Anantapur District

4.2.4a CURRENT ADOPTION ESTIMATES AT ANANTAPUR

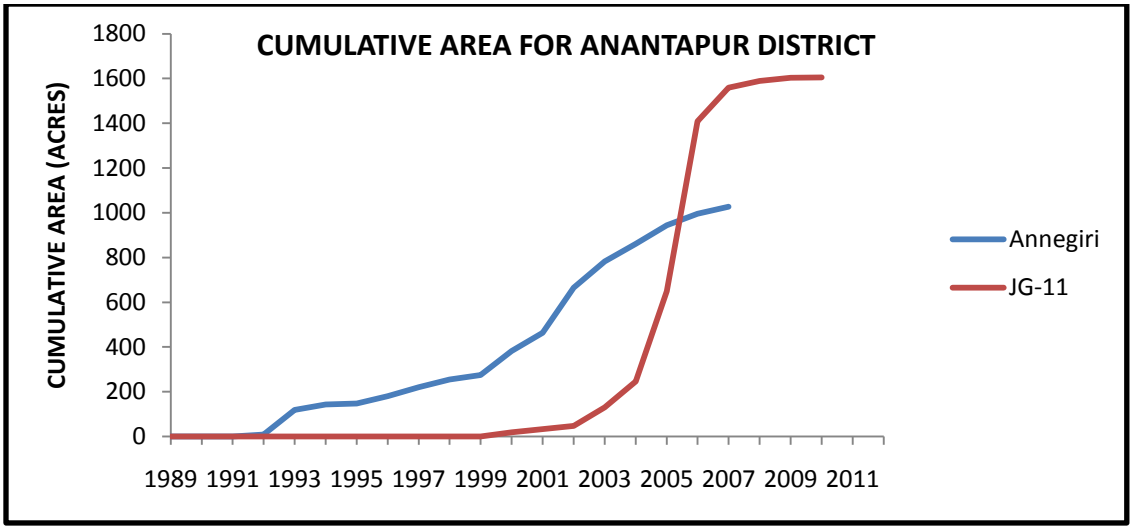


Figure 8 Cumulative area total, 2011-12

Surprisingly, after Annegiri, the only seed that has successfully been adopted is JG-11. The above graph shows that JG-11 continues to contribute to the area under cultivation as more and more farmers are choosing to cultivate JG-11 and on a larger scale.

JG-11 is now the dominant crop that grows currently in Anantapur too. It can also be noted from Figure 8.

4.2.5 Adoption patterns for Mahbubnagar district with respect to first adoption

First and peak adoption in Mahbubnagr

As can be noted in Figure 9., all the farmers that initially started with Annegiri, switched completely to JG-11 at its introduction. The *kabuli* varieties of KAK2 and Vihar have been tried, but do not continue to be cultivated, as we shall note in figure 10.

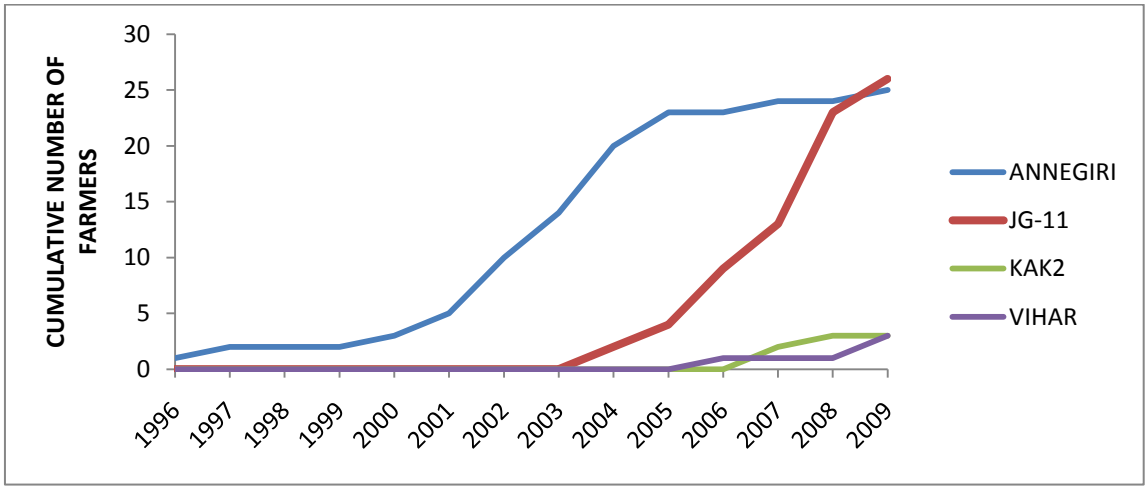


Figure 9 Cumulative number of farmers at first adoption

4.2.5a **CURRENT ADOPTION ESTIMATES AT MAHABUBNAGAR**

It is to be noted that there are a few non-adopters in this district and hence, the area under Annegiri could remain constant for a while before switching out completely to JG-11 or any other variety. Mahabubnagar, despite a few non-adopters shows 100% adoption and cultivation of JG-11 as of today.

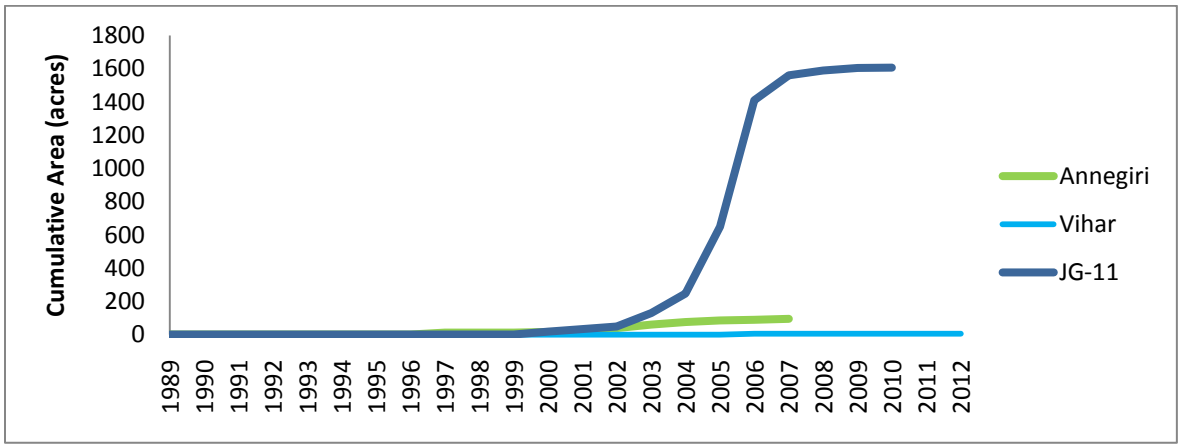


Figure 10 Cumulative area total, 2011-12

4.3 CHANGE IN AREA OF CHICKPEA IN LAST 3 YEARS – 2009-12

The micro level data suggests that the area under chickpea was constant according to nearly 75% of the respondents from Kurnool, Anantapur and Mahabubnagar. Besides, about 16% of the sample respondents have brought in more land under chickpea cultivation while 9% of the sample respondents have shown a decreasing trend. On an average, across all the 7 districts of this study, the results have been more or less similar. Overall in the 7 districts of the study, 74% respondents have suggested that the area under chickpea cultivation was constant, while 18% have shown an increasing trend and 8% have suggested an overall decrease in area under cultivation. (see table 7, figure 11)

The major crops that have been replaced in these districts are those of sunflower and groundnut in order to bring more land under cultivation of chickpea. The farmers that have moved away from the cultivation of chickpea, have switched to the cultivation of cash crops such as cotton or tobacco.

This could suggest that there is an increasing interest amongst the farmers in my sample as well as in the overall sample towards the cultivation of the chickpea crop and more so as a commercial crop.

Table 7: Area allocation under chickpea, 2009-12

District	Area trend				Crops replaced by chickpea
	Increasing	Decreasing	Constant	Total	
KUL	78 (22.2)	23 (6.6)	250 (71.2)	351 100.0)	Sunflower
ANA	10 (7.4)	19 (14.1)	106 (78.5)	135 (100.0)	Groundnut
MAH	5 (18.5)	2 (7.4)	20 (74.1)	27 (100.0)	Sunflower
Overall	93 (18.1)	44 (8.6)	376 (73.3)	513 (100.0)	-

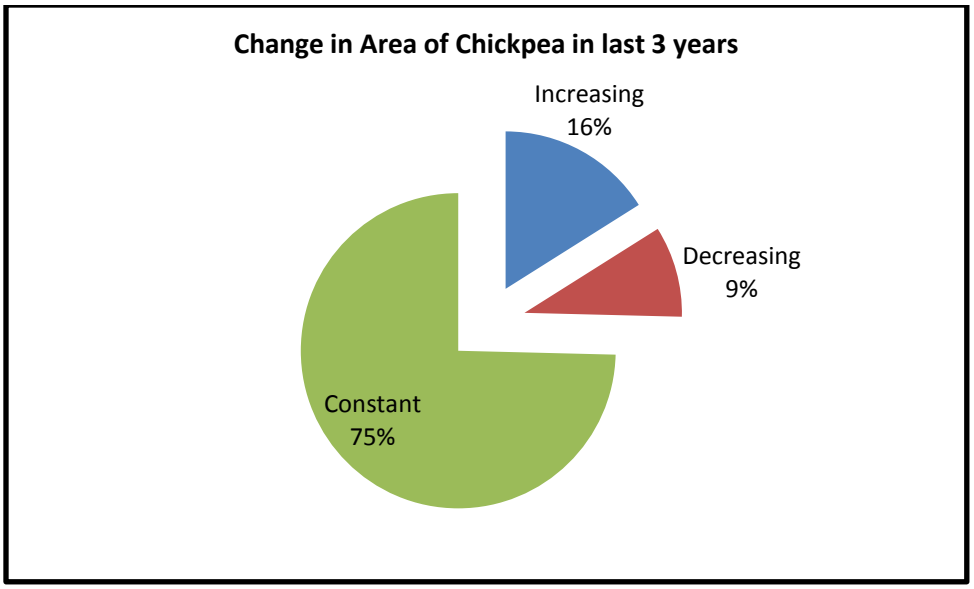


Figure 11: Change in Area, 2009-12

4.4 TRACKING THE ADOPTION OF CHICKPEA IMPROVED CULTIVARS, 2011-12

The improved cultivar of JG-11, a *desi* variety, is highly preferred over the other cultivars in the three sample districts. It is interesting to note that all sample farmers in Mahabubnagar cultivates only JG-11.

Although there is a scattered inclusion of the *kabuli* varieties of KAK-2 and Vihar it is not as evident as JG-11 in Kurnool and Anantapur.

It is also based on these variables that the disaggregated analysis on shift from Annegiri to JG-11, KAK-2 and Vihar has been based. Thus, we can note that JG-11 continues to be the reigning variety of improved cultivar adopted by farmers.

Table 8: Disaggregated analysis of current adoption, 2011-12

District (no of farmers)	**Annegiri to JG-11**		**Annegiri to KAK-2**		**Annegiri to Vihar**	
Kurnool (351)	271	77.20%	3	0.85%	46	13.15%
Anantapur (135)	104	77.03%	0	0%	0	0%
Mahabubnagar (27)	22	81.49%	0	0%	0	0%
	397		**3**		**46**	

4.4a Summary of ruling varieties in Kurnool and Anantapur

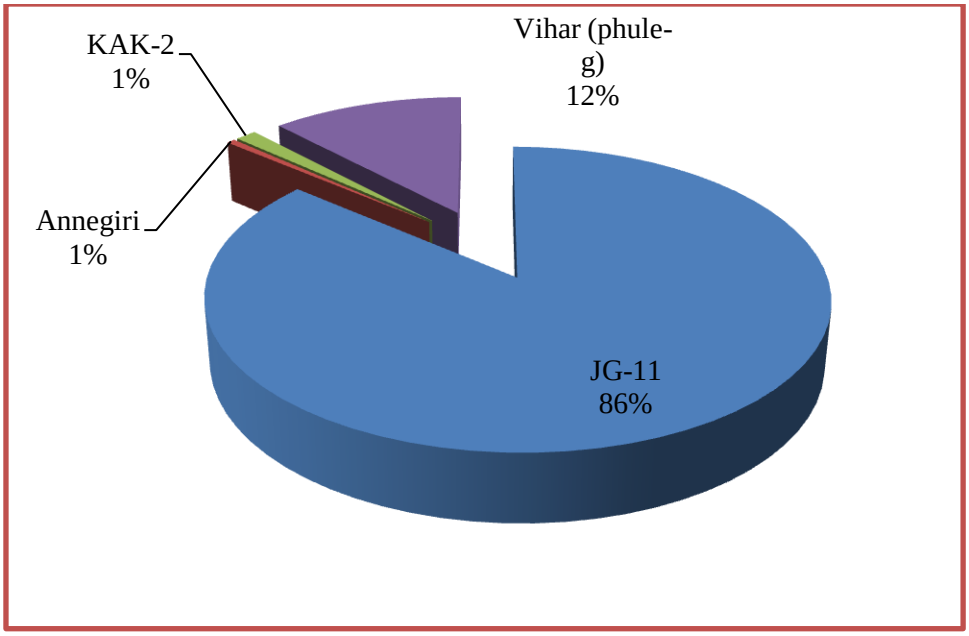


Figure 12: Ruling Varieties in Kurnool, 2011-12

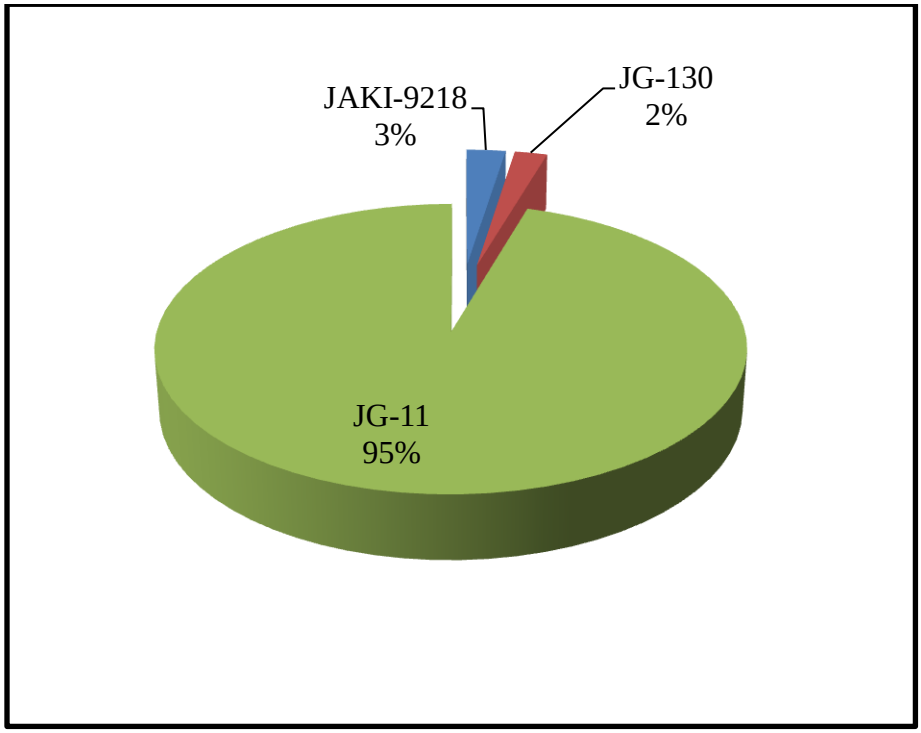


Figure 13: Ruling Varieties Anantapur, 2011-12

4.4b CURRENT VARIETIES UNDER CULTIVATION

It is also based on the variables of behaviour changes and intensification that the disaggregated analysis on shift from Annegiri to JG-11, Kak-2 and Vihar has been based. Thus, we can note that JG-11 continues to be the reigning variety of improved cultivar adopted by farmers.

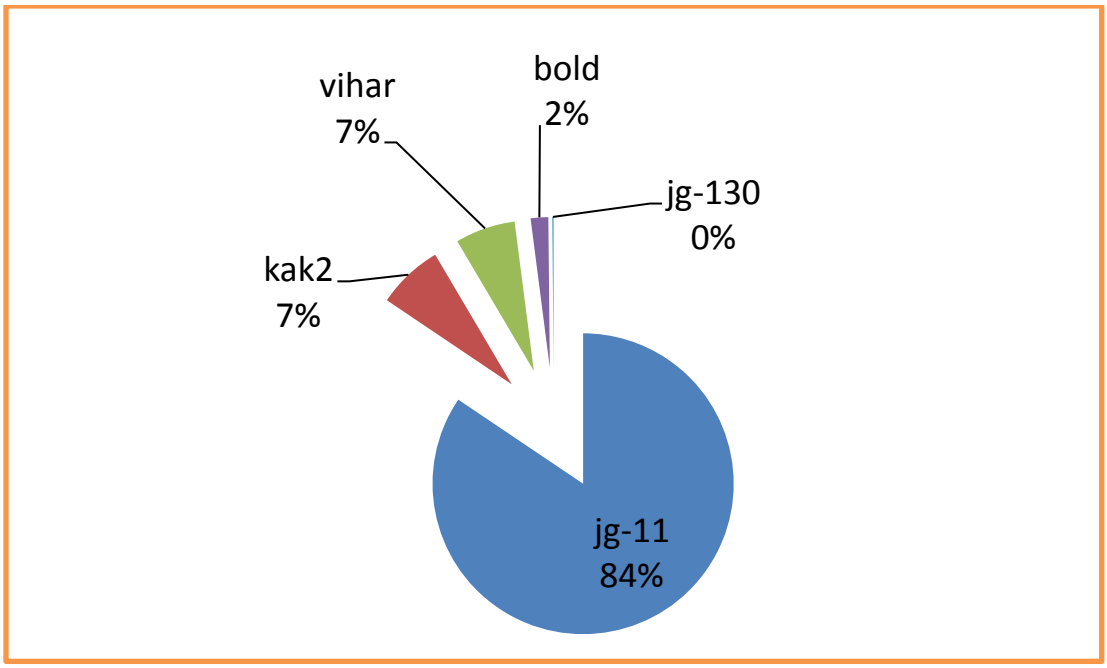


Figure 14: Ruling Varieties in all the 7 districts

4.5 DIFFUSION PROCESS

The different theoretical models of adoption show that observed diffusion patterns depend critically on complicated (and sometimes unobservable) relationships between different elements such as the risks associated with various technologies, the nature of farmers attitudes to risks, the existence of fixed adoption costs (either actual or imputed) and the availability of cash resources. Similar innovations may therefore experience different adoption patterns in different areas and by different groups of farmers. Specifically, the relationship between farm size and adoption can take different shapes due to a host of factors[12].

[12] Gershon Feder, Richard E. Just, David Zilberman, in "Adoption of Agricultural Innovation in Developing Countries: A Survey" World bank staff working papers Number 542

Thus, diffusion along with adoption are two very different yet all important processes governing the utilization of innovations. Diffusion can be interpreted as aggregate adoption[13].

4.5a First adoption behaviour pattern:

Studying the first adoption behaviour pattern we observed that there has been a positive impact of the improved technological adoption amongst the farmers. However, as we tested this hypothesis typologically, through the sample farmers that we have taken, we have observed that the main sources of information have been either villagers or most of these farmers have acquired their initial seed either through Govt. agency providing it free or through a subsidized Govt. seed scheme.

Behavioural adoption or change in pattern is based on the increase due to improved technology introduced. Thus, based on the first adoption, we observe that the adoption of a new technology which can be attributed to acquiring their seed through villagers or farmer to farmer exchange.

As has been identified in a lot of literature the availability of information to farmers which speeds up the adoption process is the presence of social networks. Social networks are people-to-people networks along which information flows between people within the network. And since better information leads to higher propensity of adoption,[14] so is the case in the state of Andhra Pradesh, as our study indicates, farmers with better information have devoted more areas to the cultivation of chickpea.

4.5b The diffusion of JG-11

Kurnool houses a major seed development centre at Nandyal. The Nandyal Research Station is the tipping point from where the diffusion of the improved cultivars of JG-11 started and has grown continually. The initial seed on-farm trials were conducted in 1996 around the Nandyal Research Station and in the Kurnool *mandal* as well. The improved cultivar was officially launched in 1999. From the table below it can be seen that the initial diffusion and adoption process began near the Kurnool Mandal in the Gudur Mandal while some of the diffusion has taken place in all the *mandals* around the Nandyal Research Station, viz., Koilkuntla, Sanjamala, Uyyalawada and gradually moved south from the Gudur *mandal* towards Aspari, Chippagiri, Adoni etc.

[13] David Sunding and David Zilberman, 2000, "The Agricultural Innovation Process: Research and Technology Adoption in a Changing Agricultural Sector (For the Handbook of Agricultural Economics)"
[14] Benjamin Berman, 2007, "Cultural Diversity, Social Learning, and Agricultural Technology Adoption"

Table 9: Diffusion of JG-11, mandalwise in Kurnool District

Sr. no	Year	District
1	1998	Gudur
2	2000	Kurnool
3	2000	Koilkuntla
4	2001	Aspari
5	2001	Sanjmala
6	2002	Chippagiri
7	2002	Midthur
8	2002	Maddikera (east)
9	2002	Uyyalawada
10	2002	Dorinipadu
11	2002	Banaganapalle
12	2004	Alur
13	2004	Adoni

The map below here shows the rapid diffusion of the new and improved cultivar.

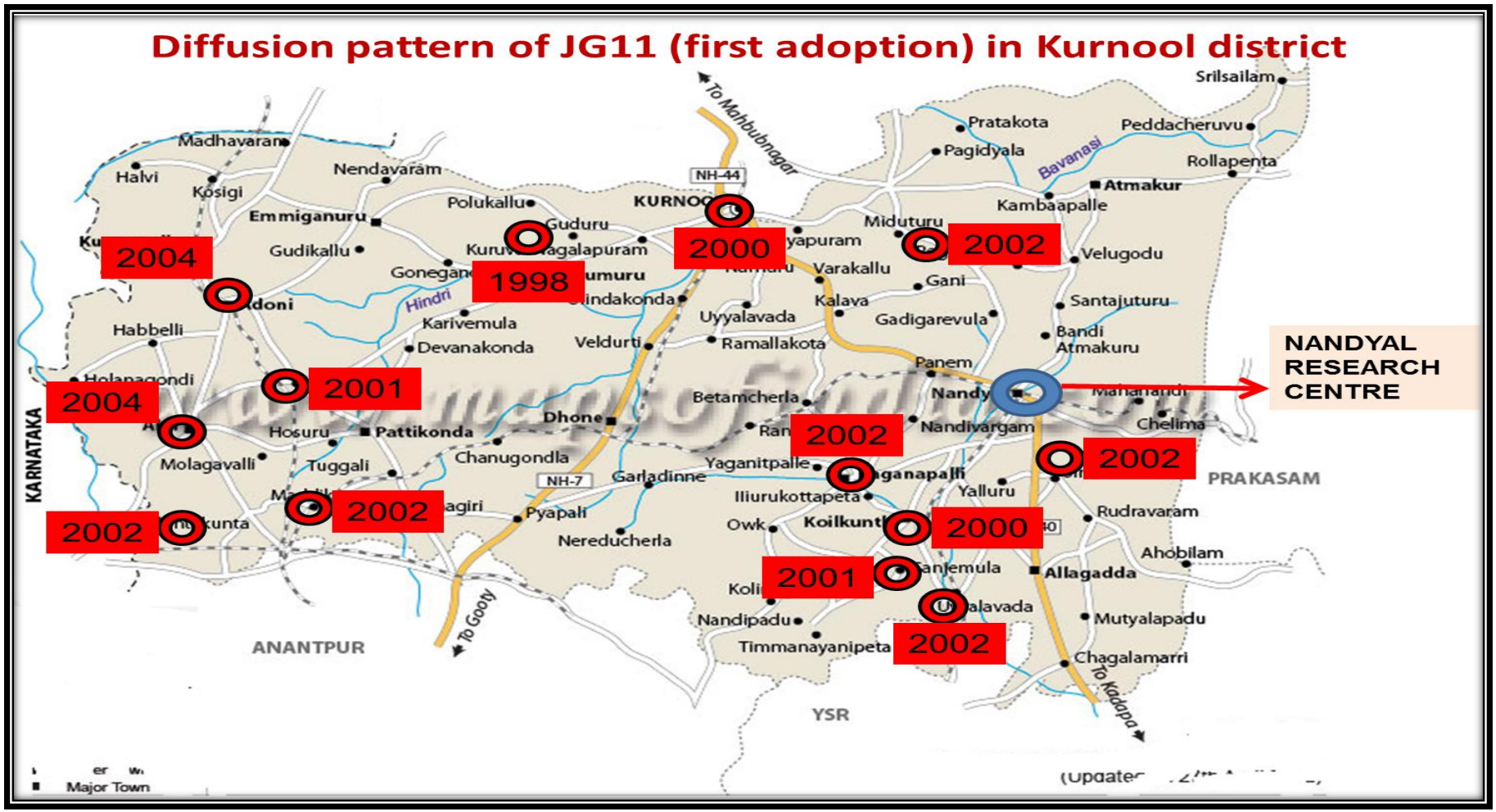


Figure 15: Map of Kurnool District

4.6 SOCIO-ECONOMIC IMPACT OF CHICKPEA

Ultimately, the effect of technology on the producers and consumers alike depends on various factors, such as household resources, markets, social assets and institutional context. The existence or absence of effective extension mechanisms, markets, favorable credit systems, and social assets greatly determine the uptake of the agricultural technology and thereby determine their ultimate effect on well-being of producers and consumers. Economic gains from a technology among different social groups may vary depending on their control of resources and access to information, credit, and markets. At early stages of introduction of a new technology, the poor may not adopt the technology until they are sure that adoption involves only minimal risk. Thus, at initial stages, the benefits of new technology go to wealthier farmers, who can absorb risks associated with the new technology.[15]

However, the same cannot be stated in the case of our study. Adoption and absorption of technology has been high. And looking at the time lag in the innovation and the adoption and then the adoption and the absorption of the improved cultivars we can conclude that the higher the rate of absorption over the 4 types of farmers could denote more knowledge among the farmers and eagerness to share which also unambiguously suggests that a scientific study comparing the benefits of improved chickpea cultivars over local varieties would be useful in formulating policies appropriate for promoting chickpea production.[16]

4.7 CROPPING SYSTEM FOLLOWED BY THE FARMERS

In all the 7 districts of the study, its is interesting to note is that 98% of the farmers as of today cultivate chickpea as a sole crop. And about 2% of the farmers are intercropping chickpea with safflower.

Whereas in the sample that I am studying, farmers are cultivating chickpea as the sole crop. In fact, in the past three years, they have replaced various crops like groundnut, sunflower, cotton and sorghum with chickpea. thus, it goes to show that chickpea has been continously giving higher returns with respect to others.

The average yield in all the 7 districts of the study of the improved chickpea cultivars in normal, best and bad years is mentioned in the table below. It shows that although the technology adoption has seen an intensification, the yields have not faltered very sharply. The technology performance has been better between normal and best years as against between bad to normal years.

[15] Mazid, A., K. Amegbeo, K. Shideed and R.S. Malhotra. 2009. "*Impact of crop improvement and management: winter-sown chickpea in Syria*" International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria. 52 pp.

[16] R. L. Shiyani P.K Joshi and M C S Bantilan, 2001, "Impact of Chickpea Research in Gujarat" in ICRISAT Impact Series no. 9

4.8 MAXIMUM AREA UNDER CHICKPEA CULTIVATION

As per secondary data from the Statistical Abstracts of Andhra Pradesh for the triennieum 2008-2011, the average area under chickpea, as well as the average yield for the samples has been mentioned in the table below.

District	Area (000 ha)	Yield (kg/ha)
Kurnool	227	1361
Anatapur	87	957
Mahabubnagar	25	1527

The above data is for the meso-level. The data that follows is for the micro-level.

District	Area (acres)	Yield (kg/acre)
Kurnool	9.9	2488.52
Anatapur	8.93	1517.69
Mahabubnagar	6.17	550

Thus, in the district of Kurnool, on an average, 10 acres of land is under chickpea cultivation and the yields per acre are exceptional. It also shows that more and more farmers are allotting area to chickpea cultivation.

4.9 Classification of Chick Pea Famers based on adoption

4.9a Classification

As per the dichotomous patterns for adoption that most studies have taken into consideration, we too have divided our farmer samples into different classes of adopters, as there are a very insignificant number of non-adopters, they have not been given special importance as they do not affect the overall adoption pattern.

The adoption behaviour of a farmer tells us a great deal about how to divide the farmers into different groups. We classified farmers as per their adoption trends into adopters and non-adopters.

Here we define adopters as those who adopt the improved cultivar (here 'Annegiri' has been considered as the benchmark before adoption of the improved cultivar) as it is initially distributed and then the same move towards the latest improved cultivar (JG-11, KAK-2, Vihar in that order in the district of Kurnool) as distributed by the Research Centre into the various *mandals* or through various sources.

Further Non-adopters are defined as those who despite having adopted the initial local variety of Annegiri that was made available, have continued to cultivate it and have not moved to the latest improved cultivars made available to the farmers.

Further, we have classified the adopters into 3 more categories, wherein we state that based upon their land holding and therein their area of chickpea production –

i. A1 – the A1 farmers are those who cultivate Chickpea on part of the own land, and do not have leased in land.

ii. A2 – the A2 farmers are those whose total owned land is allocated to the area under Chickpea cultivation only and do not lease-in land for chickpea cultivation

iii. A3 – the A3 farmers are those who grow chickpea on their own land and also have leased in land for the purpose of cultivation of Chickpea.

iv. SW – These farmers have blended into the adoption trend and have switched into cultivating chickpea from other post-rainy crops.

And finally Switchers are those who have been cultivating crops other than chickpea and have now started cultivating chickpea based either through various sources or suggestions and are the most recent adopters of the improved cultivars and continue to cultivate it. Besides, switchers were not included in the initial uptake of the seed through Annegiri, but have moved in only after introduction of JG-11, Kak-2 or the other more recent improved cultivars.

Hence, the adopters are what the entire chickpea diffusion and adoption trends started with, whilst switchers have contributed to the existing production by adding more

area and thus we observe a growth in area, production and yield in the chickpea production.

As we have classified farmers according to the type of cultivation and adoption pattern they follow, the following table highlights the number of farmers under each category:

Table 10: Adopter and Non-adopters

DISTRICT	KURNOOL	ANANTAPUR	MAHABUBNAGAR
A1	130	46	7
A2	64	43	7
A3	95	16	9
SWITCHERS	62	30	4
NON-ADOPTERS	0	0	0

Clearly, each district has its peculiarities and thus has adopters of each type differently scattered.

In Kurnool as the table shows, there are more A1 type of adopters. Since most of the adopters in Kurnool and Anantapur are the A1 type of farmers it shows that these farmers are those who cultivate Chickpea on part of the own land, and do not have leased in land. It could also be used to conclude that these farmers own larger farms and have a better yield with each passing year, despite the drought and other climatic vagaries.

Besides, there are also a large number of A3 farmers in Kurnool and Mahabubnagar, which can be concluded to state that they who grow chickpea on their own land and also have leased in land for the purpose of cultivation of Chickpea; which means interestingly that they have contributed overall to the area expansion under chickpea cultivation.

The proportion of A2 farmers too cannot be ignored, however since these are the farmers whose total owned land is allocated to the area under Chickpea cultivation only and do not lease-in land for chickpea cultivation it would be interesting to promote more intensification amongst these farmers so as to ensure economies to scale and continued chickpea cultivation.

The number of switchers too indicates that since they have contributed to the overall area expansion by blending into the adoption trend and by switching into the cultivation chickpea from other post-rainy crops.

In Anantapur, all A1 and A3 farmers cultivate only JG-11. 95% of the A2 and SW farmers cultivate JG-11 and the rest of the A2 and SW farmers cultivate JAKI-9218 and JG-130.

It would also be interesting to note that in Kurnool, 80% of A1 farmers cultivate JG-11, 15% cultivate Vihar and the rest a mix of Annegiri and KAK-2, 85% of A2 farmers cultivate JG-11 and 15% cultivate Vihar, 91% of A3 farmers cultivate JG-11 and 8% Vihar, 98% of the Swtichers cultivate JG-11 and 2% Vihar.

Whereas, in Mahabubnagar all 100% farmers land is under chickpea cultivation

While literature has shown that even with the average holding size of farmers being smaller the leased/shared-in practice of land among the farmers is not necessarily very popular.[17] However the same cannot be said in the case of the farmers in this study, since there is actually quite a large proportion of farmers

Similarly, across the different farm sizes/districts, a large proportion of the operational land was dry land.

[17] Kiresur VR et al., 2009, "*Chickpea breeding and seed delivery efforts to enhance the impact on the livelihoods of the poor in drought-prone areas of South Asia- Insights from baseline studies"*

4.10 What is cost of cultivation?

As per the Directorate of Economics and Statistics under the Ministry of Agriculture "cost of cultivation surveys are an important mechanism for data generation on the cost structure of crops." These encompass the various inputs which are involved in the cultivation of the crop. Since input is used from the beginning to the end, these surveys need to be conducted over a long duration and in multiple rounds. The data thus generated is then used to work out the cost per unit area or cost per unit weight.

In our sample, since we have classified these farmers under adopters of various types, non-adopters and switchers, it is done so in order to understand the changes that take place in the pattern of cost of cultivation, taking into consideration the average cost for land preparation, planting and sowing, seed, fertilizer application, weeding, plant protection, threshing and cleaning and marketing.

With the introduction of the improved cultivars, there are bound to be various changes as far as productivity is concerned. We also take into account the fact, that the cost of cultivation can lead to point out which inputs to implement differently in order to improve productivity at the lowest possible cost.

It can be noticed that for the Non-adopters of the improved cultivars, their average cost for land preparation and planting and sowing is higher than that for adopters. However, the cost for seed is much lower than that for the improved cultivars. The marketing cost too for non-adopters is higher than the rest of the adopters. While the average total fixed cost and total variable cost appears to be the lowest amongst the A2 farmers it comes as no surprise since they are those farmers that have contributed to almost 23% of the land under chickpea cultivation in all the 810 households.

Thus, the cost of cultivation details on the use of improved cultivars not only reduces cost on the implementation of various inputs but also promotes the adoption of the improved cultivars.

Cost of cultivation includes the various variables that determine a farmers decision to cultivate a given crop. Its understanding can help us understand how it will influence the gross revenue. With the help of the cost of cultivation it is also possible to see how different groups respond to various inputs in order to maximize revenue.

Table 16: Cost of Cultivation

Costs denoted in ☐/Acre	A1	A2	A3	NA	SW	Grand Total
Land Preparation	1387	1347	1399	2105	1642	7879
Compost/Sheep penning/Tank silt	747	870	530	0	433	2580
Planting and Sowing	512	487	487	845	682	3012
Seed	2239	2356	2559	1590	2679	11422
Seed Treatment	46	47	48	0	40	181
Fertilizer Application Cost	1836	1505	1874	1352	1969	8536
Micronutrient Application	0	0	0	0	16	16
Interculture	263	268	233	90	224	1078
Weeding Application	677	656	654	881	816	3684
Plant Protection	1086	1033	1113	1310	1114	5657
Irrigation	45	30	13	0	0	88
Harvesting	917	841	966	1281	1232	5237
Threshing and Cleaning	823	710	896	1301	1203	4934
Marketing	181	145	171	418	199	1115
Total Variable Cost	10760	10297	10941	11172	12249	55419
Total Fixed Cost	7258	6403	8275	9000	8852	39788

4.11 Behavioral changes in relation to technology adoption

Another question we asked to understand the adoption process was whether adoption of improved cultivars was leading to Agricultural intensification?

The above table shows the behaviour changes in perceptions of farmers with the adoption of new technology. These same variables also indicate intensification that goes with the introduction of a new technology. In order to further understand intensification we took into consideration various perceptions of farmers, which have been summarised.

In Kurnool, out of 351 farmers, 349 farmers have benefitted either chickpea technologies or natural resource management technologies.

Similarly in Anantapur, out of 135 farmers, 134 farmers have benefitted, while in Mahabubnagar out of 27 farmers, 26 have benefitted.

Thus here through these perceptions we can observe that, on an average, farmers have benefitted with a 20% increase in the grain yield, and a 10% reduction in the cost of cultivation, with due thanks to the introduction and heightened adoption of the improved cultivars of chickpea.

As Shively points out the soil conservation is extremely costly on small farms and costly due to increases in the short-run risk of consumption shortfall with certainty. The adoption of the Chickpea Technologies or the Natural Resource Management Technologies had adopters allocating more land to the adoption of the new technologies as there was significant improvement in the soil condition. Under most circumstances, large farmers are likely to adopt a new technology faster, however, the same cannot be said in this case as there has been dynamic influence in adoption.

The table again indicates towards the mechanization among the chickpea cultivators. Supplementary inputs in mechanization schemes is the key input that associates with increasing yields as well. It also shows that mechanization has been continuous and accelerated in recent times.

There has been an equally good growth in the yield per acre with the introduction of the improved cultivars.

Since, intensification can be input based or output based we also studied these very same variables with respect to the first area adoption of Annegiri, JG-11, Kak-2, Vihar, Dollar (Bold), wherein the adoption of Annegiri and JG-11 has been impressive amongst these pockets of Andhra Pradesh. Besides since land expansion is limited, intensification is becoming extremely important.

We hypothesize that most Annegiri farmers have now switched to the improved cultivars JG-11 and continue to cultivate them.

Based on past experiences in irrigated agriculture (especially the Rice and Wheat cultivation) during Green Revolution technology period, we asked if the introduction of improved cultivars and technologies in semi-arid tropics was leading to Agricultural intensification.

Following a manual observation that we conducted of the raw data we observed that almost all the households in all the districts have doubled their investment in mechanization, fertilizers, pesticide application. We also observe that there has been very little increase in more land allocation. And thus we can say that intensification has taken place markedly in the use of fertilizer, mechanization and pesticide application.

We started understanding those things, and we asked certain questions to help the documentation of those changes when they were growing 10 years ago, and with regards to their current inputs. Many farmers agreed that they have changed their pattern and methods of crop management. Since we have found many changes while we were interacting with the farmers it became evident that amongst the major tools for intensification 2-3 of them have documented far more changes than the rest.

As the survey conducted shows; the major variables used to study intensification are denoted below:

- Own land allocation (acres)
- Leased-in land allocation (acres)
- Mechanization (Rs per acre)
- Fertilizer application cost (Rs/acre)
- Pesticide application cost (Rs/acre)
- Irrigation expenditure (Rs/acre)
- Soil & water conservation expenditure (Rs/acre)

Of these variables, land allocation, wherein area is being allocated and more land is coming under cultivation either maybe own land or leased in land.

Another is mechanization – earlier the farmers were mainly using bullocks for various purposes, today however, they have switched to various mechanical implements for the purpose of improved productivity. Thus today the area under chickpea cultivation is completely mechanized and the farmers state that since the improved cultivars of

chickpea flourish very well under mechanization, it is also one of the major reasons as to why the farmers have opted for improved cultivars of chickpea.

Another factor is the fertilizer application cost and pesticide cost, which have been most prominent.

Many farmers expressed that earlier they used to allocate about 20-25 kg of seeds, and today they are getting almost 40-45 kg of seed, thus the seed rate is higher in the case of JG-11 and in the case of KAK2 they recommended dose was about 40-50 kgs, but today they are able to allocate about 70 kgs.

In the districts of Kurnool, Anantapur and Mahabubnagar too technological intensification has been extremely rapid. With about 0.5% of the farmers that have opted to intensify gradually over 2013-2014, the fact still remains, that the total area under land that could have been expanded has been done, and thus it is now time to intensify with technology. It also shows that intensification has taken place in over 99% of the households.

Although it focuses only on the three major components of: Mechanization, fertilization and pesticide application. The intensification of these three factors has positively influenced adoption. Besides, chickpea does not withstand weeds very well in the process of growth. Thus, pesticide application is needed. Chickpea is also a very rich source of protein, but is easily affected by insects, pests or diseases. Once again, pesticide management is required.

Chickpea is generally grown as a rainfed crop, but it is necessary to incorporate irrigation or supply extra water at two-stages, one at branching and the other at pod-filling, as this would result in higher yield. Thus, as chickpea requires barely any water management, it is clear that no chickpea farmer is likely to invest in irrigation. Very few are likely to invest in soil and water conservation since the chickpea crop improves the condition of the soil as has been perceived by most farmers.

As can be seen from the following tables (see tables 8,9,10), with the increased confidence in improved technology, there have been certain behavioural patterns that can be observed in all the districts.

A summary of perceived behavioural changes is denoted here.

There has been only a marginal increase in land allocation and that has been– either in the form of owned or leased-in land.

There have been conspicuous changes in the use of the fertilizer, pesticides and increased usage of mechanization was observed across study districts

Farmers' who initially spent Rs.1500/acre, today are willing to spend Rs.3000/acre for mechanization, since it is benefitting them significantly

Farmers' whose initial investment in fertilizer application/acre was around Rs.1400, but today willing to enhance it up to Rs.2000/acre

The relative pesticide expenditure/acre of Kurnool sample farmers was much higher (Rs.4000) when compared to the rest of the districts

Table 12 Perceived behavioural changes in Anantapur district (N=134)

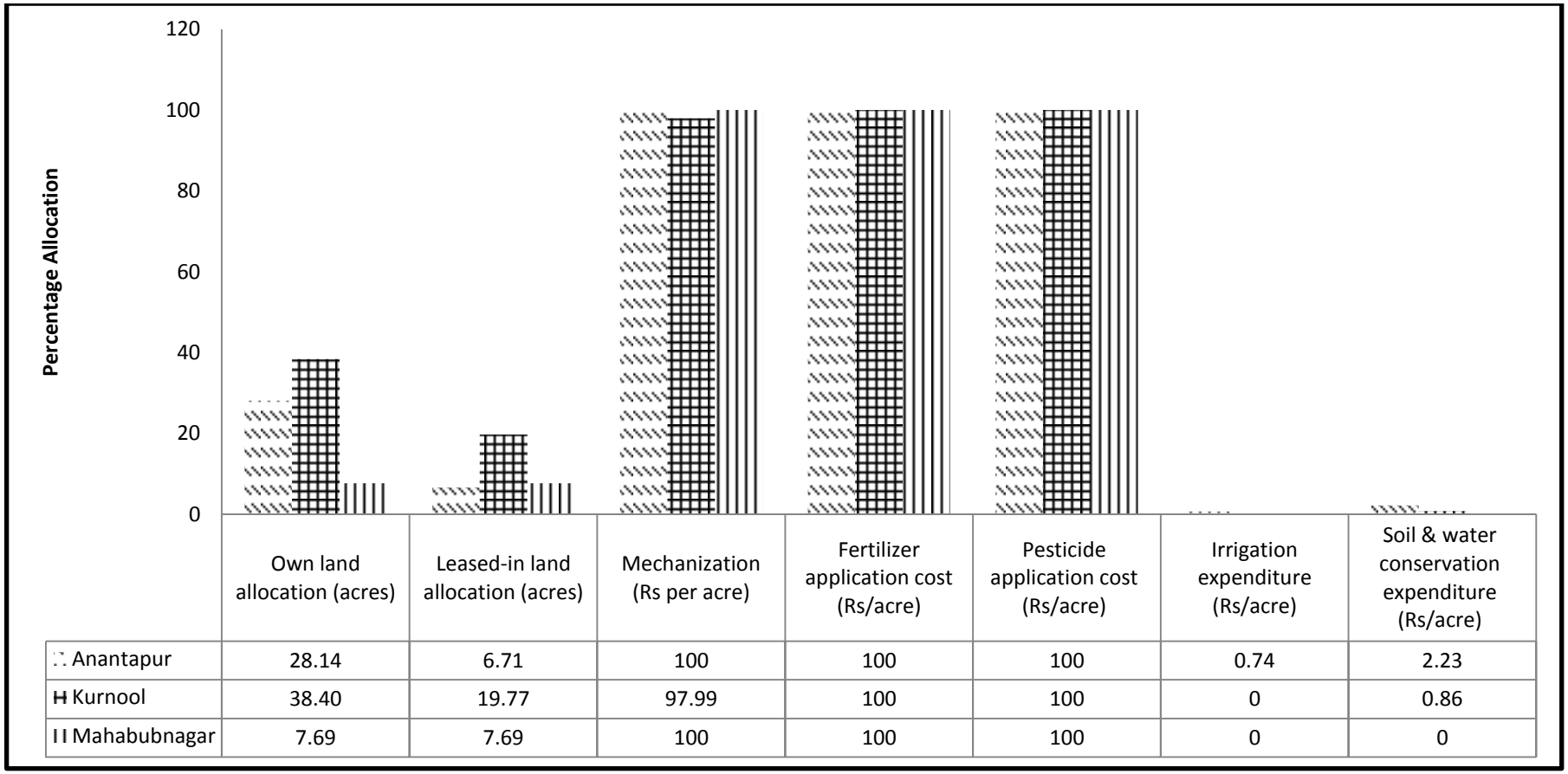
Type of change	**Change**		**Old allocation**	**Revised allocation**	**RANGE**	
	Yes	%	Average	Average	Old allocation	New allocation
Own land allocation (acres)	26	28.14%	7.11	13.03	0-20	0-40
Leased-in land allocation (acres)	15	6.71%	3.57	16.37	0-10	0-60
Mechanization (Rs per acre)	134	100%	1469.5	2175.6	300-2500	500-4000
Fertilizer application cost (Rs/acre)	134	100%	578.0	1055.7	200-1400	650-1800
Pesticide application cost (Rs/acre)	134	100%	575.89	994.32	250-1000	500-1600
Irrigation expenditure (Rs/acre)	1	0.74%	0	1200	0	0-1200
Soil & water conservation expenditure (Rs/acre)	3	2.23%	0	10000	0	0-10000

Table 13 Perceived behavioral changes in Kurnool district (N=349)

Type of change	Change		Old allocation	Revised allocation	Range	
	Yes	%	Average	Average	Old allocation	Revised allocation
Own land allocation (acres)	134	38.39%	8.04	15.77	0-70	0-70
Leased-in land allocation (acres)	69	19.7%	2.88	12.14	0-38	0-116
Mechanization (Rs per acre)	342	98%	1225.46	2177.89	0-2500	0-4000
Fertilizer application cost (Rs/acre)	349	100%	728.64	1428.47	100-2000	800-3500
Pesticide application cost (Rs/acre)	349	100%	695	1343.53	200-2000	400-4000
Irrigation expenditure (Rs/acre)	0	-	-	-	-	-
Soil & water conservation expenditure (Rs/acre)	3	0.86%	0	7000	0	0-7000

Table 14 Perceived behavioral changes in Mahabubnagar district (N=26)

Type of change	Change		Old allocation	Revised allocation	Range	
	Yes	%	Average	Average	Old Allocation	New allocation
Own land allocation (acres)	2	7.7%	3.5	4	0-6	0-7
Leased-in land allocation (acres)	2	7.7%	2	13	0-2	0-22
Mechanization (Rs per acre)	26	100%	1734.61	2678.46	600-2100	2000-3500
Fertilizer application cost (Rs/acre)	26	100%	681.92	1316.53	250-1800	900-2200
Pesticide application cost (Rs/acre)	26	100%	555.76	1028.84	250-900	600-1440
Irrigation expenditure (Rs/acre)	0	-	-	-	-	-
Soil & water conservation expenditure (Rs/acre)	0	-	-	-	-	-



	Own land allocation (acres)	Leased-in land allocation (acres)	Mechanization (Rs per acre)	Fertilizer application cost (Rs/acre)	Pesticide application cost (Rs/acre)	Irrigation expenditure (Rs/acre)	Soil & water conservation expenditure (Rs/acre)
Anantapur	28.14	6.71	100	100	100	0.74	2.23
Kurnool	38.40	19.77	97.99	100	100	0	0.86
Mahabubnagar	7.69	7.69	100	100	100	0	0

Figure 17: Percentagewise calculation of behavioural changes in farmers perceptions

4.12 DETERMINANTS TO CHICKPEA ADOPTION

The use of the Logistic Regression Function and the Odds Ratio has been made to understand the determinants of the chickpea adoption in the total study sample (N=1080) wherein, 810 of the farmers are chickpea farmers and 270 are non-chickpea farmers.

The dependent variables are adopted and non-adopted. We have assigned 1 to the adopters and 0 to the non-adopters. Results have been displayed in this section.

The explanatory variables are

- Years of farming experience (years)
- Proportion of Leased-in land in the total holding
- Total assets of households (Rs in lakhs)
- Share of black soils in the total land holding
- Proportion of own farm labour in the family
- Type of credit requirements by the household (scale 1-7)
- Share of rabi cropped area in the total land holding
- Area under commercial crops (acres)
- Area under non- commercial crops (acres)

But out of the 14 variables 9 where considered for the analysis and the rest variables were taken out because of the muliticollinearity problems.

From the analysis, the factors affecting adoption are proportion of leased-in land, proportion of black soils in the total holdings, type of credit required, area under commercial and non-commercial crops. Out of these the factors like proportion of leased-in land, proportion of black soils in the total holdings, type of credit required are significant at 5 percent level of significance. Whereas area under commercial and non-commercial crops is significant at 10 percent level of significance.

Table 15: Determinants of Adoption

Predictor	Co.eff	SE Coef	Z	P	Odds Ratio
Constant	-5.93	0.58	-10.30	0.00	
Years of farming experience	0.00	0.01	0.06	0.95	1.00
Proportion of Leased in Land	1.07	0.40	2.70	0.01	2.92
Total Assets of Households	0.01	0.01	1.49	0.14	1.01
Share of black soils in the total holdings	4.64	0.35	13.31	0.00	103.43
Share of own farm labour in family	0.51	0.49	1.05	0.29	1.67
Type of Credit requirements by households	2.78	0.48	5.77	0.00	16.19
Share of Rabi Cropped Area in the total land holding	0.47	0.25	1.86	0.06	1.60
Area under commericial crops (acres)	-0.07	0.04	-1.78	0.07	0.93
Area under non-commericial crops (acres)	0.19	0.02	7.99	0.00	1.21

Goodness of fit

Method	Chi-Square	DF	P
Pearson	3437.66	1070.00	0.00
Deviance	579.67	1070.00	1.00
Hosmer-Lemeshow	20.86	8.00	0.01

From the above table, the odds ratio show that the probability for growing chick pea in black soil is more for adopters than the non-adopters. Similarly the probability for adoption is high for farmers having more area under non-commercial crops.

Thus we can say that adoption has been affected by the above mentioned factors.

CHAPTER V

CONCLUSIONS:

As a result, it is worth noting that the rate of adoption of any agricultural innovation can be measured in two ways: (1) in terms of the number of farmers who adopt the innovation, or (2) in terms of the total area on which the innovation is adopted.[18]

In our survey we can conclude that we have taken into consideration both these methods for measuring technological adoption.

Thus in the districts of Kurnool, Anantapur and Mahabubnagar it can be seen that adoption has been high. Diffusion has taken place in a very dynamic way and there is room for growth. What is noteworthy is that since the usual factors that influence adoption such as education, age, tenancy status do not hold much value, the adoption in all the afore studied districts is phenomenal. Most studies have shown that farmers have found application of technology a tedious process, however in the case of these progressive chickpea farmers so is not the case.

Overall, Annigeri (old cultivar) took nearly 12-16 years to reach the peak level of adoption whereas JG-11 (improved cultivar) reached its peak within 8-10 years. Tracking improved chickpea cultivars adoption in Andhra Pradesh, 2011-12 proved that nearly 98% area is under improved cultivars. The single dominant variety ruling the state is JG11 with nearly 85% share of cropped area. It was followed by Vihar (mostly in Kurnool) and KAK2 (highly in Prakasam). Presence of Annigeri was observed in some pockets of Medak and Nizamabad districts.

The adoption lags were conspicuously different across study districts. Districts like Prakasam and Kurnool exhibited 6-8 years while Nizamabad and Medak took nearly 10 years. Most of the sample (66%) shifted from Annigeri to JG11 and another 15% sample farmers shifted directly from Annigeri to Kabuli (KAK2 or Vihar) types

Overall, nearly 35% sample farmers fell under A1 category and another 20% sample under A2. The remaining 45% represented the A3 and SW types. A3 and SW group farmers were much progressive contributing significantly to Chickpea Revolution

The initial results on behavioural changes provided strong evidence towards the intensification process. Allocation of more area, mechanization and applying more inputs are some of the significant variables, and the same need to be analyzed further. Since, some of the determinants for adoption of chickpea are: availability of Leased-in land, availability of suitable black soils, credit availability, share of rabi crops and allocation of area under non-commercial crops that have affected or influenced adoption.

[18] Michael L. Morris, Robert Tripp, and A.A. Dankyi, 1999, "*Adoption and Impacts of Improved Maize Production Technology: A Case Study of the Ghana Grains Development Project*"

However, the factors that generally affect adoption are categorized into social, socio economic, economic and political factors, with respect to the state of Andhra Pradesh it would be interesting to study what are the external factors that affect adoption instead of the traditional factors.

It would also be beneficial to create and promote an improved market infrastructure in order to promote commercialisation and export. The government needs to stabilize the minimum statutory price for chickpea in favour of the growing number of cultivators and reduce its import of chickpea in order to promote chickpea cultivation and boost farmer's morale. This would be beneficial in the longer run, as the farmers can then trust the various policies announced by them to favour the farmers.

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