Designing Rural Technology Delivery Systems for Mitigating Agricultural Distress:

A study of Anantapur District

M S Swaminathan Research Foundation
Chennai

Office of the Principal Scientific Adviser
to the Government of India, New Delhi

Front Cover: Groundnut field with sorghum as border crop - Anantapur District

Back Cover: Woman farmer threshing red gram (harvested groundnut in the backdrop) – Anantapur District

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FOREWORD

The US Department of Agriculture has forecast a shortfall of 15 to 17 million tonnes in India's rice output during 2009-10. Government has announced that about 2 million tonnes of rice may have to be imported soon to feed the public distribution system without interruption, since government stock has come down to 15.35 million tonnes on 1st October 2009. The reduction in Kharif crop production is largely due to widespread drought in many parts of the country as well as heavy flood in parts of Andhra Pradesh and Karnataka. Ensuring food security for a human population of 1.1 billion and a farm annual population of 1 billion is thus a formidable task.

Fortunately, unlike in China, whose annual food grain production is currently 500 million tonnes, we have a large untapped yield reservoir in most cropping systems, even with the technologies on the shelf. A Rs.25,000 crore Rashtriya Krishi Vikas Yojana has been launched to help in bridging the prevailing gap between potential and actual yields.

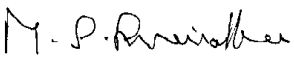
Designing Rural Technology Delivery Systems for Mitigating Agricultural Distress: A Study of Anantapur District focuses on the technological dimension of the agricultural crisis that is currently gripping the Indian economy. A perusal of this study will show that it will be possible to bridge the prevailing yield gap in the district, provided integrated attention is given to knowledge delivery, input supply, popularization of appropriate technologies, soil health, water harvesting and management, and market management. Dr R Rukmani and Ms Manjula have adopted a methodology that combines secondary data analysis with primary survey. A cross section of key persons - Farmers, Farm Leaders, Scientists, Academicians and Bureaucrats were interviewed by them.

The study was funded by the Office of the Principal Scientific Adviser to the Government of India and was closely monitored by a Project Review and Monitoring Committee. Our gratitude goes to Dr R Chidambaram as well as the Chairman and members of the Committee, Dr Panjab Singh, Former Vice Chancellor of Banaras Hindu University; Dr C R Bhatia, Former Secretary, Department of Bio-Technology; Dr S F D'Souza, Associate Director, Bio-Medical Group and Head, Nuclear Agriculture and Biotechnology Division, BARC, Mumbai and Dr R P Sharma, INSA Sr. Scientist, National Research Centre on Plant Biotechnology, IARI, New Delhi and Dr R P Gupta of the Office of the Principal Scientific Adviser to the

Government of India, for all the interest they have taken in this important project and for the encouragement and guidance they have given to the researchers.

The results of the study show that there are considerable opportunities for increasing the productivity and profitability of small and marginal farm holdings through a technological upgradation of farm practices, supported by assured and remunerative marketing opportunities.

I hope this study will help to spread a mood of confidence in our agricultural capability. Those who are designing the "bridge the yield gap" programme in State Governments will benefit from studying this Report. My sincere thanks go to Dr R Rukmani and Ms Manjula Menon for their painstaking and meticulous documentation and for the compilation of this "Message of Hope Report".



M S Swaminathan
November 2009

Acknowledgement

We thank our Chairman, Professor M.S.Swaminathan, for providing us an opportunity to study the technological dimension of the agricultural crisis in Anantapur district. His constant motivation, guidance, and stimulus have helped us immensely.

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Prof V B Athreya, Dr T N Balasubramanian, Dr J Jeyaranjan, and Prof K Nagaraj, apart from being a source of support for us, have provided critical inputs, guidance, and valuable comments all through. We would like to acknowledge the active help and support extended right through our project period by several people in Anantapur. We would particularly like to thank Dr Y V Malla Reddy, Director, Accion Fraterna Ecology Centre, Mr Imam, Mr S M Bhasha, Mr Nageswara Rao, Prof. Ramakrishna Reddy and the staff of Rural Development Trust. We would also like to thank the government officials from various Government Departments in Anantapur and Hyderabad for taking time off to answer all our queries and providing valuable inputs. We are also grateful to the scientists of the Acharya N G Ranga Agricultural University, Hyderabad, International Crop Research Institute for Semi-Arid Tropics, Hyderabad, Central Research Institute for Dryland Agriculture, Hyderabad, and Research Stations at Anantapur for their time and technical insights.

Our deep sense of gratitude to the farmers of Thopudurthi and Thirumaldeverpally villages, for their valuable time and whole hearted hospitality. The Adarsha Ryuthus Mr Chandrasekar and Mr Obleshu were of immense help during our visits to the village and we acknowledge their help and hospitality. Last but not the least, we are very grateful to Mr P V Gowd for helping us with our field work. Besides helping in translation on the field he brought to the project his professional knowledge of agriculture and his practical experience as a farmer.

We acknowledge the assistance received from the Library, Accounts, and Administration at the Foundation. Colleagues, in particular, Drs V Arivudai Nambi, R Rengalakshmi and L Vedavalli have been of great help and we thank them. We thank Dr Shubashree Desikan for her help in editing the report. Our special thanks to Mr Sakthi Velan for his help in the final stages of the report.

R Rukmani and Manjula, M.
November 2009

Introduction

Anantapur is the southern-most district of the Rayalseema region of Andhra Pradesh. While agriculture remains the most important economic activity of the district, it is characterised by high levels of instability and uncertainty. Being located in the rain-shadow region of Andhra Pradesh, the district is drought-prone. By now, it is well established that while a generalised rural crisis is prevalent across the country, a disproportionate burden has fallen on its drier tracts. In 2006, Anantapur was one of the thirty-one districts identified by the Government of India as being prone to agriculture-related suicides. A few committees have been set up by the Government of Andhra Pradesh to study the agricultural crisis as well as the problem of farmers' suicides in the state. While these committees have looked at a whole gamut of issues underlying the agricultural crisis of Andhra Pradesh, our study of Anantapur district focuses specifically on the technological dimension of the crisis. Our study addresses such factors that have a bearing on agricultural production and productivity, namely, the physical environment; the extent and nature of agricultural inputs used; the nature of crop protection practices followed; the overall management practices adopted in cultivation including irrigation practices and aspects of technology delivery.

Anantapur district is bounded by Kurnool District in the north; Cuddapah District in the north-east; Chitoor District in the south-east; and Karnataka State on the West (Map 1). The district has a total geographical area of 19.13 lakh hectare. For administrative purposes, the district is divided into three revenue divisions, namely, Anantapur, Dharmavaram, and Penukonda; there are sixty-three revenue *mandals*. As per 2001 census, the district has 10 towns and 964 revenue villages and a total population of 3.64 million. Almost 75 percent of the population in the district lives in rural areas. Agriculture remains the predominant activity in the villages, with 80 percent of total workers engaged in agriculture, either as cultivators or agricultural labourers. In urban areas, about 11 percent of the workforce is engaged in agriculture. Mining is also an important activity in Anantapur District as it is endowed with rich deposits of iron ore and lime stone, as well as other minerals. There are more than fifty small-scale industrial units in the district, of which nearly one-half are to do with granite. There are also couple of cement industries and steel industries in the district.[1]

1 The basic information on the district is drawn largely from the district's official website.

Map 1 Anantapur District

Source: *http://anantapur.gov.in/*

The focus of this study is to understand the factors underlying the agricultural crisis, with specific reference to non price factors that affect crop production and productivity, in Anantapur, and the methodology consists of a combination of secondary data analysis and primary surveys, interviews and consultation with a cross-section of people. While an analysis of secondary data on Anantapur District provides a macro-picture of changes in the district as a whole, the personal interaction with key informants provides an insight into specific local concerns. In order to choose two *mandals* out of the sixty-three in Anantapur District, *mandal*-level data on rainfall, percentage of net sown area irrigated, density of pumpsets, cropping intensity and percentage of agricultural workers for the year 2002–03

were considered. With regard to each one of the indicators, *mandals* were ranked as low, moderate, or high, where the district average and values equal to that were ranked *moderate*; any value lower than that was ranked *low;* and any value higher than that was ranked *high*. Fifteen *mandals* that had a low percentage of agricultural workers (below 53.46 percent) were excluded from this analysis and from the remaining 48 *mandals* two groups were culled out that had the following characteristics:

- high rainfall (600–700 mm), moderate-to-high density of pump sets (seven pumps per hectare), low level of irrigation (less than 12.6 percent of net sown area irrigated), moderate-to-high cropping intensity (greater than or equal to 1.04), and high incidence of agricultural workers (above 53.46 percent);
- low rainfall (341–400 mm), moderate-to-high density of pump sets, low level of irrigation, low cropping intensity, and high incidence of agricultural workers.

It is clear that the basic difference between these two groups of *mandals* is essentially with regard to rainfall and cropping intensity, while the pattern with regard to level of irrigation and density of pump sets remains the same. The high incidence of pump sets combined with low level of irrigation is indicative of a scenario where investment in pump sets has not resulted in higher levels of irrigation. This scenario typifies the current agricultural problem of Anantapur, as discussed in the literature, and therefore *mandals* reflecting these characteristics were chosen. In addition, considering the fact that agricultural problems in areas with relatively high rainfall would be different from those with low rainfall, we chose the *mandals* using level of rainfall as an indicator. Having listed the *mandals* with the above characteristics, on the basis of preliminary enquiries, we chose Kothacheruvu *mandal* with high rainfall and Atmakur *mandal* with low rainfall. In Atmakur *mandal*, the popular variety of groundnut that is cultivated is TMV2 while in Kothacheruvu it is JL24. Having chosen the *mandals*, two villages—Thopudurthi village in Atmakur *mandal* and Thirumaldeverpally village in Kothacheruvu *mandal*-were chosen using random numbers.[2] The survey was conducted in both these villages during January and February, 2009. The attempt in the village survey was essentially to understand the constraints faced by farmers with regard to adoption of technology and problems encountered by them with regard to cultivation in general. Group discussions with the farmers were held in both the villages. This

2 Please see Annexure 1 for details of survey villages.

was followed by intensive qualitative interviews with a few individual farmers.[3] Apart from the village survey, we had discussions with a large number of experts in relevant fields. Scientists from the State Agricultural University; National and International Research Institutes; Agricultural Officers and Village Extension Workers from the Department of Agriculture; Officers from the Departments of Irrigation and Watershed, and Seed Corporations etc.; leaders and members of farmers' organisations; and experts from other non-governmental organisations working in Anantapur were all consulted.

The report is organised in two sections: Section 1 provides detailed information on various aspects of agriculture in Anantapur District while Section 2 provides a list of recommendations that are needed to revive agricultural growth in the district.

3 The checklist used in the interviews with farmers is given in Annexure 2; Annexure 3 provides basic details of the farmers who were interviewed at length in the 2 survey villages.

1. Salient Features of Agriculture in Anantapur District

1.1. Agro-ecological Characteristics[4]

Anantapur District is in the arid agro-ecological zone and is marked by hot arid bioclimatic condition with dry summers and mild winters. The district is characterised by hills, ridges, and undulating and gently sloping lands. Of the total geographical area of the district, hills and ridges cover 14 percent; undulating lands, 27 percent; gently sloping lands and very gently sloping plains extend over 54 percent; and valleys cover 5 percent.

1.1.1. Rainfall

The geographical location of Anantapur District is such that it does not get the full benefit of either of the monsoons. The south-west monsoon gets cut off by the Western Ghats, while the full benefit of the north-east monsoon is not derived, either, as the district lies far from the eastern coastline. The district is in the rain-shadow area and the normal rainfall is 553 mm. There are four distinct rainfall zones in the district as illustrated by Map 2.[5] An analysis of monthly rain fall over ninety-four years—from 1911 to 2004—indicates an annual mean rainfall of 568.5 mm with a coefficient of variation (CV) of 28 percent.[6] That the coefficient of variation of rainfall is higher than the threshold level of 25 percent for annual rainfall suggests variability and lower degree of dependability on rainfall in the district.

In more than one-half of the years studied, the actual rainfall is below the annual mean rainfall of 568.5 mm. That is, fifty-one out of ninety-four years have experienced below mean rainfall in Anantapur district (Figure 1). Further, on average once in every five years, the district experiences drought conditions. Eighteen out of ninety-four years are classified as drought years, as the annual actual rainfall in these years has been 75 percent below the annual mean rainfall of

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4 This section relies largely upon various publications of National Bureau of Soil Survey and Land Use Planning. (NBSSLUP 1996, 1999, 2005a, 2005b, 2005c), and Kolay A.K.1993.

5 Normal rainfall is the average rainfall for a specific region over a block of 30 years. The blocking of 30 years runs from the first year of the first decade to the last year of the third decade (for example, 1971 to 2000). Normal rainfall data for the mandals have been obtained from Chief Planning Officer, Anantapur.

6 Monthly rainfall and rainy days data were obtained from IMD,Pune.

Map 2 Mandals Classified by Normal Rainfall - Anantapur District

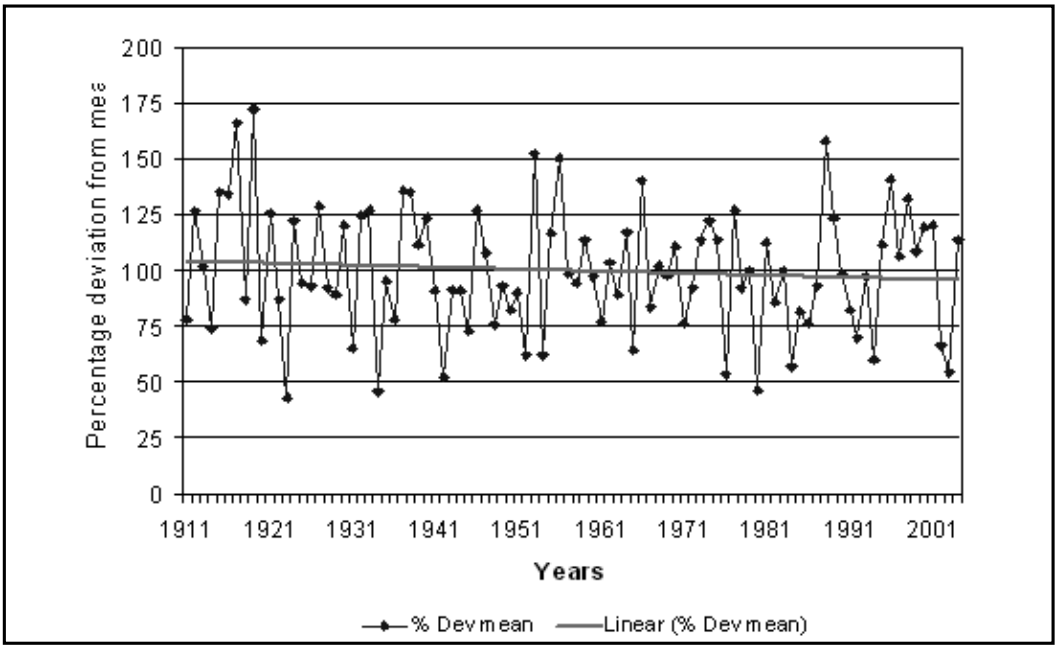
Source: *http://anantapur.gov.in/*

568.5 mm.[7] Fourteen out of these eighteen years are moderate-drought years while four may be classified as severe-drought years.

An analysis of the contribution of seasonal rainfall to total annual rainfall of the district, from 1911 to 2004, shows that the south-west monsoon (June to September)

7 According to the India Meteorological Department, meteorological drought occurs when the actual annual rainfall is less than or equal to 75 percent of the mean annual rainfall. Severe drought occurs when the actual annual rainfall is below 50 percent of the mean annual rainfall; moderate drought occurs when the actual annual rainfall is 50 to 75% of the mean annual rainfall.

Figure 1 Percentage Deviation from Mean Annual Rainfall - Anantapur District



Source: *Data collected from Indian Meteorological Department (IMD), Pune.*

contributes 58 percent; north-east monsoon (October to December) 28 percent; hot weather period (March to May) about 13 percent; and cold weather period (January and February) 1 percent. Normal rainfall shows a marginally declining trend across all the seasons in the district over a ninety-year period, as indicated in Table 1 and Figures 2 and 3.

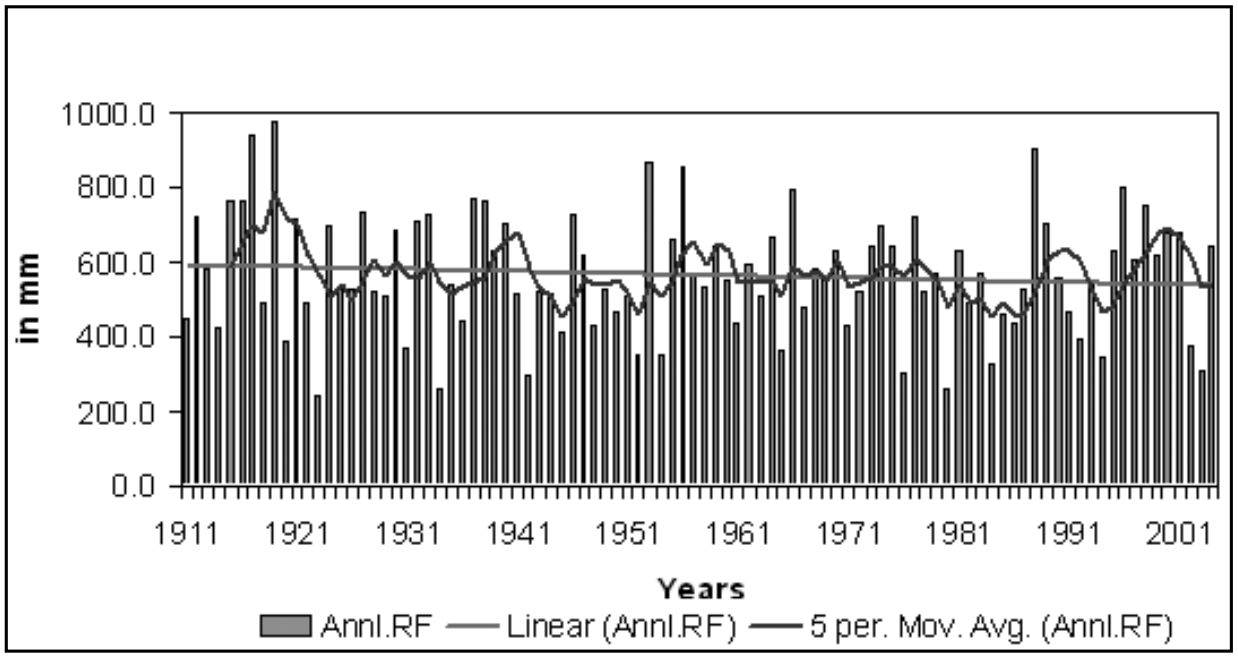
In addition to the marginally declining trend of the quantum of rainfall, variability in rainfall is also an important issue affecting the agricultural prospects of Anantapur District. Variability in rainfall is noticed in all seasons, except the south-west monsoon, as testified by the values of the coefficient of variation calculated over 1911 to 2004. That is, on average, about 42 percent of annual rainfall is subject to a high degree of variability. However, rainfall is assured during the south-west monsoon, though with a low mean of 329.9 mm. Yet, the effective rainfall (which

Table 1 Normal Rainfall (in mm) Across Seasons - Anantapur District

Period	South-west monsoon	North-east monsoon	Cold weather period	Hot weather period	Annual rainfall
1911–40	350.27	166.57	13.58	72.93	603.35
1941–70	315.97	148.88	2.06	84.35	551.26
1971–2000	335.58	157.51	2.06	64.30	559.46

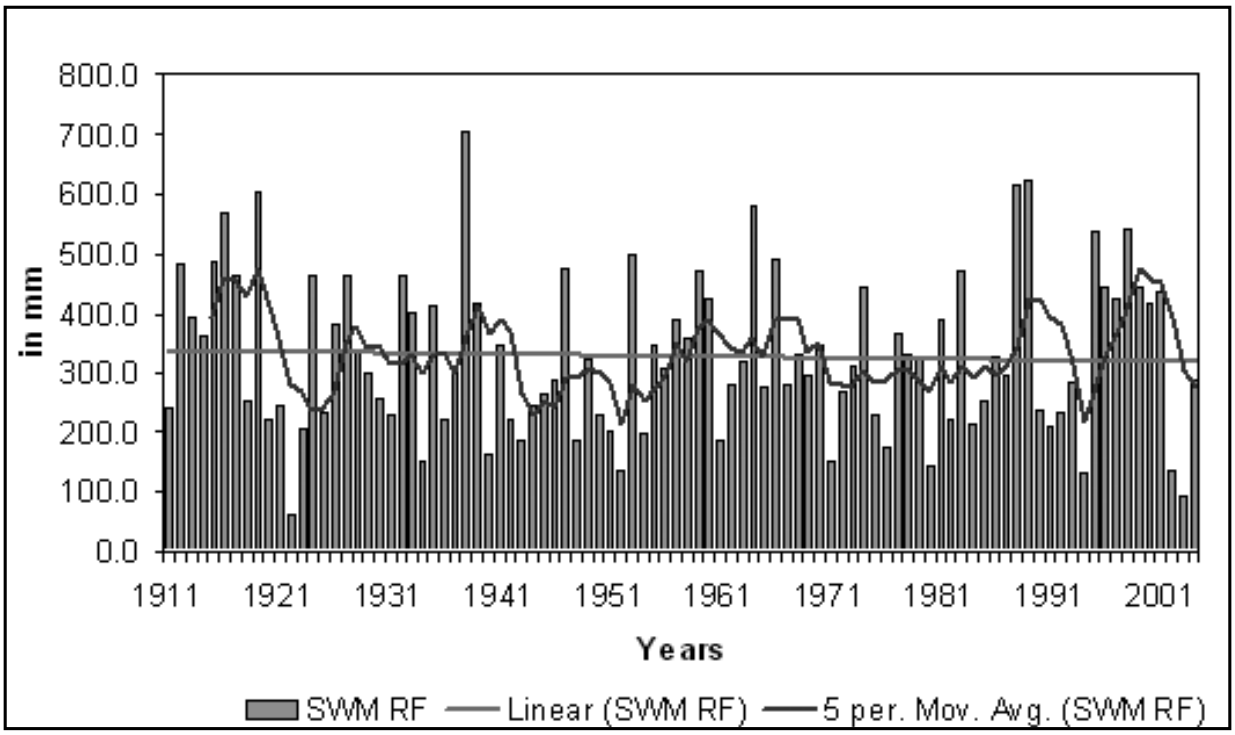
Source: Data collected from IMD, Pune

Figure 2 Annual Rainfall- Anantapur District



Source: *Data Collected from IMD, Pune*

Figure 3 Rainfall during South West Monsoon - Anantapur District



Source: *Data Collected from IMD, Pune.*

indicates the part of the rainfall that is available as soil moisture in the root zone to meet the crop evapotranspiration requirement) is computed to be 198 mm for south-west monsoon over the period 1911 to 2004. The effective rainfall in the district is at least 50 percent below the amount required to reap potential groundnut yield. Further, comparing mean rainfall and potential evapotranspiration (PET)[8] indicates that during the main crop-growing period of south west monsoon, quantum of rainfall is lower than the levels of potential evapotranspiration in the district. The rainfall deficit with respect to PET was 70 percent in June; 64 percent in July; 52 percent in August; and 2 percent in September. The soil-moisture stress condition under different stages of crop growth would result in inadequate plant population; higher percentage of flower drop; poor seed setting etc; and thereby have implications for crop yields.

The length of growing period (LGP), which is an assessment of the period during the year when both moisture availability and temperature are conducive to crop growth, is calculated to be 119 days in Anantapur district. The mean growing period dates between 7 July and 2 November. An analysis of the probability of dry-spell occurrence during the mean growing period (7 July to 2 Nov) by employing Markov-Chain Analysis indicates that out of a total of eighteen weeks of growing period in the district, thirteen weeks experience dry spells with a probability of more than 60 percent and fifteen weeks experience dry spell with a probability of more than 50 percent.[9] A high probability of dry spell would have significant implications for yield of rain-fed/dry land crops as yield would depend not only on the quantum of rainfall but also on the distribution within the season. Gadgil notes, "Dry spells induce moisture stress and have a major impact on growth and development when they occur at some life history stages. …….Dry spells and wet spells can also trigger the growth of pests/diseases/weeds and hence have impact on the yield. The impact may also be on the operational efficiency, as in the case of an intense dry spell during harvest which results in difficulty in retrieving all the pods from the hard soil." (Gadgil *et.al*, 1999)

8 Potential evapotranspiration (PET) captures the environmental demand for evapotranspiration.

9 Meteorologically, a dry spell is defined as a period of fifteen days without any rain fall. In this analysis a meteorological standard week with rainfall less than 25 mm is considered a dry spell. This analysis is done for mean rainfall of thirty years over 1975 to 2005 using weekly rainfall data provided by Agro-met cell, ANGRAU. The probability of occurrence of a dry-spell week followed by a dry-spell week was computed using conditional probability with a limit of 25 mm weekly rainfall.

Our analysis clearly brings out the limitations posed by rainfall pattern for crop growth in Anantapur district. Level of rainfall as well as effective rainfall is low with a high probability of dry-spell occurrence in the growing period. During south-west monsoon, the quantum of rainfall is lower than potential evapotranspiration, thus having serious implications for crop growth.

1.1.2. Soil Characteristics

The soils of Anantapur originated from both the granite and granite-gneisss land forms, as wells as the Dharwar landforms. Both these land forms are characterised by hills and ridges and undulating and gently-sloping lands. There are about thirty-four soil families in the district of Anantapur, and among these, the Anantapur and Penukonda soil families are the most predominant.

The land capability classification which describes the capability of soils for different uses classifies soil into eight classes. The classification is based on inherent soil characteristics as well as external land features and other environmental factors that limit the use of land. Any land capability class is thus a grouping of land units that have equal relative degrees of limitation or advantage. Soils suitable for cultivation are grouped under classes I to IV while soils not suitable for cultivation but very well suited for forestry, wild life, and grassland are under classes V to VIII. In Anantapur district, less than 4 percent is classified as class II; 44 percent as class III; and 25 percent as class IV (Table 2).

Table 2 Land Capability Classes - Anantapur District

Land Capability Class	Area (in hectares)	Percentage of Area
I	nil	nil
II	65,082	3.43
III	831,895	43.89
IV	482,122	25.43
V	nil	nil
VI	177,453	9.36
VII	339,048	17.89
Geographical Area	1,895,600	100.00

Source: *NBSSLUP 2005a*

To bring to recall the significance of this soil classification, Class I lands are defined as, 'level lands with deep, well-drained soils of a satisfactory texture and structure….They are suitable for growing a variety of crops by adopting ordinary good farming practices. …..They are very fertile lands.' These are totally absent in Anantapur district. Class II lands are those that may be cultivated regularly although special conservation practices like contour farming are to be followed for maintaining the productivity of lands. The available nutrients on Class II lands are poor. Class III lands, which account for the majority of cultivable land, can be cultivated only by following intensive soil-conservation practices like terracing. Class III lands are 'moderately sloping lands with a moderately deep soil. …They are more severely affected by salinity and alkalinity and soil erosion than Class II lands. They have poor nutrient content and moisture-retention capacity'. Class IV lands are suitable for occasional cultivation. That is, Class IV lands can be brought under intensive cultivation only once in four years, and the remaining years it should be left under grasses. Land capability classification in a nutshell indicates that while 73 percent of geographical area of the district is cultivable, 25 percent of this can be cultivated only once in four years and the remaining 48 percent can be cultivated only if conservation measures are adopted rigorously. In other words, water erosion; shallow rooting depth; gravelliness; moderate slopes; and salinity, as well as climatic limitations affect successful crop cultivation in the district.

In the district, red alfisol soils are predominant, accounting for 78 percent, while black soils are found in 20 percent of the total geographical area. It is estimated that 63 percent of the total geographical area of the district is covered by sandy loam; 14 percent is under rock land; and about 19 percent is under clay. Large areas in the district have coarse soil-surface texture, are poor in water and nutrient retention, and are prone to wind and water erosion. The strong westerly winds that blow across the district are also a factor that contributes to soil erosion. An estimate of soil loss due to erosion suggests that the total estimated soil loss from the entire district to be 91.7-lakh ton per annum.[10] Using this estimate, in the total geographical area of 19,10,000 hectare of the district, the estimated soil loss per hectare is 4.8 ton per annum. In addition to this, large areas in Anantapur have shallow rooting depth for plant growth. Further, it is estimated that about 59 percent of soils of Anantapur have low 'available water capacity', a measure which

10 The estimate of soil loss due to erosion is over and above the permissible limit of soil loss of 10 tons per hectare per annum. The estimate is based on data provided by NBSS & LUP 2005.

indicates the amount of moisture that can be easily absorbed by the plant from the soil for its optimum vegetative growth. The soils of the district having very low water storage capacity, Anantapur suffers from excessive water run off.

In the district, 31 percent of the total geographical area is classified as strong water-erosion class; 2 percent as extreme water-erosion class; 50 percent as moderate water-erosion class and 17 percent under slight water-erosion class[11]. This again is attributed to the predominantly sandy loam texture of the soils and the poor water-holding capacity of the soils. The high water-erosion tendency exhibited by the soils make the already scarce rainfall unavailable for effective plant growth, thereby reducing the length of the growing period.

To analyse the chemical properties of soils, the organic carbon measure is of great significance as it gives an indirect measure of available nitrogen; soil microbial activity; and nutrient absorption capacity of the soil. The soil fertility analysis done by the Department of Agriculture in the district of Anantapur in 2007–08, which take into account a total of 19,192 soil samples, suggests that 80 percent of the samples are low in nitrogen while phosphorous and potassium are available in moderately high levels. They are also deficient in micro-nutrients like zinc and iron, and on the whole the district has low organic carbon content in the soils. Further analysis of the chemical properties of soils in the district indicates that the problem of salinity/sodicity is mostly prevalent in the black soils. The important characteristics of saline soils are the presence of excessive amount of neutral soluble salts like chloride and sulphate of sodium. Soil sodicity is characterised by the presence of high levels of exchangeable sodium. A saline–sodic soil is one which has both a high amount of soluble salts and high percentage of exchangeable sodium. Both, salinity and sodicity, pose problems for crop growth and performance. On the one hand, there is excessive absorption of sodium and chloride that leads to crop-growth retardation, and on the other, there is reduced uptake of some essential plant nutrients like potassium and calcium, often resulting in nutrient imbalances and deficiencies. This is of serious implication to a rain-fed/dry land groundnut growing tract like Anantapur. Potassium is of utmost importance to rain-fed crops, to tide over moderate moisture stress in the upper layers, as greater root generation and penetration helps the crop to effectively source soil moisture from the lower layers. Lack of calcium will affect the proper shell formation of

11 Water erosion is usually referred to as the removal of top soil and other solid materials by transport of water. Extreme cases of water erosion results in formation of rills, gullies and valleys.

groundnut. The problem with sodicity is expressed in the soil physical properties. A higher proportion of exchangeable sodium percentage in the soil, results in the breakdown of soil aggregates, and lowers the permeability of the soils to air and water. Sodicity also tends to make the soil more dispersed. Soil dispersion results in the formation of a dense impermeable surface crust that poses difficulty for the emergence of seedlings.

The effect of sodicity on soil chemical properties is by its influence on the soil pH, which further leads to the soil becoming calcareous. A higher pH created by sodicity results in lowering the solubility and availability of some essential plant nutrients like phosphorous, calcium, magnesium, iron, manganese, and zinc. Calcium and magnesium react with carbonates of sodium and form the insoluble calcium and magnesium carbonates, resulting in calcareousness of the soil. It is estimated that 12 percent of the geographical area of Anantapur district has problems of soil calcareousness. This has direct implication for availability of phosphorous to the plants. Phosphorous reacts with calcium carbonate and gets fixed as calcium phosphate in the soil, which is highly immobile and unavailable to the plants. The soils of Anantapur are classified to have medium cation-exchange capacity, an indication of the medium capacity of the soils to supply nutrients as well as the medium responsiveness of the soil to application of fertilisers[12].

To sum up, the soil of Anantapur has great limitation in terms of its physical and chemical properties. These limitations have serious implication for crop productivity in the district. The coarse texture; shallow depth; poor water-retention capacity; high erodability of soil; as well as the undulating topography promoting easy soil and water runoff are some of the dominant physical constraints for cultivation in the district. The low–medium organic content, low–medium cation exchange capacity and percent base saturation, the tendency for acidity/alkalinity–sodicity, etc are the major chemical characteristics of the soils of the district that act as the limiting factors for proper crop establishment and growth.

1.2. Land-Use Classification and Land Holding Structure

While a cursory look at the land-use pattern in the district of Anantapur, over 1961–62 to 2005–06, suggests a more or less stable pattern, a more thorough analysis brings out two important changes in land use (Table 3 and Figure 4). First, culturable waste land has declined sharply over the years, from an extent of 1.7-

12 Cation-exchange capacity is an index of soil fertility.

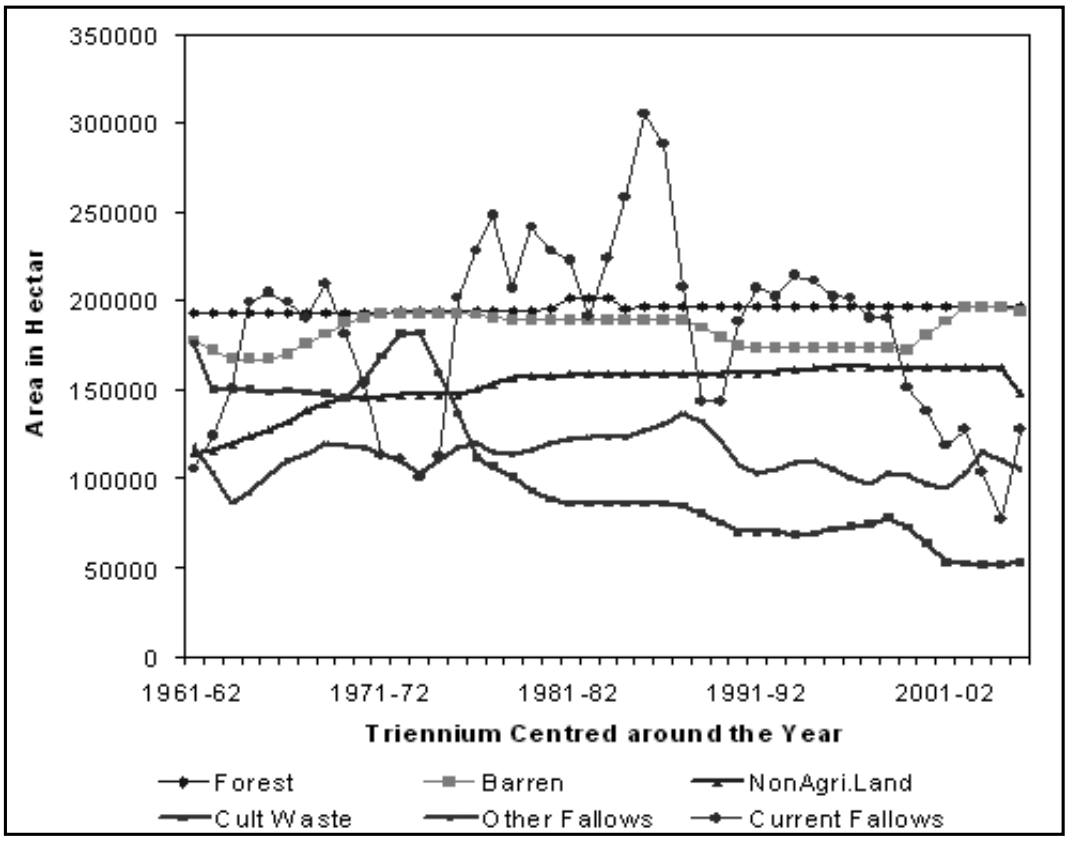
Table 3 Changes in Land-Use Pattern in Anantapur District, 1961–62 to 2005–06

(in '00 Ha.)

Three year averages centred around the year	Net sown area	Current Fallows	Other Fallows	Culturable Wasteland	Barren Land	Permanent Pastures	Forest Area	Misc. Trees	Non-Agri Land
1961–62	10246.00	1058.58	1183.34	1761.54	1785.07	268.45	1930.26	180.13	1139.63
	52.40	**5.41**	**6.05**	**9.01**	**9.13**	**1.37**	**9.87**	**0.92**	**5.83**
1971–72	9345.88	1138.43	1129.86	1695.15	1929.36	258.82	1935.94	236.87	1464.62
	48.84	**5.95**	**5.90**	**8.86**	**10.08**	**1.35**	**10.12**	**1.24**	**7.65**
1981–82	8900.24	2235.27	1220.92	856.11	1895.53	233.26	2017.20	194.61	1581.78
	46.51	**11.68**	**6.38**	**4.47**	**9.91**	**1.22**	**10.54**	**1.02**	**8.27**
1991–92	9682.69	2072.34	1024.81	701.91	1741.01	236.69	1967.97	114.20	1593.30
	50.60	**10.83**	**5.36**	**3.67**	**9.10**	**1.24**	**10.28**	**0.60**	**8.33**
2001–02	10361.04	1191.42	952.02	533.86	1888.48	270.37	1967.78	352.21	1617.74
	54.15	**6.23**	**4.98**	**2.79**	**9.87**	**1.41**	**10.28**	**1.84**	**8.45**
2005–06	10327.32	1279.95	1055.73	527.31	1942.66	259.68	1968.45	286.41	1479.59
	53.97	**6.69**	**5.52**	**2.76**	**10.15**	**1.36**	**10.29**	**1.50**	**7.73**

Note: *Figures in bold are percentages with respect to the geographical area of the district*
Source: *Government of Andhra Pradesh, 2006; GoAP various years.*

Figure 4 Land-Use Classification- Anantapur District



Source: *Government of Andhra Pradesh, 2006; GoAP Various Years.*

lakh hectare in early 1960s to about 0.5-lakh hectare in mid-2000s.[13] In 1961–62, culturable wastes formed 9 percent of geographical area, while by 2005-06, this percentage decreased to less than 3 percent.

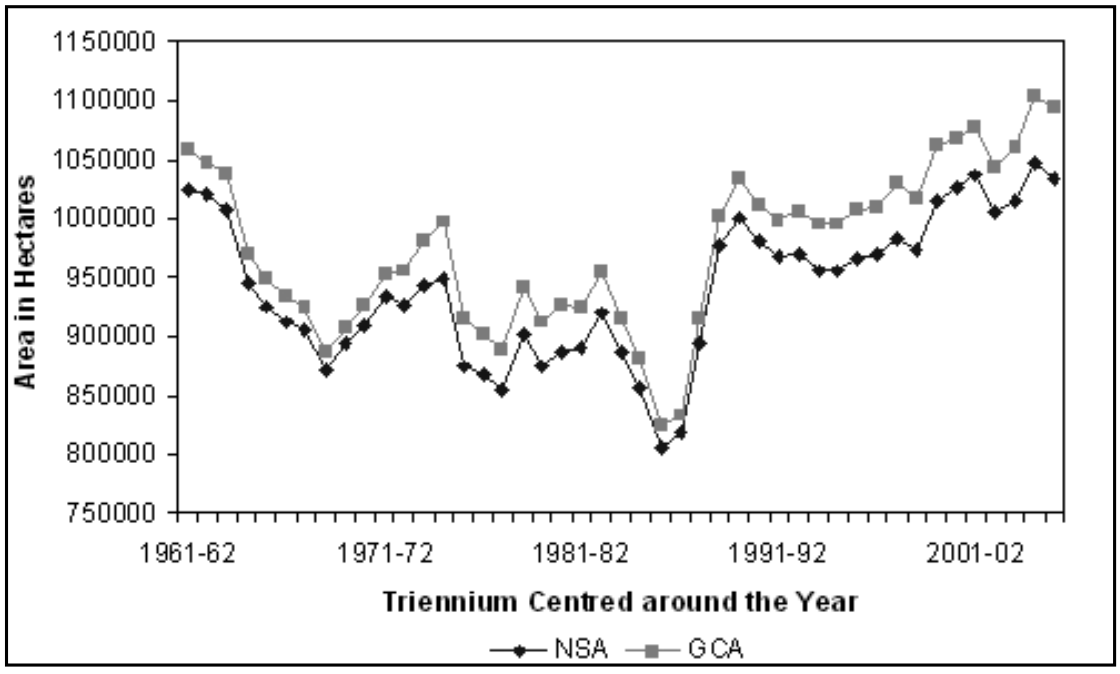
The decline in culturable wastes is accounted for partly by an increase in land put to non-agricultural use; an expansion in area that remains barren; an increase in area under trees; as well as a general tendency to bring culturable waste land under cultivation. The culturable wastes that are brought under cultivation in a year, however do not get cultivated every year and perhaps remain as fallows in some years, as is suggested by a fluctuating pattern of current and other fallows in the district. Non-agricultural land has increased from 5.83 percent of geographical area of the district to 7.73 percent over 1961–62 to 2005–06. As regards other classifications of land-use, the area under forests remains stable at about 10 percent of geographical area throughout the period under consideration while the areas

13 Culturable waste land includes land available for cultivation, whether not taken up for cultivation or taken up for cultivation once but not cultivated during the current year and last five years or more in succession for one season or other. Such lands must be either fallow or covered with shrubs and jungles which are not put to any use.

cultivated with trees and pasture land, each accounting for less than 2 percent of geographical area, have registered moderate increase in the recent years. Though a considerable extent of the area is under forests in Anantapur District, the nature of these forests is such that this does not contribute towards improving the arid climate in the region. The *Anantapur District Gazetteer,* published in 1905, notes, 'The forests of the district nowhere consist of really dense growth or large timber and in many parts they contain practically no tree at all' (GoAP. 1993) That the nature of forests have remained as pathetic as they were a hundred years ago is clear from the description of forests in the recent publication of the state government as, 'The forests in the District are thin and scanty……There are numerous isolated peaks and rocky clusters which are devoid of any vegetation'. (CPO. 2006–07)

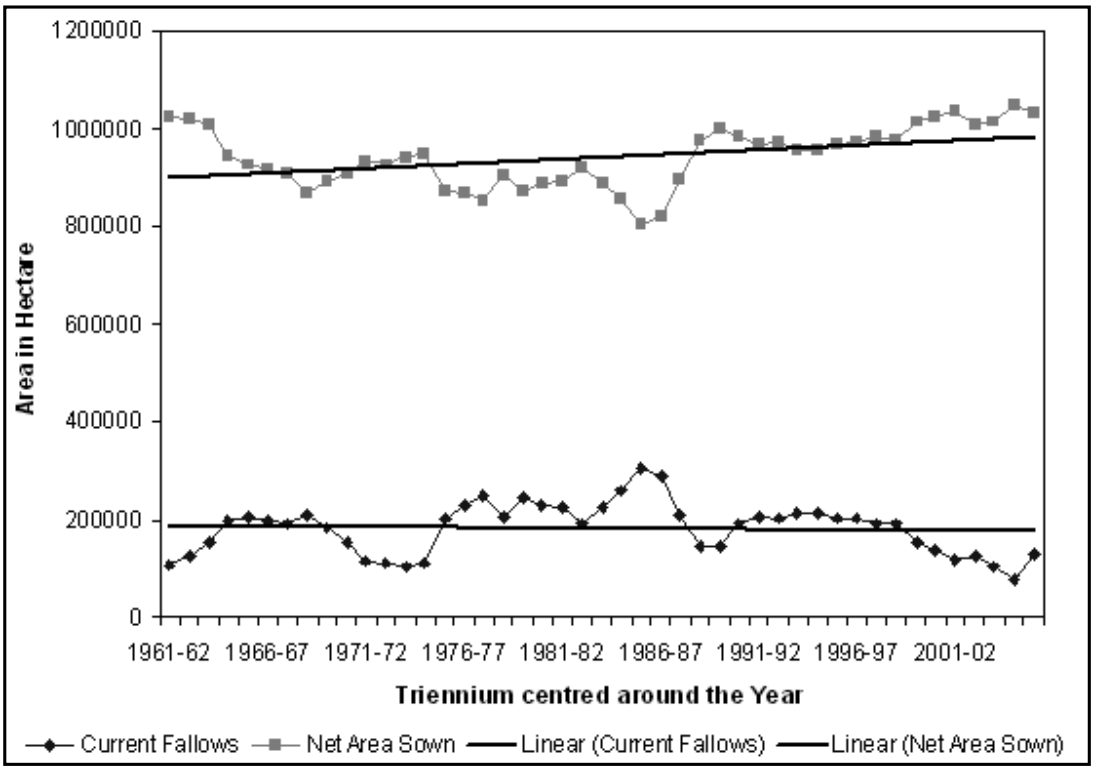
Second, net sown area as well as gross cropped area in the district of Anantapur over four and a half decades fluctuates a great deal (Figure 5). This is clearly indicative of a high degree of instability in agriculture in the district. The extent of net sown area was more than 10-lakh hectare in early 1960s and it went down to 8-lakh hectare during the mid-1980s and it expanded again to reach 10-lakh hectare by the mid-2000s. A declining trend in net sown area as well as gross cropped area in the district is observed during the 1960s and 1970s but this gets reversed in the mid-1980s, a feature perhaps related to the promotion of tube-well irrigation around the 1980s in the district.

Figure 5 GCA and NSA-Anantapur District



Source: *Government of Andhra Pradesh, 2006; GoAP various years.*

Figure 6 Net Sown Area and Current Fallows - Anantapur District



Source: *Government of Andhra Pradesh, 2006; GoAP various years.*

The division of sown areas is shown in Figure 6, when one can see that over the four decades under consideration, whenever net sown area registers a fall, current fallows have registered a rise. The pattern of change exhibited by current fallows is almost like a mirror image of net sown area. While the close correspondence between net sown area and current fallows is clearly a sign of an agricultural system that depends on the vagaries of monsoon, the extent of fallows also appears to be related to the occurrence of land degradation that is taking place. An analysis made by Ratna Reddy using data from National Remote Sensing Authority, shows that while the extent of land degradation in the state of Andhra Pradesh accounts for 10 percent of geographical area and 19 percent of the cultivable area, in Anantapur district it accounts for 15 percent of geographical area and 21 percent of cultivable area in the year 1988–89. (Reddy, Ratna. 2002) The practice of leaving land fallow is quite substantial across all size classes of farmers in Anantapur district.

In the year 2001, as Table 4 illustrates, 7.78 percent of total area under land holdings is classified under current fallows. Farmers in both ends of the spectrum—marginal and large—record a high percentage of land as fallow, namely, 11 percent, while farmers in other size classes also leave a considerable extent, 6 percent to 8 percent, as fallows. While the exact reasons for withdrawal of land from cultivation would

Table 4 Structure of Land Holdings in Anantapur District, 2001

Size Class of Operational Holdings	Number of Holdings	Area in Ha.	Area under Current Fallows in Ha.	Current Fallows as percentage of total area	Average Size of Holdings (in Ha.)
Marginal	206,326	113,902	12,287	10.79	0.55
	34.46	**9.51**			
Small	185,705	272,953	18,109	6.63	1.47
	31.02	**22.78**			
Semi-Medium	146,238	373,874	23,497	6.28	2.56
	24.43	**31.21**			
Medium	51,434	299,541	23,870	7.97	5.82
	8.59	**25.00**			
Large	8,969	137,726	15,443	11.21	15.36
	1.50	**11.50**			
All Classes	598,672 **100.00**	1,197,996 **100.00**	93,205	7.78	2.00

Note: *1. Marginal holdings are below 1 Hectare; Small holdings between 1 to 2 hectare; Semi Medium between 2 and 4 hectare; Medium are between 4 and 10 hectare and Large are above 10 hectare.2. Figures in bold are percentages with respect to the total.*

Source: *http://agcensus.nic.in/ cited on 06-09-08*

vary from one farmer to another, considering the high magnitude of degraded land that is prevalent in the district, it is reasonable to assume that treatment of degraded land would help reduce the extent of fallows across all size classes of farmers. The relationship that prevails between land degradation and fallows thus has an important policy implication. By addressing the issue of land degradation, the fallow lands, at least in part, can be brought back to cultivation.

Analysing the land-use classification in our survey villages, it is noted that culturable land that is underutilised—current fallows, other fallows and culturable waste land—is more or less of the same order in our survey villages as in the district as a whole in 2005–06 (Table 5). In the whole district as well as in Thirumaldeverpally village, about 15 percent of geographical area remains as fallow and culturable waste while in Thopudurthi, the corresponding percentage is about 12 percent. Thirumaldeverpally village also reports a high percentage of land—as high as 20 percent—that is left barren. In Thirumaldeverpally village, the changing irrigation scenario in the village partly explains the high extent of fallows and barren land. Some portion of the culturable land in the village used to receive irrigation from a

stream as well as from a rain-fed tank. Over the years, while the stream has more or less dried up, irrigation from the rain-fed tank is quite uncertain. The portion of culturable lands in the village that used to receive irrigation from the stream and tank are predominantly covered by black soil which is not particularly suitable for groundnut cultivation. Therefore, with the decline in the water flow in the stream and tank, farmers are forced to dig tube wells to continue to cultivate this land. If a farmer is unable to successfully dig a bore well, then he is left with no choice but to withdraw this land from cultivation either on a permanent basis or until such time when there is water available for irrigation.

As regards the structure of land holdings in Anantapur district, marginal and small holdings (less than 2 hectare) account for two-thirds of operational holdings with a share of one-third of total operated area in the district in 2001. As regards bigger holdings, nearly one-tenth of all holdings in the district are above 4 hectare in size, accounting for one-third of total operated area in 2001 (Table 4). The state of Andhra Pradesh provides a contrasting picture as compared to Anantapur district. In 2001, 82.7 percent of all operational holdings are marginal and small (less than 2 hectare) with the share of operated area being 46 percent in the state. Similarly, 4.92 percent of all holdings are medium and large (above 4 hectare) accounting for 27.33 percent of operated area. Average size of holdings in Anantapur district, at 2 hectare, is higher than that in the state as a whole at 1.25 hectare, in the year 2001. (http://agcensus.nic.in/) While the extent of land concentration in Anantapur district is relatively higher than that in the state as a whole, it is important to note that the condition of even semi-medium farmers owning less than 4 hectare in a dry region such as Anantapur would be no better than the small farmers in irrigated areas (Reddy, Narasimha. 2007)

The structure of land holdings in the survey villages of Thopudurthi and Thirumaldeverpally are distinctly different from each other (Table 6). While the average land holding size in 2005–06 in Thirumaldeverpally was less than a hectare, that is, 0.93 hectare, it was 2.3 hectare in Thopudurthi. Thirumaldeverpally comprises a large number of small and marginal land holders with a total absence of large holding. More than 90 percent of holdings in Thirumaldeverpally occupy nearly 66 percent of operational area. As a contrast, in Thopudurthi, medium and large holdings are quite significant and account for 10 percent of all operational holdings with 33 percent of operational area. However, more than 50 percent of holdings in Thopudurthi are marginal and small accounting for less than one-third of total operational area.

Table 5 Land-use Classification in Survey Villages, 2005–06

	Area in Hectares for Triennium Centred around the Year 2005-06							
Village	**Total Geographical Area**	**Net sown area**	**Barren and Uncultivable land**	**Land put to non-agrl use**	**Other fallows**	**Current fallows**	**Culturable waste**	**Miscellaneous tree crops**
Thopudurthi	2,060.89	1,305.33	238.02	266.15	97.95	71.53	81.92	0.00
	100.00	**63.34**	**11.55**	**12.91**	**4.75**	**3.47**	**3.97**	**0.00**
Thirumaldeverpally	492.33	268.00	99.00	49.00	1.00	73.33	0.00	2.00
	100.00	**54.43**	**20.11**	**9.95**	**0.20**	**14.90**	**0.00**	**0.41**

Note: *Data refers to triennium centred around the year 2005–06; Figures in bold are percentages with respect to geographical area*

Source: *Data collected from Mandal Revenue Office, Kothacheruvu and Atmakur*

Table 6 Structure of Land Holdings in Survey Villages, 2005–06

Village	**Number of Holdings**							**Operational Holdings in Acres**					
	Marginal	**Small**	**Semi-medium**	**Medium**	**Large**	**Total**		**Marginal**	**Small**	**Semi-medium**	**Medium**	**Large**	**Total**
Thirumaldeverpally	170	45	15	5	Nil	235		205.8	154.87	103.45	78.16	Nil	542.28
	72.34	**19.15**	**6.38**	**2.13**		**100.00**		**37.95**	**28.56**	**19.08**	**14.41**		**100.00**
Thopudurthi	147	252	279	57	16	751		225.89	942.73	1674.1	803.41	630.59	4276.72
	19.57	**33.56**	**37.15**	**7.59**	**2.13**	**100.00**		**5.28**	**22.04**	**39.14**	**18.79**	**14.74**	**100.00**

Source: *Data collected from the Mandal Revenue Office, Kothacheruvu and Atmakur*

1.3. Irrigation

As is generally the case in drought-prone areas, in Anantapur too, there is a conspicuous absence of perennial rivers. All the rivers in Anantapur district—Pennar, Jayamangala, Chitravathi, Vedavathi (or Hagiri)—are non-perennial and have their origin in the neighbouring state of Karnataka. Given this environment, the earlier rulers had recognised the need to promote several indigenous water harvesting systems. It has been observed that, 'The most indigenous rain water harvesting and management systems like feeder channels, cascading chains of tanks and networking water bodies could be seen in Anantapur district…….The life and culture of Anantapur people revolved around these traditional water bodies…… The whole village was responsible to use, to conserve and to maintain the safety of the water bodies through locally established institutions like *khudi maramath, neerugatti* and *pinnapedda'*. (Kadalika 2004) The *Anantapur District Gazetteer* notes that there were over 700 tanks in the district in the beginning of the twentieth century. The gazetteer further notes that special grants used to be conferred for the maintenance of the tanks. To quote, `These grants confer certain proportions of the ayacut on favourable tenure on condition that the grantee keeps the tank in order'. (GoAP 1993, p.63). Spring channels have also been an important feature of Anantapur irrigation scenario and the gazetteer notes, `These are either dug from jungle streams and nullahs which supply tanks or flow down to the rivers, or from the tank beds, hill sides, valleys and so forth. The supply in the former class is of course much better than in the latter and in ordinarily good years it is sufficient for two crops and is more reliable than that derived from many of the larger tanks….. They are marvels of industry, being often excavated to a considerable depth for a mile or more'. (ibid. pp.64–5) River channels have also been a significant feature of Anantapur agriculture. The gazetteer comments, `They are merely diversions, by means of temporary sand dams, of the small streams which in wet weather flow down the river beds after the floods have subsided or, more usually, are dug in the bed of the river to take off the spring water'. (ibid. p.64) In the year 2004, the District Collector of Anantapur district initiated a survey to identify the number of water bodies that existed in the district. The survey identified a total of 5,824 water bodies in the entire district[14]. Of this, 1,373 are big tanks with an average *ayacut* of

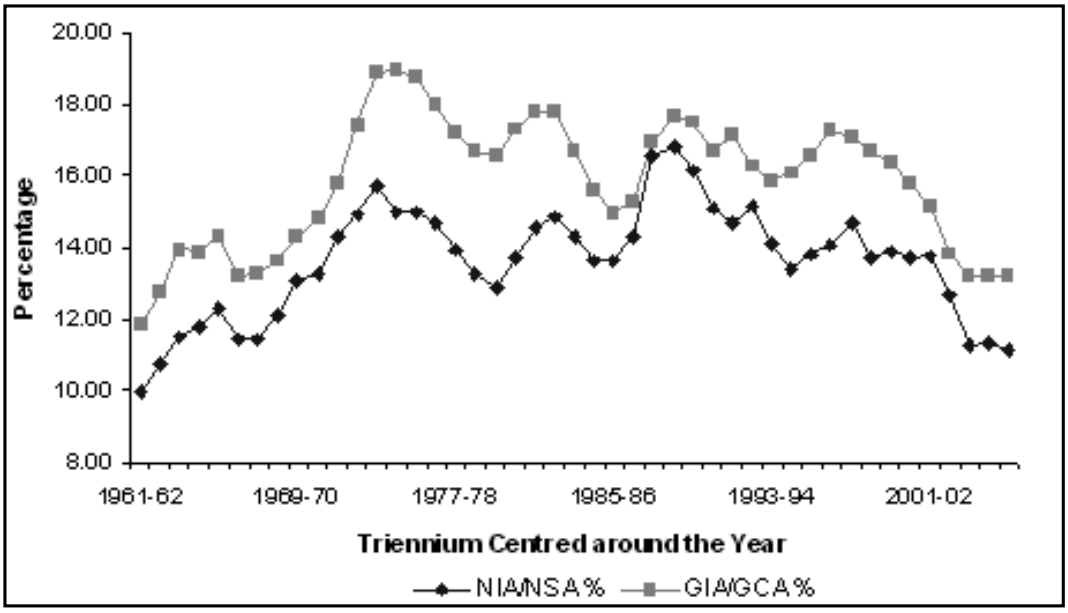
14 In Anantapur region small *kuntas*, water reservoir not meant for irrigation but for cattle and other uses, used to be found in almost all villages. There was a belief that digging a *kunta* in memory of one's parents would help the souls of the departed persons to quench their thirst. Such beliefs probably explain the reason why even today one-fourth of the small tanks are in private ownership in Anantapur district.

above 100 acre; 2094 are small tanks with an *ayacut* of 10 acre; and 203 are spring channels. The survey found that only about one-fourth of the identified water bodies, that is, around 1500, were functional at the time of the survey. (Kadalika. 2004) This survey clearly indicated that while the earlier rulers had recognised the importance of constructing large number of small water bodies in a rain-shadow region such as Anantapur, the modern state, by promoting private irrigation over community-based irrigation systems, has contributed towards the destruction of the indigenous rain water harvesting and management systems that prevailed in the region.

Analysing district-level data on irrigation, it is clear that the percentage of area irrigated was about 10 percent in the early 1960s and reached a peak of 16 percent to 17 percent during late 1980s. Then again there was a decline, and by the mid-2000s the percentage of area irrigated was only 11 percent to 12 percent. Gross irrigated area as a percentage of gross cropped area shows a similar trend too (Figure 7). While an analysis of the extent of area under irrigation, over the period 1960–61 to 2006–07, shows an overall increasing trend, there has been a decline in the extent of area under irrigation since late 1980s (Figure 8).

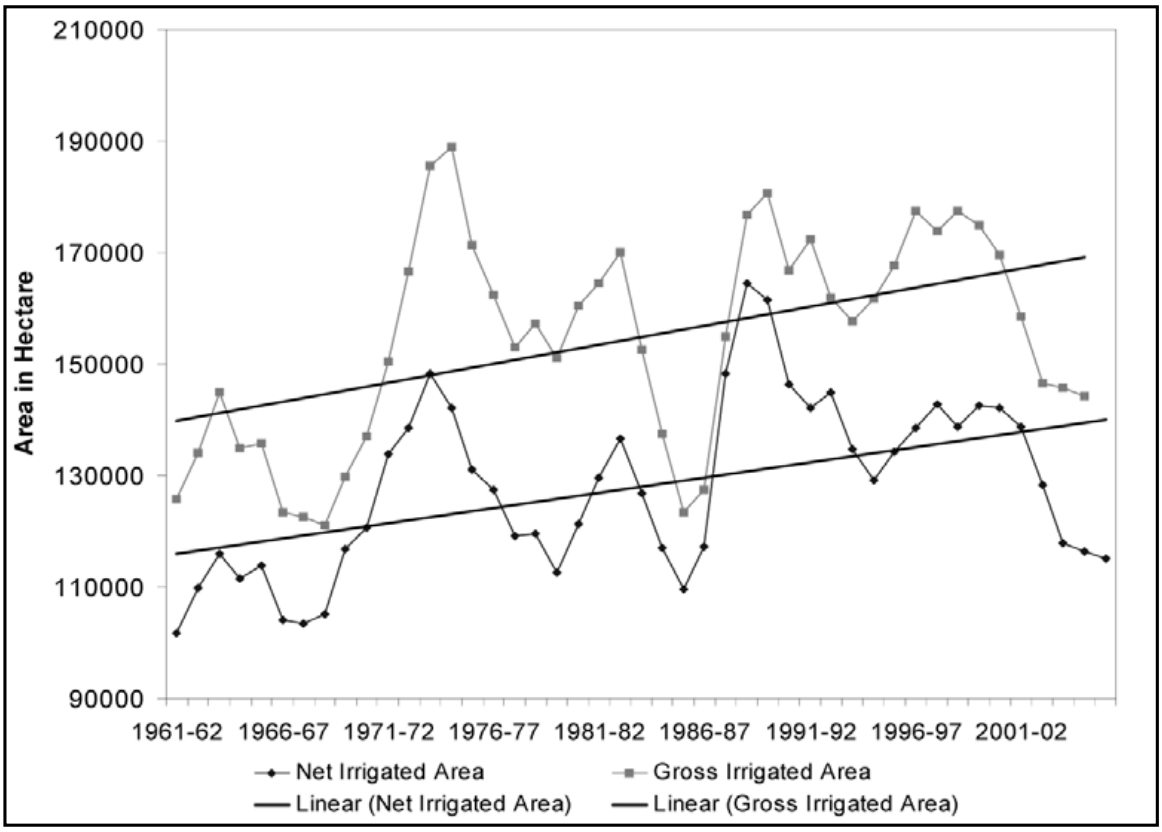
This decline in irrigated area is responsible for bringing about a fall in percentage of area irrigated in the district since the late 1980s. The fall in irrigated area since the late 1980s is largely related to a fall in area irrigated by tanks, open dug wells

Figure 7 Area Irrigated as a Percentage of Area Cultivated - Anantapur District



Source: *Government of Andhra Pradesh, 2006; GoAP various years*

Figure 8 Area under Irrigation - Anantapur District

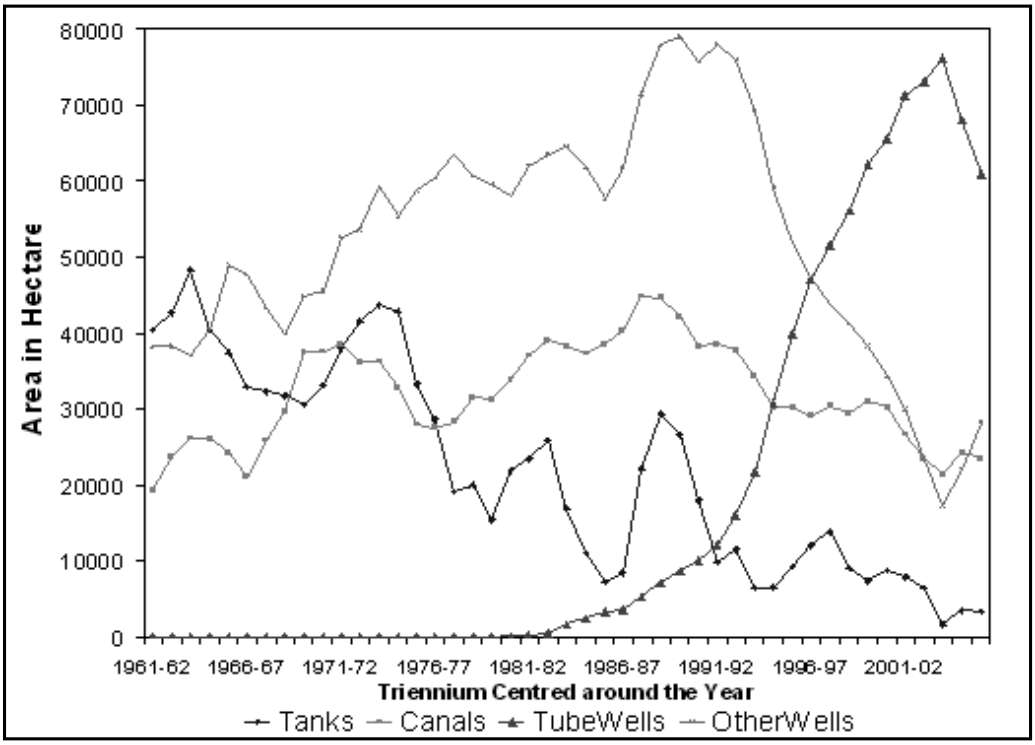


Source: *Government of Andhra Pradesh, 2006; GoAP various years*

and other irrigation sources and even the increase in area irrigated by tube wells has not been enough to compensate the loss of irrigation from all other sources in this period (Figure 9 and 10).

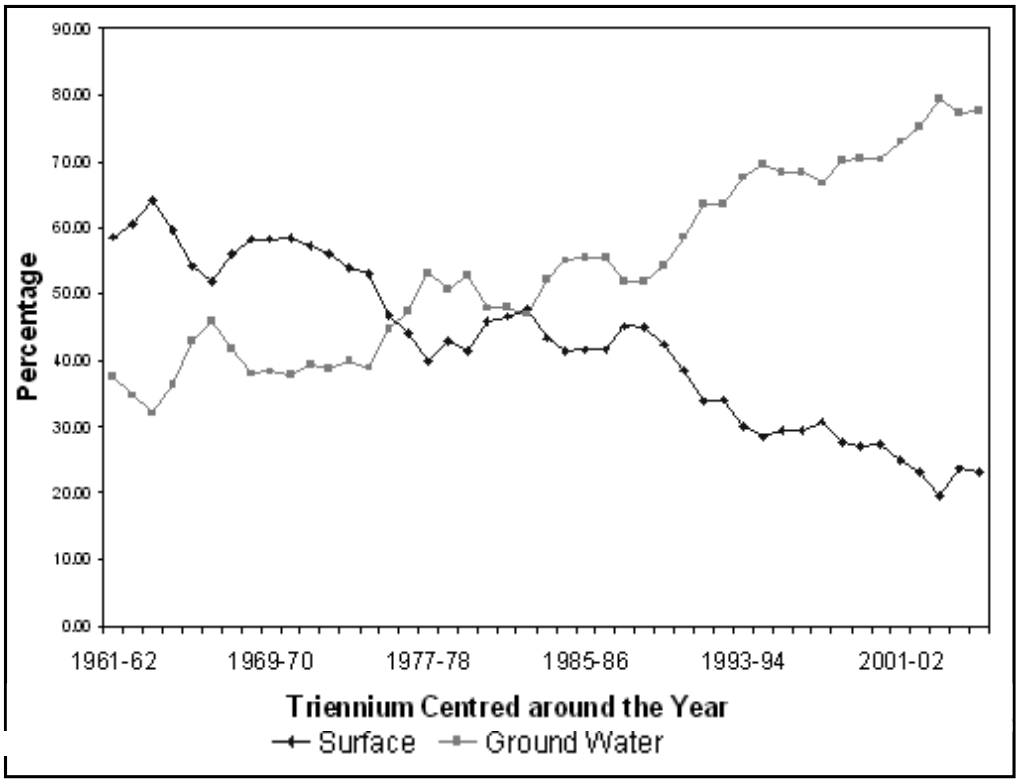
Table 7 clearly shows that while irrigation from tanks accounted for 40 percent of net irrigated area in the early 1960s, its importance waned significantly and it accounts for less than 5 percent of net irrigated area by the 2000s. During the 1980s, with active support from the government, tube wells were introduced in the district and their importance increased rapidly over the years and by 2005–06 more than one-half of the irrigated area is seen to receive irrigation from tube wells. Though the importance of open dug wells has declined over the years, they continue to remain a vital source of irrigation in the district. The rapid increase in bore-well irrigation resulted in the depletion of water levels and defunctioning of some of the bore wells and most of the dug wells in the district.(Go AP 2008). Data available with the ground water department further shows that of the sixty-three *mandals* in Anantapur district, thirty-three *mandals* fall in the over-exploited

Figure 9 Area under Various Sources of Irrigation - Anantapur District



Source: *Government of Andhra Pradesh, 2006; GoAP various years*

Figure 10 Percentage of NIA under Different Sources of Irrigation - Anantapur District



Source: *Government of Andhra Pradesh, 2006; GoAP various years*

category; five in critical; thirteen in the semi-critical; and only twelve in the safe category, as on 2004.[15] That is, only in 12 *mandals* is the percentage of ground water utilisation to groundwater availability below 70 to 75 percent. (Map-3).

Map 3 Mandal-wise Ground Water Resource - Anantapur District

Source: *Department of Groundwater, Anantapur*

15 If the percentage of ground water utilisation to groundwater availability is more than 100 percent, the area is classified as over-exploited; 90 percent to 100 percent, critical; 70 percent to 90 percent, semi critical; below 70 percent, safe.

Table 7 further indicates that 'Other sources' which include spring channels, supply channels, small waterways etc have registered a tenfold decline over the four-and-one-half decades under consideration. Though 'other sources' account for a very small percentage of total irrigated area, the decline in this source combined with a decline in tanks clearly point towards a neglect of traditional water sources over the years. Figure 10 also indicates the decline in importance of surface irrigation over the years in the district.

In 2008–09, 305 minor irrigation tanks (that is, those with ayacut area above 100 acre) and 200 Panchayat tanks (that is, those with ayacut area below 100 acre) were counted in the district of Anantapur. Except for two tanks, Bukkapatnam and Dharmavaram, that are river fed, all other tanks are supplied by small streams or *vankas* or from local rainfall. By 2008, about 100 minor irrigation tanks have been

Table 7 Sources of Irrigation in Anantapur District

	Area Irrigated by Different Sources (in hectare)					
Triennium Average centred around the year	**Tanks**	**Canals**	**Tube Wells**	**Other Wells**	**Other Sources**	**Net Irrigated Area**
1961–62	40344	19238	12	38234	3951	101779
	39.64	**18.90**	**0.01**	**37.57**	**3.88**	**100**
1966–67	32862	21037	0	47688	2505	104091
	31.57	**20.21**	**0.00**	**45.81**	**2.41**	**100**
1971–72	37977	38533	0	52563	4666	133738
	28.40	**28.81**	**0.00**	**39.30**	**3.49**	**100**
1976–77	28676	27460	1	60334	10892	127363
	22.52	**21.56**	**0.00**	**47.37**	**8.55**	**100**
1981–82	23364	37080	197	61923	6924	129488
	18.04	**28.64**	**0.15**	**47.82**	**5.35**	**100**
1986–87	8396	40303	3541	61573	3471	117285
	7.16	**34.36**	**3.02**	**52.50**	**2.96**	**100**
1991–92	9792	38423	12056	78104	3834	142210
	6.89	**27.02**	**8.48**	**54.92**	**2.70**	**100**
1996–97	11992	29076	47025	47472	2934	138499
	8.66	**20.99**	**33.95**	**34.28**	**2.12**	**100**
2001–02	7920	26735	71344	29904	2738	138642
	5.71	**19.28**	**51.46**	**21.57**	**1.97**	**100**
2005–06	3259	23539	60958	28319	397	115035
	2.83	**20.46**	**52.99**	**24.62**	**0.35**	**100**

Note: *Figures in bold font are percentages w.r.t. net irrigated area.*
Source: *Government of Andhra Pradesh, 2006; GoAP various years.*

converted into percolation tanks and their sluices have been closed because the ground water recharge that is possible due to storage of water is believed to be more beneficial compared to open irrigation from tanks in the context of their not filling up to full tank capacity.

Irrigation from canals has remained more or less stable over the entire period, accounting for about one-fifth of net irrigated area. As mentioned earlier, all the rivers that flow in Anantapur district, Pennar, Jayamangala, Chitravathi, and Vedavathi, are non-perennial and have their origin in Karnataka state. As regards surface irrigation there is one major irrigation project Tungabhadra Project High Level Canal (TBP HLC) which was sanctioned in 1959–60. The first stage of this project was completed in 1966. There are also six Medium Irrigation Projects, three of which are on river Pennar. Except one medium irrigation project, all the other medium and major projects have been completed during 1956 to 1966. The registered *ayacut* of the major and medium irrigation sources is 69,596 hectares, while less than fifty percent of the *ayacut* actually receives irrigation in any given year in the district. A major surface irrigation project that shall have a significant impact on the irrigation scenario of Anantapur District in future is the ongoing project, Handri Niva Sujala Sravanthi (HNSS). This project is designed to benefit the districts of Kurnool, Anantapur, and Cuddapah for drinking water as well as irrigation purposes. The project has been proposed to lift surplus water of Krishna river at Malyala Village, Kurnool District. The water will be conveyed through a 216-km-long canal by eight lifts to irrigate land in Kurnool and Anantapur districts. The project is expected to be completed by 2011 and as per the plan 1.18 lakh hectare will be the *ayacut* area in Anantapur District. This project holds much promise and the feasibility of this project was discussed even by the Irrigation Commission in 1972 (GoI 1972) The Irrigation Commission comments, 'Low rainfall zones will mostly have rain-fed cultivation, and any increase in production will have to come through moisture conservation, the use of drought resistant varieties, cultivation of pastures etc. But where water can be made available either from local sources or by transfer from a neighbouring basin,(emphasis added) the policy should be to benefit as large a section of the community as possible and at the same time enable farmers to obtain reasonable yields'. (ibid. p.112)

The demand of some civil society organisations working in Anantapur is that all tanks, wherever possible, must be supplemented with HNSS water but without a commitment on *ayacut.* In addition to the ongoing major and medium irrigation projects it is imperative that local irrigation sources are revived to bring about

stability in the irrigation regime of Anantapur district. Considering that the survey on water bodies spearheaded by the District Collector in 2004 clearly showed that more than 70 percent of water bodies that existed have fallen under disrepair in the district, it is very important that the state takes on the responsibility of repair and maintenance of these water bodies.[16]

1.3.1. Irrigation Scenario in the Survey Villages

In Thirumaldeverpally as well as Thopudurthi villages, the entire area that is irrigated at present employs ground water sources. In 2006–07, in Thirumaldeverpally, ten tube wells and twenty-one open-dug wells and in Thopudurthi six tube wells and fifty-one open-dug wells were counted as per the revenue records. Table 8 indicates that the percentage of area irrigated in Thopudurthi is about the same as that in the entire district, about 11 percent of net sown area, while Thirumaldeverpally has just about 8 percent of net sown area under irrigation in 2005–06. In Thirumaldeverpally while net irrigated area has not changed much over the 25 years under consideration, the source of irrigation has changed: in 1981 and 1991 wells and government canal contributed equally to net irrigated area while in 2005–06, tube wells account for 13 hectares and open dug wells irrigated 8 hectares. Irrigation through canal, however meagre may be the extent, has collapsed over the years.

One of the two big tanks that is river fed in Anantapur district, the Bukkapatnam tank, is located not very far from Thirumaldeverpally village. While the Chitravathi river feeds the Bukkapatnam tank, the excess water after the tank is full flows towards Thirumaldeverpally village. There are number of villages in the command area of the tank. From some of these villages the excess water from paddy fields also joins the flow in the river towards Thirumaldeverpally. There is a check dam across Chitravathi which was built in the pre-Independence period at a place close to Thirumaldeverpally village. This check dam had helped to draw a stream, measuring roughly 5 kms. , towards the village that had been useful in irrigating land in the village. While land irrigated through this stream has been recorded

16 When detailed planning for repair and maintenance of tanks is attempted, it is important to take note of the following:

- Wherever tank bunds are breached, strengthening of bunds should be undertaken;
- Wherever tanks are not converted into percolation tanks, it is necessary to first desilt the tanks; Along with desiltation of tanks, feeder channels as well as supply channels are to be constructed. This is necessary because there are instances where check dams have been constructed indiscriminately, obstructing the flow of water in to the tank. Therefore, unless the inlet and outlet channels are both taken care of, tank irrigation can not be revived.

Table 8 Net Irrigated Area in Survey Villages

	Net Irrigated Area (in Ha.)			NIA as a Percentage of NSA		
Village	**1981**	**1991**	**2005-06**	**1981**	**1991**	**2005-06**
Tirumaladeverpally	20.64	20.64	21.33	9.16	9.14	7.96
Thopudurthi	57.06	87.00	151.67	3.4	4.87	11.62

Note: *1981 and 1991 data are from the District Census Handbooks while 2005–06 refers to triennium centred around that year and is collected from Mandal Revenue Office.*

Source: *1. Data collected from Mandal Revenue Office, Kothacheruvu and Atmakur. 2. Census of India 1981. 3. Census of India 1991*

as irrigation from government canal in the censuses of 1981 and 1991, in 2005–06 we find that the entire irrigation in the village is from tube wells or dug wells. Major reasons that are attributed for decline of irrigation from the stream relate to construction of a dam on Chitravathy river in Karnataka, increase in number of tube wells in the river irrigated area. In addition to irrigation from the stream, the village also used to receive irrigation from a rain-fed tank, Irupanna tank, located in Mylepally, a hamlet of Thirumaldeverpally village. Over the years, the importance of both these sources has declined.

In Thopudurthi village, in addition to open-dug wells, spring channels and tanks used to be important sources of irrigation. However, over the years, for various reasons, irrigation from these sources has diminished and tube well irrigation has come in a big way. In the early 1980s, under the Chief Ministership of Shri N T Rama Rao, the state government vigorously promoted bore-well irrigation in the state. It is during this time that many of the farmers in Thopudurthi attempted to sink bore wells. Several special schemes were launched by the state to subsidise sinking of bore wells, installation of pump sets etc. One of the schemes offered 80-feet-long bore pipes, free of cost, to the farmer as well as a 10-feet-long casing pipe for open dug wells that had gone dry. Farmers were required to dig a pit of 10×10×12 cubic foot dimension and submit a photo of the pit along with their land revenue passbook to obtain the free supply of pipes. Geologists were also arranged by the State to survey the area and determine the location for taking the bores in the farmers' fields. Our interviews with farmers clearly brought out the fact that the high cost of digging bore wells combined with low success rate of bore wells and the cost involved in mobilising the finances etc. resulted in several farmers

getting indebted and losing their land. Some of the instances we observed during our village survey are as follows:

- A farmer with a 10-acre holding received electricity connection to his field in the year 1985. He dug a bore within the open-dug well, as the open-dug well had gone dry. This bore well served for two years. By 1990, he sank three bore wells, of which two failed, and one yielded water for three years and it went dry by 1993. Between 1993 and 2003, he did not have any source of irrigation. In 2003, he sank five bore wells, of which three failed. The total cost of sinking the five bores was Rs1.5 lakh, which he had borrowed from a private money lender at the rate of interest of 2 percent per month.
- A 50-year-old farmer in this village, whose father used to own 100 acres, says his father had to sell off about 50 acres of his land to meet the expense of drilling nearly fifty-five bores during 1987–88 until 2007.
- A farmer with a 7-acre holding had sunk five bore wells over a five-year period of which only one was successful.

1.4. Cropping Pattern

Kharif is the major crop season in Anantapur District. Of the 9.75-lakh hectares of gross cropped area in the district in 2006–07, 7.94-lakh hectares, that is, 81 percent of gross cropped area gets cultivated during the *kharif* season.

Traditionally, food grains dominated the cropping pattern of the district. Minor millets such as *samai, varagu, korra* and major millet such as *sorghum,* various pulses and paddy were the major food grains in the district. An analysis of cropping pattern in Anantapur district over 1960–61 to 2006–07 shows that during early 1960s, more than two thirds of gross cropped area was cultivated with food grains, predominantly millets, with some amount of pulses and paddy (Table 9 and Figure 11). Among non-food crops, cotton and groundnut were important. The variety of groundnut that was grown during the 1960s was the spreading variety which was a 150-day crop grown during the kharif season. The table and graphs show that area under pulses and paddy has remained stable over time while millet area has declined sharply since the late 1970s, and the area under groundnut has increased. Around this period, the spread variety of groundnut was getting replaced by bunch variety in the district. Farmers preferred the bunch variety over the spreading variety because it was a shorter-duration crop and involved less drudgery in cultivation. While the duration of the bunch variety was 90–110 days, that is, about forty to fifty days lower than spreading variety, the drudgery

Table 9 Cropping Pattern in Anantapur District

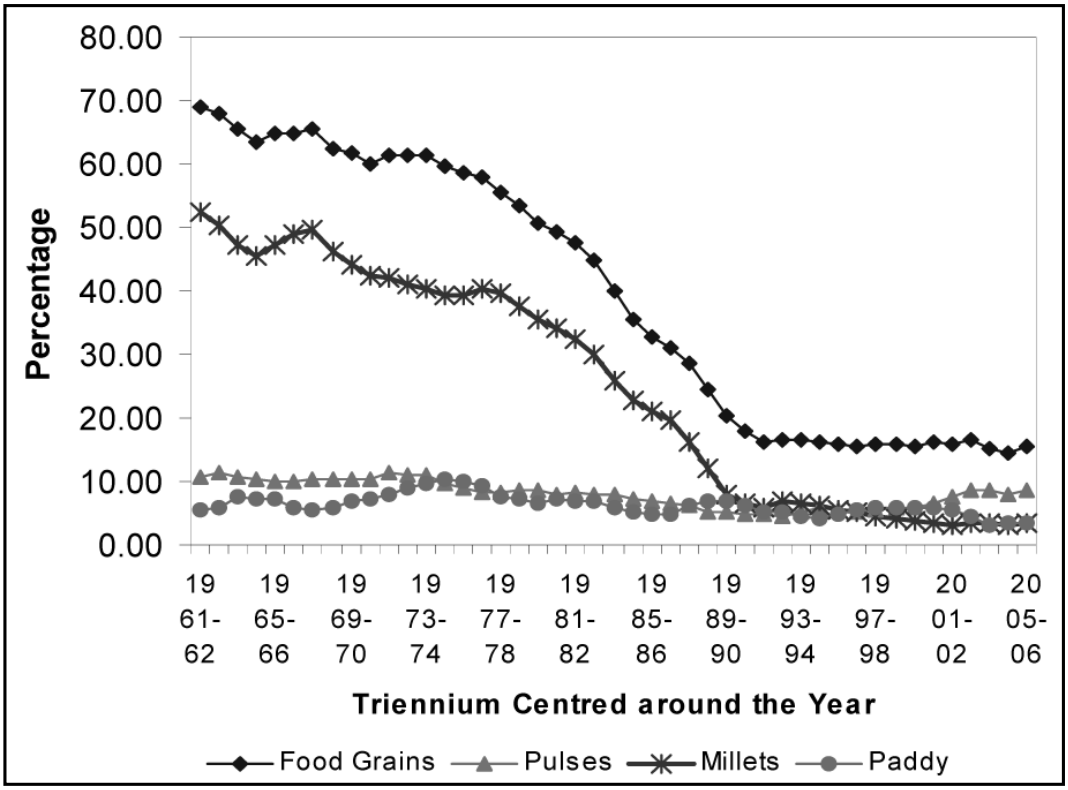
	Area under Major Crops, (hectare)						
Triennium centred around the year	**Total major millets**	**Total minor millets**	**Total pulses**	**Paddy**	**Total food grains**	**Groundnut**	**Cotton**
1961–62	333,255	221,173	114,232	58,970	728,753	194,840	61,325
	31.48	**20.89**	**10.79**	**5.57**	**68.83**	**18.4**	**5.79**
1971–72	249,954	151,110	107,336	74,537	584,274	255,119	26,951
	26.26	**15.88**	**11.28**	**7.83**	**61.38**	**26.8**	**2.83**
1981–82	177,102	123,082	75,370	63,531	440,785	374,264	17,650
	19.16	**13.32**	**8.15**	**6.87**	**47.69**	**40.49**	**1.91**
1991–92	54,027	5,896	46,870	50,753	163,015	735,022	14,592
	5.41	**0.59**	**4.69**	**5.08**	**16.32**	**73.6**	**1.46**
2001–02	30,672	1,369	82,244	57,676	172,356	780,624	9,405
	2.85	**0.13**	**7.63**	**5.35**	**16.00**	**72.46**	**0.87**
2005–06	36,656	667	93,443	38,307	169,365	811,156	4,578
	3.35	**0.06**	**8.55**	**3.5**	**15.49**	**74.18**	**0.42**

Note: *Figures in bold are percentages w r t. gross cropped area.*
Source: *Government of Andhra Pradesh, 2006; GoAP various years.*

involved in harvesting the bunch variety was also lower. Two pairs of bullock were required to be employed for harvesting the spreading variety as against one pair required for the bunch variety.

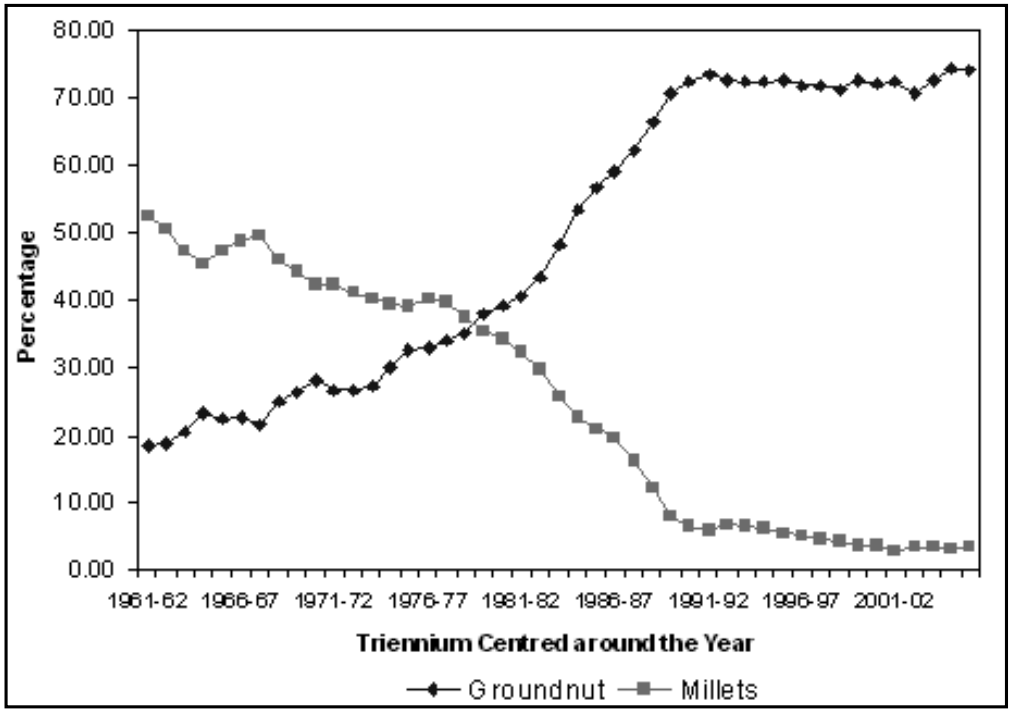
Figure 12 clearly shows how expansion of groundnut has been at the expense of millets in the district. The area under groundnut has increased fourfold, from being slightly less than 2 lakh hectare in the early 1960s to 8 lakh hectare by 2005–06. Nearly 50 percent of groundnut area in the entire state of Andhra Pradesh belongs to Anantapur district now (2006–07). In 1961–62 the area cultivated with millets was much greater than the total groundnut area, while by 2005–06 millet area was a mere 38,000 hectares. Minor millets have more or less disappeared from cultivation, while the area under major millets has reduced by 90 percent. As groundnut is largely cultivated with pulses as an intercrop, the importance of pulses has remained more or less stable over the years. In Anantapur, groundnut

Figure 11 Percentage of GCA under Foodgrain - Anantapur District



Source: *Government of Andhra Pradesh, 2006; GoAP various years*

Figure 12 Percentage of GCA under Millets and Groundnut - Anantapur District



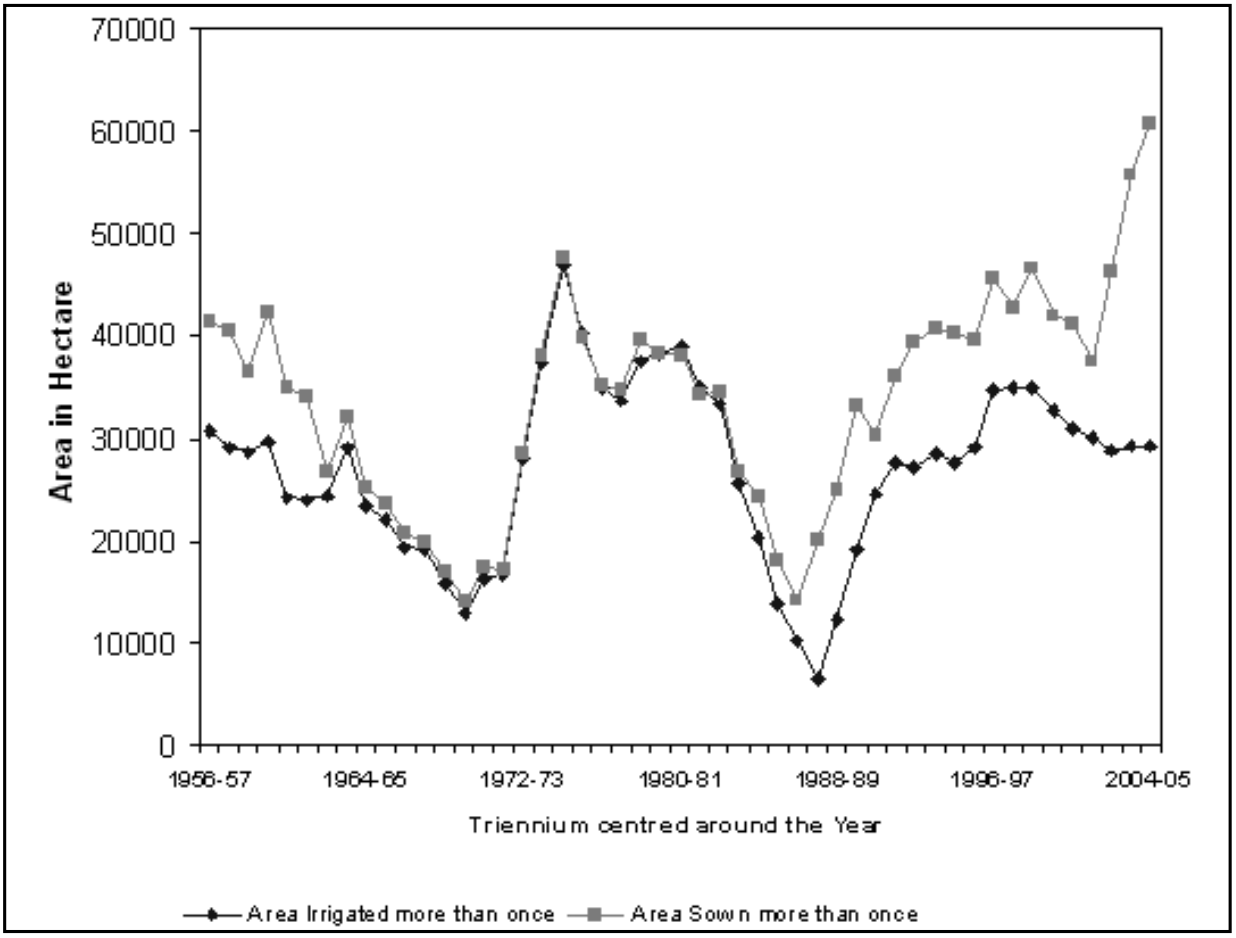
Source: *Government of Andhra Pradesh, 2006; GoAP various years*

is essentially a kharif crop with 98 percent of total groundnut area being cultivated during the kharif season.

Cropping intensity is quite low, in the range of 1.02 to 1.06, over 1961–62 to 2005–06 in the district with area sown more than once increasing by a mere 20,000 hectare over this period. Quality of irrigation in Anantapur district is such that even the increase in net irrigated area has not resulted in pushing up the cropping intensity. Cropping intensity in the irrigated area fluctuates a great deal and remains in the range of 1.24 to 1.34 and does not register an increasing trend over the four-and-one-half decades under consideration.

Figure 13 shows that for a substantial period, area sown more than once is in close correspondence with area irrigated more than once, though since 2001–02 the trend is different. A considerable extent of area that is not receiving irrigation is getting cultivated in more than one season in the district in the recent years. This

Figure 13 Intensity of Cropping - Anantapur District



Source: *Government of Andhra Pradesh, 2006; GoAP various years*

implies an increase in perennial crops in the district. According to data provided by Department of Horticulture, area under fresh fruits in the district increased from 20,215 hectare in 1998–99 to 66,092 hectare in 2006–07 (www.indiastat.com). While increase in area under irrigation itself is quite scanty and the nature of irrigation is quite precarious, the irrigated area is cultivated with paddy, sunflower, groundnut and fruits in that order. In 2001–02, of the gross irrigated area, 33.93 percent was cultivated with paddy; 28.01 percent with sunflower; 16.04 percent with groundnut; and 13.96 percent with fruits.

1.4.1. Cropping Pattern and Cultivation Practices in the Survey Villages

The pattern observed in the district as a whole holds for our survey villages too where 80 percent of the gross cropped area gets cultivated with groundnut in 2005–06 (Table 10). As pulses are sown as an intercrop with groundnut, about 5 percent of total area in both villages is under pulses. As Table 10 indicates, paddy is also grown in these villages depending on availability of irrigation.

On the basis of the field survey we conducted during the months of January and February, 2009, in the villages of Thopudurthi and Thirumaldeverpally, the following details may be provided on aspects of groundnut cultivation. Cultivation practices for groundnut crop do not vary across the two villages, though with respect to adoption of intercrop, border crop, and nature of implements used there are some variations. These variations can perhaps be related to the nature of agricultural extension available to the farmers across these two villages. Agricultural extension activities are available on a relatively larger scale in Thopudurthi as compared to the remote village of Thirumaldeverpally.

Table 10 Cropping Pattern in Thopudurthi and Thirumaldeverpally, 2005-06

	Area (in hectare) under Major Crops in Triennium Centred around the Year 2005–06							
Village	**Paddy**	**Sorghum**	**Ragi**	**Total pulses**	**Total fruits and vegetables**	**Groundnut**	**Sunflower**	**GCA**
Thopudurthi	77.00	17.00	4.33	73.33	46.00	1,077.67	35.67	1,358.33
	5.67	**1.25**	**0.32**	**5.40**	**3.39**	**79.34**	**2.63**	**100.00**
Tirumaldeverpally	9.33	0	0	15.33	1.67	231.33	0	282.00
	3.31			**5.44**	**0.59**	**82.03**		**100.00**

Source: *Data collected from Mandal Revenue Office, Kothacheruvu and Atmakur*

The ruling groundnut variety in Thopudurthi village is TMV 2 while it is JL 24 in Thirumaldeverpally village. TMV-2 is a highly drought tolerant variety that is suitable for low rainfall areas such as Thopudurthi village, whereas JL 24 is suitable for high rainfall areas such as Thirumaldeverpally village. Groundnut is usually intercropped with red gram or green gram or cowpea in the villages. The recommended intercrop ratio for red gram is 11:1 to 15:1, respectively. That is, 11 to15 rows of groundnut for every row of red gram. Many farmers cultivate red gram mixed with cowpea and green gram as intercrop with groundnut. The practice of taking cowpea as an intercrop in groundnut is of serious concern, as cowpea is an alternate host for the tobacco streak ilavirus, which is the causal agent of peanut stem necrosis in groundnut. Cowpea will serve as a source of inoculum for the virus. Further, it is an irony that this practice is being resorted to at a time when the Department of Agriculture is having demonstration plots on the concept of raising border crops to trap the wind-borne vectors of peanut-stem necrosis.

Farmers in our survey villages have also resorted to growing border crop around the groundnut field as recommended by the Department of Agriculture. Border crop is recommended as a non-pesticide management (NPM) strategy against peanut stem necrosis disease, which is a major disease affecting the groundnut tract of Rayalseema region of Andhra Pradesh. It is recommended that four rows of border crops, of sorghum or bajra or a mixture of both or any other tall cereal crop, is grown around the groundnut field. Majority of the farmers interviewed in Thopudurthi village said that they could see a visible reduction in the pest/disease attack in their field after adopting the practice of raising four rows of border crop. This could be further corroborated from the fact that none of the farmers interviewed in Thopudurthi had reported incidence of stem necrosis disease in their groundnut field. On the other hand, in Thirumaldeverpally village though farmers resort to growing of border crop, the concept behind growing of border crop appears to have been completely missed out. Farmers often grow only one row of border crop and even cowpea is used as a border crop. Seven out of eleven farmers whom we interviewed reported some incidence of pest/disease, in particular, the occurrence of peanut stem necrosis disease in Thirumaldeverpally village.

Land preparation for the groundnut crop starts in the month of June with the first monsoon shower. Two rounds of ploughing followed by one of harrowing is the usual practice adopted by farmers. Ploughing is usually done with tractor and the implement used is a plough (country or mould board), and harrowing is done with t-tine harrows employing bullock power. Those farmers who do not

own either a tractor or bullocks hire them on rent. Farm-yard manure (FYM) is applied at the time of land preparation. FYM is first spread on the field and then it is ploughed into the field. As the quantity of FYM is not sufficient to cover their entire operational holding, most farmers alternate the area of FYM application every year. Penning of sheep on the field is done by a few farmers.

Groundnut seeds are treated with plant protection chemicals by most farmers. The seeds are spread on a mat and the chemical is dusted over the seeds and are mixed with the hands. For every 30 kg. bag of groundnut seeds, 100 g of seed treatment material, DithaneM-45, is supplied through the department of agriculture at subsidised rates. Groundnut seeds are recommended to be treated with DithaneM-45 at the rate of 3 g per kilogram of seed to protect the seeds against fungal diseases like leaf spot, rust, and stem rot. In addition to this, farmers are also advised to treat their seeds with chlorpyriphos at the rate of 6 ml per kg of seeds, to protect against root grubs. However, chlorpyriphos is not supplied through the department and farmers have to buy this from the open market. Given this we find that few farmers treat the seeds with chlorpyriphos. As regards use of DithaneM-45, though the supply by the department is commensurate with the quantity of seed supplied, because of the fact that the quantum of seeds used by farmers is in general over and above what is supplied by the department, there is a thin spread of DithaneM-45 on the entire quantity of seeds used. This suggests that though seed treatment is undertaken by farmers it may not be very effective as the required quantity of chemical is not used.

Sowing of groundnut is done using seed drills. In Thirumaldeverpally, a traditional single-funnel seed drill referred to as *gorru* is used, while in Thopudurthi, the two-funnel seed drill is widely used. When the single-funnel seed drill is used, the seeds of both the main and the intercrop are sown using the single funnel, while the fertiliser is broadcast at the time of sowing behind the seed drill, after the seeds are dropped. On the other hand, while a two-funnel seed drill is used, the fertiliser is applied at the time of sowing before the seed has been dropped on the field as one funnel is used for sowing the seeds of the main and the intercrop, while the other funnel is exclusively used for fertiliser application. Double-funnel seed drill places the fertiliser near the plant root zone and therefore is a relatively better method. Sowing for rain-fed groundnut is during July in both the villages, while for irrigated groundnut it is during June.

In both villages, weed management is done by hoeing with hand hoes followed by hand weeding. Hoeing is the process of loosening the soils around the weed, to facilitate its easy removal. The hoe severs the top of the weeds from their roots just below the soil surface. The hoe cuts the stem of the weeds after carefully scraping the soil at the surface. Hoeing is done twice, and the first hoeing is done 15–20 days after sowing. This is immediately followed by hand weeding. The second hoeing is done at 25–30 days after sowing and this is immediately followed by the second hand weeding. Plant protection chemicals are applied after 35–40 days of sowing and the chemicals are sprayed using mechanical sprayers. Harvesting of groundnut is done in the first week of December. Harvesting is done by pulling the plants by hand manually or by ploughing the groundnut field using tractor/ bullock power. If it rains just before harvesting, plants are uprooted manually, otherwise tractor/bullock is used. The harvested produce is either transported to their backyard for drying or left in the field for drying. The produce is left for drying for a minimum of 10–15 days, and the heap is repeatedly turned on all sides to facilitate uniform drying. In Thopudurthi, threshing was mostly done using the mechanical thresher. In Thirumaldeverpally, both the harvesting and threshing operations were mostly done manually. The threshed pods are left in a heap, and it is dusted with Folidol to protect against pod bugs. In Thopudurthi village, some farmers also decorticated the threshed pods. The village had two mobile decortication units and one stationary decortication unit. The produce is sold to private traders who come and collect the produce from the village. The produce is mostly sold as pods in bags, and the bag size varies from 33–45 kg, from one farmer to another. The quality of the produce is judged visually by the trader, and he fixes the rate accordingly. There is no formal grading done.

Those farmers, who have irrigation facilities and plan to take up irrigated groundnut in *kharif,* carry out land preparation by the month of May, and sowing is also completed by the last week of May. Irrigated groundnut is harvested in the month of October. Cultivation practices for irrigated groundnut are similar to that of rain-fed groundnut as discussed above. Irrigated groundnut crop is usually followed by sunflower cultivation during the period October to January. Sunflower crop is followed with groundnut in the *rabi* season, January to August. Alternatively, on irrigated fields that are not suitable for groundnut cultivation, three rounds of crop, *ragi,* paddy and paddy, in that order is grown. *Ragi* is taken from June to August, followed by paddy from September to December end, followed by paddy again during the months of January to March.

1.5. Crop Production

The changes observed in production of principal crops in the district over 1960–61 to 2006–07 reflects the changes that have occurred with regard to area under crops. There is a sharp decline in production of *sorghum* and millets, while pulses production has increased threefold (Table 11). A striking feature of overall outturn of crops in the district is that though groundnut production shows an overall increasing trend, the rate of increase is far below the rate of expansion of area under groundnut. While groundnut area expanded nearly four times over the forty-five-year period under consideration, the production of groundnut barely doubled. Moreover, there is a great deal of fluctuation in the rate of growth of groundnut production over the years. These factors raise important questions regarding the level of groundnut yield.

Table 11 Production of Principal Crops in Anantapur District

(in tonnes)

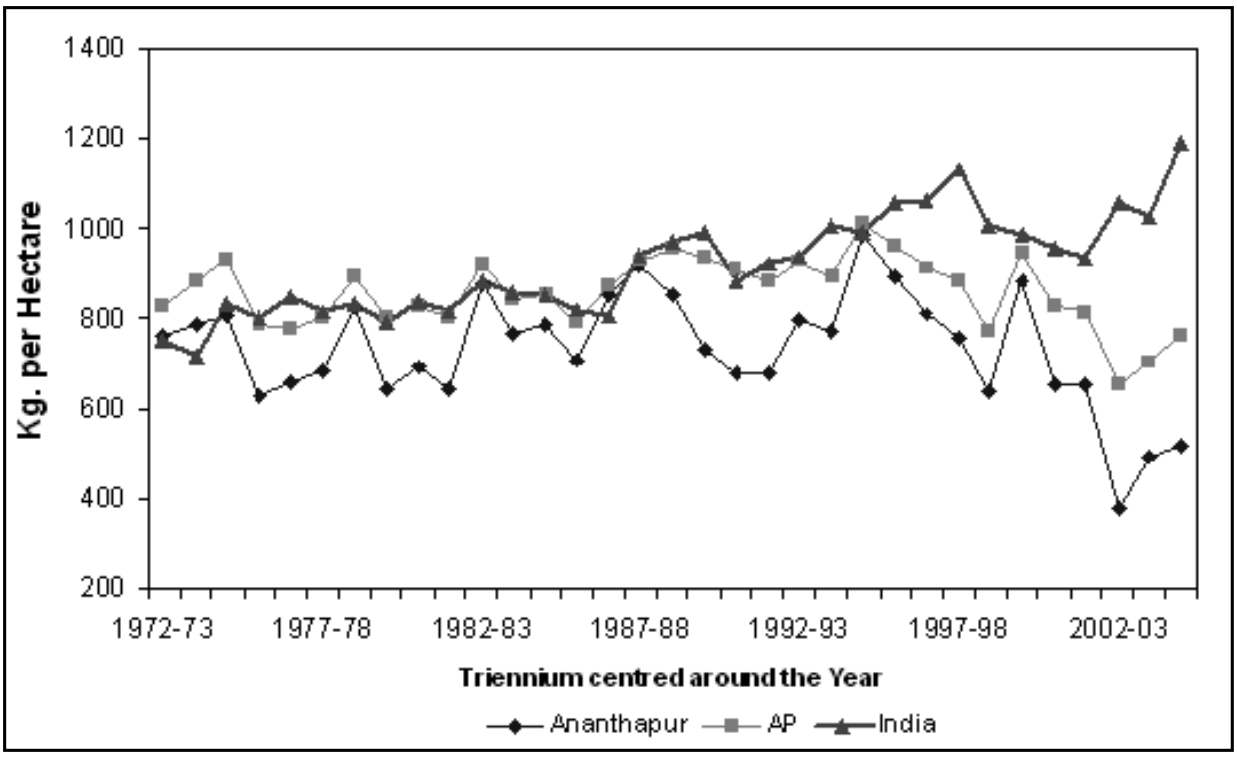
	Total Production (in tonnes) of Principal Crops					
Year	**Rice**	**Sorghum**	**Major and Minor Millets**	**Pulses**	**Foodgrains**	**Groundnut**
1960–61	79,638	75,162	234,382	21,990	336,330	179,850
	100	**100**	**100**	**100**	**100**	**100**
1966–67	106,953	77,180	234,543	14,360	356,146	108,698
	134	**103**	**100**	**65**	**106**	**60**
1971–72	118,973	54,505	185,438	12,326	317,443	201,669
	149	**73**	**79**	**56**	**94**	**112**
1976–77	79,170	31,938	116,572	3,900	201,062	88,363
	99	**42**	**50**	**18**	**60**	**49**
1981–82	151,205	78,129	245,076	15,039	412,630	364,111
	190	**104**	**105**	**68**	**123**	**202**
1986–87	73,023	61,573	122,810	8,229	204,509	386,930
	92	**82**	**52**	**37**	**61**	**215**
1991–92	150,708	41,620	67,689	15,411	234,087	496,497
	189	**55**	**29**	**70**	**70**	**276**
1996–97	167,368	29,351	17,595	11,828	253,856	555,251
	210	**39**	**8**	**54**	**75**	**309**
2001–02	204,515	24,166	48,480	59,405	312,613	363,020
	257	**32**	**21**	**270**	**93**	**202**
2006–07	125,559	13,849	53,722	73,144	252,600	391,965
	158	**18**	**23**	**333**	**75**	**218**

Note: *Figures in bold are indices w r to year 1960-61*
Source: *Government of Andhra Pradesh, various years.*

1.6. Yield of Groundnut

Analysing the yield of groundnut over the period 1971–72 to 2005–06 in Anantapur district, the state of Andhra Pradesh, and all of India it is clear that yield levels have always remained relatively low in Anantapur (Figure 14). The disturbing fact as far as the pattern of groundnut yield in the district is concerned is that the divergence between all-India yield levels and district levels have widened over the years. In 1972–73, the yield levels were more or less similar across the district, state, and the country at 762 kg/ha, 831 kg/ha and 751 kg/ha, respectively. However, for the triennium centred around 2004–05, yield of groundnut is recorded as 516 kg per hectare in Anantapur district, 760 kg. per hectare in Andhra Pradesh while it was 1,188 kg per hectare in the country as a whole. Moreover, the district and state exhibit a declining trend in groundnut yield since mid 1990s.

Figure 14 Yield of Groundnut



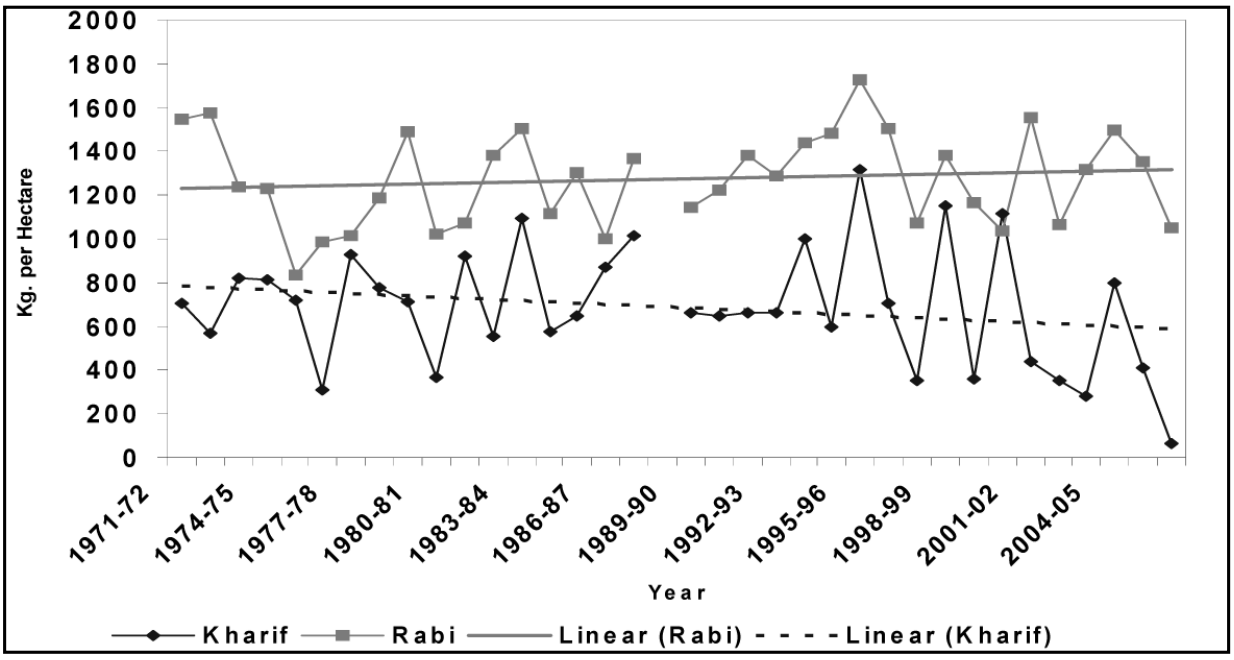
Source: *Government of Andhra Pradesh, various years.*

In addition to the low level of groundnut yield, Anantapur district also experiences a very high degree of fluctuations in yield levels. Fluctuation in yield over thity-three years, running from 1971–72 to 2005-06, is much higher in the district compared to the state and all India. Instability in yield is measured as the average percentage deviation of actual value in each year around the three-year moving

average value for that year. This simple measure of instability indicates that yield instability is highest in Anantapur at 27 percent as compared to 14 percent in the state and 12 percent in all India.

Another disturbing feature is the declining trend of groundnut yield in the kharif season in Anantapur district (Figure 15). As 98 percent of groundnut area in Anantapur district is sown during the *kharif* season, the fluctuating and decling pattern of groundnut yield has extremely important implications for the agricultural economy of the entire district. Given this context of low and declining

Figure 15 Groundnut Yield - Anantapur



Source: *Government of Andhra Pradesh, various years*

yield of groundnut, it is extremely crucial that other factors, such as quality inputs, which have a bearing on crop yield, are strengthened. Addressing the issue of quality inputs is also absolutely necessary considering that agriculture operates under unfavourable natural conditions in Anantapur district.

1.7. Inputs

1.7.1. Seeds

One of the major constraints faced by farmers in Anantapur district is with regard to availability of good quality groundnut seeds. The ruling variety of groundnut in the district is TMV 2. This is a pure-line selection released from

Tindivanam Oil Seeds Research Station in Tamil Nadu in the year 1942. During the 1970s, TMV 2 was introduced in Anantapur when the spreading variety of groundnut was slowly getting replaced by bunch varieties. This variety remains popular among farmers as it is seen to have several advantages. It is a drought-tolerant variety that is adaptable to local climatic conditions. The rejuvenation level of TMV 2 is quite high as it is capable of producing more than one flush of flowers. The first flush of flowers usually occurs during twenty-two to thirty days of sowing. Suppose the pod-setting fails due to unnatural conditions, the second flush of flowers will come as soon as the natural conditions become conducive. Though the second flush of flowers may not be as abundant as the first flush, farmers will still manage to reap a harvest. Farmers believe that the varieties that have been released in the recent years, by the university Acharya N G Ranga Agricultural University (ANGRAU) as well as the The International Crop Research Institute for Semi-arid Tropics (ICRISAT), lack the ability to flush more than once. In Anantapur, where incidence of dry spells and drought-proneness is high, farmers prefer varieties that flush many times. Though TMV 2 is susceptible to all the major pests and diseases it still remains the most popular variety with the farmers as it has several advantages.

The research system, ANGRAU and ICRISAT, have released several new and improved varieties of groundnut over the years for Andhra Pradesh. The State Agricultural University's Agricultural Research Station at Kadiri in Anantapur district has its main focus on groundnut breeding and developing groundnut based cropping system for the scarce rainfall zones in Andhra Pradesh. The Agricultural Research Station at Tirupati in Chittoor district under the State Agricultural University also has its main focus on groundnut and groundnut based cropping systems in Andhra Pradesh. Over the period 1971–2006, the University has released nearly thirty varieties developed by breeders in these two research stations. In March 2009, five more varieties were released by ANGRAU, out of which four are from Kadiri, and one is from Tirupati Research Station. ICRISAT also has groundnut as one of its mandate crops. In collaboration with Rural Development Trust, ICRISAT has conducted on-farm varietal selection of a number of improved varieties on farmers' fields. A crop variety released in 2006, ICGV 91114, received wide acceptance among farmers and in *kharif* 2008 nearly 40,000 hectare (about 5 percent of groundnut area in the district) is cultivated with this variety. While Kadiri 6 and JL24 (released from Jalgaon) are preferred in some parts of Anantapur district, TMV 2 remains the ruling variety if one considers the district as a whole.

At present, the farmers in the district have three sources to access groundnut seeds from: his/her own retained seeds; seeds purchased from other farmers; and seeds they receive at subsidised rate through the department of agriculture. The public sector agencies that have a major share in groundnut seed production in Andhra Pradesh are: Andhra Pradesh State Seed Development Corporation; Andhra Pradesh Cooperative Oilseeds Growers' Federation Ltd, Hyderabad Agricultural Cooperative Association etc. For a crop like groundnut, where seed volume is high and where retained seeds can be used by the farmers, the involvement of private sector in seed production is absent. Table 12 provides data on the quantum of groundnut seeds distributed by the department of agriculture. With the department taking on the responsibility of supplying seeds as a distress-alleviating measure, the quantity of seed supplied has increased significantly. More than one-third of the total seed requirement of the district is met by the department since 2006. This practice deviates from the earlier norm of supplying seeds on subsidy only when there was a crop failure in the district.

Table 12 Some Aspects of Groundnut Seed Distribution by Department of Agriculture - Anantapur District

Year	Groundnut seed distributed (in Quintals)	Groundnut area in Kharif (in Ha.)	Groundnut seed requirement (in Quintals)	Seed distributed as a percentage of seed requirement
1995	19,842 (100)	710,000	1,242,500	1.60
1996	6,045 (30)	725,000	1,268,750	0.48
1997	18,283 (92)	638,000	1,116,500	1.64
1998	108,767 (548)	743,000	1,300,250	8.37
1999	49,662 (250)	685,000	1,198,750	4.14
2000	178,335 (899)	792,000	1,386,000	12.87
2001	97,852 (493)	759,000	1,328,250	7.37
2002	200,268 (1009)	732,000	1,281,000	15.63
2003	279,546 (1409)	671,000	1,174,250	23.81
2004	364,425 (1837)	858,000	1,501,500	24.27
2005	186,249 (939)	877,000	1,534,750	12.14
2006	411,000 (2071)	644,000	1,127,000	36.47
2007	521,656 (2629)	875,000	1,531,250	34.07
2008	550,107 (2772)	Not Available	Not Available	Not Available

Note: *Seed requirement is estimated using a seed rate of 175 kg of pods per hectare and the kharif area under groundnut; Figures in brackets give the index w.r.to the year 1995.*

Source: *Data collected from Department of Agriculture, Anantapur District*

Table 13 provides details on various varieties of groundnut seeds distributed by the department of agriculture in Anantapur District during the kharif season of 2008. While in 2008, two-thirds of seeds distributed were TMV 2 variety, we were informed that till 2006 nearly 80 percent of distributed seeds were TMV 2. Only two varieties of groundnut seeds, TMV 2 and JL 24, were distributed by the agricultural department till 2006. Red Pollachi, Narayani, and K6 are being distributed by the department only since 2007.

Table 13 Details on Seed Varieties Distributed by Department of Agriculture, *Kharif* 2008

Groundnut Variety	Quantity (in Quintals)	Percentage of Total Quantity
TMV 2	353,770	64.31
JL 24	132,498	24.09
Red Pollachi	17,871	3.25
K 6	37,286	6.78
Narayani	8,682	1.58
Total	550,107	100.00

Source: *Data Collected from Department of Agriculture, Anantapur.*

Of the seeds that are distributed on subsidy, through the Department of Agriculture in Anantapur district, only 20 percent are certified seeds and the rest are truthful seeds. In 2008 Kharif, of the 5.5-lakh quintals of seed distributed by the department of agriculture only one-lakh quintals were certified seeds and the rest are truthful seeds. Truthful seeds are those that are not subjected to the seed certification process but have a label provided by the seed producers themselves, indicating the germination and purity levels of seed. In other words, truthful seeds are those whose quality is vouched for by the producers themselves and not by the state seed certifying agency.

The system of seed production and distribution with regard to groundnut in Anantapur District has several implications for seed quality and thereby on yield:

- Seed production in the formal sector, that is, groundnut produced for purposes of seed by registered farmers or in seed villages, plays a very limited role in the overall seed requirement of the district. While one-third of seed requirement of farmers is met by the agricultural department, only a small portion of it, say, about 20 percent, is produced as certified seeds. The bulk of the seed requirement is met by farmers themselves, either by way of their own retained seeds or from other farmers or friends or relatives or from middlemen who deal

in seeds during sowing seasons. In other words, a large proportion of the seeds that are used are not carefully selected for the purpose of seeds. The ruling variety TMV 2 is a variety that was released six decades ago and is in use in Anantapur district for more than three decades. Given that the environmental effect is highly pronounced in groundnut, it is very likely that the 'pure lines selected as TMV-2' would have developed genetic variability due to natural hybridisation, mutation and mechanical mixtures. Therefore, when this variety is used continuously over many years the virility of seeds gets eroded as the genetic and physical purity of the seed wears down over the years. In sum, the extent of impurity of TMV 2 seeds leaves much to be desired.

- Though the quantity of seeds that are produced by the formal seed production system is limited, it is believed that the entire quantity that is produced as seeds do not reach the farmers. The breeder-foundation-certified seed chain is often broken and seeds get diverted to the open market. For instance, even though the seed agencies enter into an agreement with farmers regarding procurement of seeds produced by them, the contracts often do not bind the farmers and seeds produced do get diverted into the open market. For instance, when there is a delay in declaring the procurement price by the seed producing agencies the farmers may go ahead and sell the produce in the open market. In the open market the produce is bought for commercial purposes and not necessarily for seed purpose. Farmers may even sell part of the produce in the open market while selling the remaining to the seed agency. Thus, groundnut produced for seed purpose gets diverted for consumption purpose thereby reducing the availability of good quality seeds. Moreover, this practice also results in a lower seed multiplication ratio for groundnut.
- It is an irony that while the quantum of seed supplied by the agricultural department from 1995 to 2008 has increased nearly thirtyfold, there has been no corresponding expansion in the infrastructure needed to produce the additional requirement of seeds. The bulk of the seed that gets distributed by the agricultural department consists of 'Truthful Seeds' that may not stand the test of the State Seed Certifying Agency. Moreover, there is not even a seed farm for groundnut that is being supported by the district's agricultural department.
- The quantum of seed supplied by the department of agriculture has increased from less than 0.2-lakh quintal to 5-lakh quintal. The rapid increase in 'seed'

supply gives scope for varietal mixture, resulting in farmers not getting pure seed of any variety. Different varieties would have different maturing period and this would result in pest and disease infestation bringing down the yield and thereby increasing the cost of cultivation.

1.7.2. Fertilisers

Recommendation of nutrients for rain-fed groundnut, as per the Package of Practices issued by ANGRAU, is 8 kg/acre of nitrogen; 16 kg/acre of phosphates; 20 kg/acre of potash; 47 kg/acre of sulphur; and 37 kg/acre of calcium. In addition to the recommendation of chemical fertilisers it is also recommended that 4 to 5 tonnes of farm yard manure (FYM) is applied per acre. Calcium has a major influence on pod formation and pod filling; sulphur helps in enhancing the oil content of the groundnut kernel; potassium helps regulate nutrient and water uptake by the plants and is therefore important for plant growth; nitrogen is needed during the vegetative phase of a plant's growth; and phosphorous is very crucial for initiation of flowering and in the reproductive phase of the plants.

Table 14 indicates the quantity of chemical fertiliser applied per acre of cultivated area in the district of Anantapur and the consumption of all three major nutrients has increased over 1991–92 to 2006–07. If we assume that the fertiliser application for groundnut crop is the same as the average fertiliser application for all crops, then we find that except for nitrogenous chemical fertilisers, the application of all other chemicals is way below the recommended norm[17] and thus leads to imbalanced nutrient application, which may affect soil health.

In our survey villages we found that while almost all farmers apply chemical fertilisers, the recommended dosage is generally not adhered to by any of the farmers. Among the macro-nutrients, nitrogen and phosphorous are usually

Table 14 Per-acre application of Chemical Fertilisers (in kg) in Anantapur District

Year	Nitrogen (N)	Phosphorous (P_2O_5)	Potash (K_2O)	Total (NPK)
1991–92	9.62	7.06	2.38	19.06
2006–07	13.49	9.65	6.04	29.18

Source: *GoAP.various years.*

17 Considering that three-fourths of net sown area in the district is cultivated with groundnut, the average fertiliser consumption of the district can be taken to be the same as that for groundnut crop

applied by many farmers while potassium tends to be applied only by some farmers[18]. As regards micro-nutrients, such as sulphur and calcium, most farmers do not apply these nutrients. While nitrogen is a very important nutrient which is needed during the vegetative phase of a plant's growth, groundnut being a leguminous crop which can fix atmospheric nitrogen, the lower-than recommended dose application of nutrient nitrogen may not have any serious implication for crop growth and productivity. Similarly, considering that the district of Anantapur has moderately high levels of phosphorous, a lower-than recommended dose of phosphorous application may not have any serious implication on groundnut crop flowering and pod formation. However, the absence of the micro-nutrients sulphur and calcium would affect the pod filling and oil formation stages. As regards farm yard manure (FYM), by and large farmers apply them though the quantum of application varies a great deal across farmers. Farmers also keep alternating the area of FYM treatment on their plot as the quantity applied is usually lower than required.

1.7.3. Pesticides

In Anantapur, the Department of Agriculture has initiated special measures to enable farmers to reduce the use of chemical pesticides in pest management in agriculture. *Polambadi* or Farmers Field School has been launched by the Government of Andhra Pradesh through the Department of Agriculture, where the emphasis is given to the use of eco friendly measures (bio agents & bio pesticides) for control of crop pests. 'The main principles of polambadi are (a) grow a healthy crop; (b) conserve natural enemies; (c) conduct regular field observation; and (d) farmers become integrated crop management (ICM) experts. Integrated crop management is to be achieved through a combination of integrated nutrient management (INM), integrated pest management (IPM), and agronomic practice including farm mechanisation. A *polambadi* will have a maximum of thirty farmers. During the year 2007–08, in groundnut during *kharif*, a total of 180 *polambadis* were conducted, of which 60 *polambadis* were conducted by the concerned *Mandal* Agricultural Officers, and 120 *polambadis* by the farmer facilitators, namely *adarsha ryuthus*. During rabi season in 2007–08, a total of 135 *polambadis* were conducted in groundnut crop, of which forty-five were conducted by MAOs and ninety by the *adarshryuthus'. (*http://anantapur.gov.in) In the two villages we surveyed, Thoppudurthi has a *polambadi* while Thirumaldeverpally is almost completely

18 Fertilisers like urea, diammonium phosphate, single super phosphate, and muriate of potash are commonly used.

devoid of any agricultural extension activity. In addition to the efforts taken by the agricultural department, there are several non-governmental organisations in the district that propagate integrated crop management.

In both the villages we surveyed, important IPM measure that was adopted by farmers relates to growing of border crops as well as intercrop while other measures such as use of bio-pesticides and bio-agents is limited. Farmers do resort to extensive use of chemical pesticides in our survey villages.

In Thopudurthi village mainly pests rather than diseases are reported by farmers. Major pests reported in groundnut are red hairy caterpillar, aphids, and *Spodoptera litura,* while in red gram it is pod borer, namely *Heliothis armigera/ Helicoverpa armigera*. In general, chemical pesticides used by farmers are as per recommendations for the respective pests. As recommended, monocrotophos against red hairy caterpillar and quinalphos/monocrotophos against aphids is used, but there are also instances when wrong chemicals are used for control of pests. For instance: (a) fenvalarate, a synthetic pyrethroid, is used against aphids whereas the commonly recommended chemicals for aphids are those in the organophosphate group, namely monocrotophos, quinalphose, rogor etc.;(b). A mixture of an organophosphate insecticide like monocrotophos and fungicide namely Bavistin was being used against *Spodoptera litura,* a groundnut defoliator. Bavistin is a fungicide and is mainly used as a seed-treatment chemical, and also for soil/root drenching in the event of an incidence of a fungal disease. Mixing of an organophosphate insecticide and a fungicide itself is not a recommended practice for control of any insect/ pest.

In Thirumaldeverpally village, stem necrosis is reported to be the major disease in groundnut. Though the farmers are not aware of the name of the new disease, the symptoms listed out by the farmers pertain to stem necrosis[19]. Peanut stem necrosis is a viral disease resulting in the death of young groundnut plants. Thrips acts as vectors for the virus. This is a disease which has caused a lot of concern to the groundnut growers of Anantapur, since it results in complete crop failures.

The major recommendation, by the scientific community for the control of this disease consists of a mixture of cultural practices and chemical control to manage

19 The scientific community also reports the epidemic prevalence of stem necrosis in the groundnut growing tracts of Anantapur as a new phenomena which started somewhere around early 2000s. The first epidemic incidence of bud necrosis was reported in the year 2000 in Anantapur during the rainy season.

both the virus and the vector (International Crop Research Institute for the Semi-Arid Tropics, 2003). Cultural practices consist of raising tall-growing grass/cereals as border crops to prevent the wind-borne vectors, namely the thrips form entering the groundnut fields. The crops recommended as border crops are sorghum or pearl millet. The other measures include eradication of parthenium weed, which is a potential host for the virus, not growing susceptible hosts like sunflower, marigold, and cowpea in the neighbouring fields, and maintaining optimum plant population. The chemical recommendation is seed treatment with Confidor (imidaclorprid) and following it up with systemic insecticide like monocrotophos/ quinalphose etc to control thrips in the early stages of crop growth. However, in Thirumaldeverpally village none of the above-mentioned recommendations are found to be practiced by farmers to prevent the disease at an early stage. The only recommendation that is being practiced in the field is the spraying of systemic insecticide like Monocrotophos to ward off thrips. This too is done after the incidence of the disease is noticed. Moreover, farmers grow a border crop of cowpea in their groundnut fields which is a potential host for the virus and serves as a source of inoculum of the virus. Moreover, none of the farmers interviewed except for one, has treated the seeds with imidaclorprid, as recommended.

Our village surveys clearly point out the need to carry on the message of Integrated Crop Management on a much wider scale, to reach many more farmers, than is currently being done.

1.8. Technology Delivery System:

As in other parts of the country, in Andhra Pradesh too the responsibility of agricultural technology delivery lies with the department of agriculture. At the district level, the department of agriculture is headed by a Joint Director. The structure of Training and Extension Wing of the department at the district level consists of one Deputy Director, a few Assistant Directors, *Mandal* Agricultural Officers, and Agricultural Extension Officers. In Anantapur district, for the 11 divisions[20] there are 11 sanctioned posts of Assistant Directors, 63 sanctioned posts of *Mandal* Agricultural Officers for the 63 *mandals* and 139 sanctioned posts of Agricultural Extension Officers. The department also uses the services of farmer facilitators, namely *adarsha ryuthus.* 2,598 *adarsha ryuthus* have been recruited as on 2007–08 in the district.

20 The Department of Agriculture, Anantapur is divided the district into eleven divisions for administrative purpose.

While the Department of Agriculture has sanctioned staff strength of 551 posts, in January 2009 we found 57 percent of these posts remaining vacant. However, during February 2009, recruitment of staff had taken place and the vacant posts of *Mandal* Agricultural Officers were filled up. However, the posts of Agricultural Extension Officers (AEO), those who have the mandate to visit villages and provide technical guidance to farmers, have not yet been filled. Out of 139 sanctioned posts, only 38 have been filled. That is, 73 percent of Agricultural Extension Officers posts remain vacant as on March 2009. This is a huge backlog, considering that even if all the 139 sanctioned posts of Agricultural Extension Officers are filled up it would be far from adequate to meet the ideal norm of 1,000 farm families per Agricultural Extension Officer. In fact, with the present allotment of officers, the number of farm families assigned per officer would be almost 3,915, which is much higher than the stipulated 1,000 farm families per officer. Anantapur district would require more than 500 Agricultural Extension Officers if every officer is to cater only to 1,000 farm families. Given that nearly three-fourths of the extension officers' posts are vacant, it is quite clear that large number of villages in Anantapur district remain unattended by any agricultural officer at present.

Adarsha Ryuthus serve as interface between the farmers and the Department of Agriculture. According to the guidelines there has to be one *adarsha ryuthu* per 250 farm families. The posts of *adarsha ryuthus*, Farmer's Friend, were created in year 2005. *Adarsha Ryuthus* are supposed to serve as facilitators at the village level for generating more awareness among farmers on various aspects of agriculture. The minimum qualification prescribed for *adarsha ryuthus* is the following: she/he should have passed class 10; should be a practicing farmer; and should be between 25–45 years of age. *Adarsha Ryuthus* are paid an honorarium of Rs.1,000 and there are two to three *adarsha ryuthus* per village.

The Extension Wing in the Department of Agriculture has undertaken many activities in the past few years to increase awareness among farmers regarding improved crop-production techniques, on reducing the cost of cultivation by adopting simple techniques of pest and disease management like the NPM (non-pesticidal management), growing border crops which serve as trap crops for the wind borne vector of peanut stem necrosis disease in groundnut, seed treatment to ward of disease/pest attack at an early stage etc through their Farmer's Field Schools (*Polambadi*). But in spite of these visible efforts by the Department of Agriculture, several gaps in technology adoption were observed during our village survey.

Farmers resort to sub-optimal dose of fertiliser application; mix non-compatible pesticides; follow inefficient method of seed treatment; absence of awareness for the need for a border crop; erroneous practices such as taking cowpea as border crop while cowpea is an alternate host of peanut stem necrosis disease. Cowpea serves as a source of inoculum of the virus, tobacco streak ilavirus, which causes peanut stem necrosis. This erroneous practice at a time when peanut stem necrosis disease is spoken about as an epidemic in the groundnut fields of Anantapur describes the nature and extent of agricultural extension that is available in the district.

Some instances that highlight the huge gap that prevails between laboratory and the land are the following:

- Peanut stem necrosis is a viral disease resulting in the death of young groundnut plants. The first epidemic incidence of bud necrosis was reported in the year 2000 in Anantapur during the rainy season. In Thirumaldeverpally village, stem necrosis was reported to be the major disease in groundnut. This is a disease which has caused a lot of concern among groundnut growers of Anantapur, since it results in complete crop failures. The major recommendations for the control of this disease consist of a mixture of cultural practices and chemical control to control both the virus and the vector. Cultural practices consist of raising tall growing grass/cereal as border crops to prevent the wind borne vectors, namely the thrips from entering the groundnut fields. The crops recommended as border crops are sorghum or pearl millet. The other measures include eradication of parthenium weed, which is a potential host for the virus, not growing susceptible hosts like sunflower, marigold, and cowpea in the neighbouring fields, and maintaining optimum plant population. The chemical recommendation is seed treatment with Confidor (imidaclorprid) and following it up with systemic insecticide like Monocrotophos/Quinalphose etc to control thrips in the early stages of crop growth. In Thirumaldeverpally, almost none of the above-mentioned recommendations were found to be practised by the farmers to prevent the disease at an early stage. The only recommendation that was being practised in the field was the spraying of systemic insecticides, such as Monocrotophos, to ward off thrips. This too was found to be done after the incidence of the disease was noticed. Considering the epidemic nature of the disease and the ability of the disease to spread rapidly, the limited extension activity on appropriate practices, even in pockets that are severely affected by the disease, is quite appalling.

- The idea of growing tall-growing cereal as border crops is a strategy to prevent the spread of the wind-borne vector of stem necrosis in the groundnut crop from one field to the other. The border crop should not be an alternate host for the causal agent of stem necrosis, namely, tobacco streak ilavirus. Ironically, in Thirumaldeverpally, we met farmers who were taking cowpea as a border crop. As noted earlier, cowpea is a potential host for the virus and serves as a source of inoculum of the virus. Thus, the practice of growing cowpea would, in fact, trigger the spread of stem necrosis in groundnut field.
- Chemical required to treat groundnut seeds, DithaneM-45, is supplied by the Department of Agriculture along with the groundnut seeds supplied to farmers. The method of seed treatment adopted by the farmers was quite inefficient, leading to loss of chemicals and improper coating over the seeds. The recommended method of seed treatment is to put the seeds inside a polythene bag, add the chemical, tie the bag, and then turn it upside down and sideways. This method will ensure effective coating of the seed treatment chemical on the seeds. We rarely found any farmer practicing the recommended method of seed treatment, though almost all the farmers we interviewed were in the practice of treating their seeds.
- Farmers in Thirumaldeverpally village in Kothacheruvu *mandal* continue to resort to a very inefficient system of fertiliser application, namely, broadcasting**.** In this village we found that farmers broadcast fertilisers instead of placing it at the root zone before sowing the seeds. This results in a lot of wastage of nutrients. The nutrients in the fertilisers are not effectively absorbed by the plants. This results in the inefficient nutrient uptake of the already less-than-recommended dose of fertiliser being applied.
- Using the traditional *gorru* (seed drill): This consists of a single funnel with four holes which is connected to four different draw tubes. This is one main reason why farmers resort to broadcasting of fertilisers instead of placing it in the plant root zone. A single funnel system has only four draw tubes, and all of these are used for sowing the seeds of the main crop (groundnut) and the intercrop (red gram). It is necessary to have one more funnel with four draw tubes to allow for the fertiliser to be applied at the site of seed placement. Therefore whenever *gorru,* which is essentially a single-funnel seed drill, is used, fertiliser is broadcast. The use of single-funnel seed drill at a time when the Government of Andhra Pradesh has declared a flat subsidy of fifty percent of the cost (with

an upper limit of Rs30,000) on the purchase of any agricultural implement indicates the dearth of communication and extension activities.

All this highlight the need for improvement in both the quantity and quality of the prevailing technology delivery system in Anantapur. As on date, technology and knowledge transfer system that prevails in the district of Anantapur leaves much to be desired.

1.9. Concluding Observations:

The district gazetteer, published in 1905, notes that natural conditions in Anantapur district are extremely unfavourable for agricultural growth. To quote, 'The natural conditions of Anantapur could scarcely be more inimical to agricultural prosperity than they are. The soil is, most of it, wretchedly infertile, the rainfall is light and uncertain, fuel and fodder are scarce, irrigation facilities are few, the indigeneous cattle are bad, manure is difficult to get and the people are few in number'. (GoAP 1993, p.67). These conditions remain true even today in Anantapur. However, considering that agriculture supports nearly 70 percent of the district's population, it is extremely important that all possible measures are taken so that natural constraints for agricultural growth are either overcome or minimised. The constraints faced by Anantapur agriculture are summarised below, while in the section that follows some recommendations for ways to mitigate the agricultural problems of Anantapur are elaborated.

The geographic location of Anantapur, in the rain-shadow area of the south deccan plateau, gives the district an arid agro-ecology characterised by the potential evapotranspiration highly exceeding the rainfall throughout the year. Rainfall is highly erratic and the average number of rainy days annually is 35.5. The resultant low moisture availability period, and frequent dry spells that occur in the district, pose severe limitation to cultivation of crops in the district. In addition to this, the topography of the landforms predisposes the district to severe soil and water erosion. The soils of the district have great limitation in terms of its physical and chemical properties which has serious implication for crop cultivation in the district. Moreover, two-thirds of cultivable area can be cultivated only if conservation measures are adopted rigorously. In other words, water erosion, shallow rooting depth, gravelliness, moderate slopes, and salinity as well as climatic limitations seriously affect cultivation in the district.

The net sown area as well as gross cropped area in the district of Anantapur fluctuates a great deal which is clearly indicative of a high degree of instability in

agriculture in the district. Anantapur has no perennial river, but traditionally has had a large number of rain water harvesting and management systems like feeder channels, tanks etc. A survey conducted by the district authorities in the year 2004, identified a total of 5,824 water bodies in the entire district, but only one-fourth of the identified water bodies were found to be functional at the time of the survey. Rapid increase in bore-well irrigation and indiscriminate use of ground water since the 1980s has led to a serious fall in ground water levels. In the year 2004, only twelve out of the sixty-three *mandals* comprising Anantapur fall within the safe category of ground water utilisation, according to the Ground Water Department of the district.

The cropping pattern of the district has also undergone vast changes over the decades. Traditionally, food grains dominated the cropping pattern of the district with more than two-thirds of the gross cropped area under food grains. With the adoption of the bunch variety of groundnut in Anantapur, since late 1970s, groundnut became the major crop. However, groundnut crop is marked by low yield levels that exhibit a declining trend. Related to this factor is the major constraint faced by farmers with regard to availability of good-quality groundnut seeds. The most popular variety in Anantapur is TMV-2 which was released in the year 1942. The research system, ANGRAU and ICRISAT, has released several new and improved varieties of groundnut over the years. But these varieties have not been adopted on a large-scale by farmers. In addition to this, there is the issue of quality of seeds supplied through the Department of Agriculture in Anantapur. The bulk of the seed that gets distributed through the Department of Agriculture are under the 'truthful label', that is a huge volume of seeds that get distributed do not pass through the seed tests of the State Seed Certifying Agency.

The current status of agricultural technology delivery system in Anantapur leaves much to be desired. The Training and Extension wing of the Department of Agriculture, operates with a bare minimum of field-level extension officers. A large number of sanctioned posts remains vacant, resulting in overburdening of available field-level staff. The huge backlog in filling up sanctioned posts affects the quantity as well as quality of extension activities in the district. This comes out very clearly from the wide disparity, in terms of awareness and access to information, between farmers in different parts of the district. In spite of various efforts taken by Department of Agriculture to reach out to farmers, several erroneous cultivation practices are adopted by farmers.

To sum up, while scarce rainfall, poor soil condition, and frequent droughts have always been a feature of Anantapur agriculture, it is important to note that these adverse natural conditions are only one aspect of the agricultural problem facing the economy. The highly unstable agricultural economy has undergone fundamental changes with regard to cropping pattern and irrigation practices:

- A food grain–based crop production system has changed into a commercial crop–based production system;
- There has been a gross neglect of traditional water bodies and a rapid rise in private bore-pump irrigation.

Both these changes have increased the links the farmer has with the market forces. Reliance on cash for consumption as well as agricultural production increased over the years. In addition, there have been other problems such as soil degradation, pending irrigation projects, lack of adequate soil and water conservation activities, lack of availability of quality inputs, lack of awareness of correct agricultural practices among farmers, lack of agricultural extension etc. Further, all these changes have been happening in a context where economic reforms, initiated in the early 1990s, resulted in withdrawal of several state-support services, reduction in the plan outlay for agricultural research and education, import of edible oil, volatility in groundnut prices and a general dwindling of returns from agriculture.[21] A complex set of factors have thus added a new dimension to the unstable agricultural economy of Anantapur district.

21 A major lacuna in our study is the absence of any attempt to relate the policies associated with economic reforms to the current crisis in agriculture in Anantapur.

2. Recommendations

Our study, on the agricultural status of Anantapur district, clearly brings out the need for several interventions in order to have a substantial revival of agriculture. Considering that the natural conditions that prevail in the district are not very conducive for agricultural growth, appropriate interventions are absolutely essential to sustain and improve agriculture on which nearly three-fourths of the district's population depend. The risk faced by a farmer in Anantapur is enormous and one of the significant steps taken by the Government of Andhra Pradesh is to treat a village as the unit of insurance under the National Agriculture Insurance Scheme. This step safeguards the interest of farmers against local level natural calamities. This innovativeness introduced by the Government of Andhra Pradesh in the insurance scheme has helped in mitigating the risk borne by farmers due to variability in rainfall and other vagaries of nature. Across the country, crop insurance schemes treat the *mandal*/taluk as the insurance unit. Therefore, the initiative taken by the Government of Andhra Pradesh to cover the risk faced by farmers which is related to village-level variability is unique and deserves a special mention. On the same lines, it is hoped that several other steps needed to safeguard the interests of farmers will be taken up by the state government. Some key areas where major interventions are required are as follows.

2.1. Availability of Good-Quality Seeds

One of the major constraints faced by farmers in Anantapur district is with regard to availability of good-quality groundnut seeds.

- **Seed Villages**: A major limiting factor for productivity of groundnut is lack of availability of good-quality seeds. Promoting the concept of the seed village would help towards production, multiplication, and distribution of quality seeds that would be available locally and accessible to farmers. Groundnut being a bulky crop with a high seed rate, the sheer logistics of procurement and distribution of groundnut seeds further necessitates promotion of the seed village concept. Department of Agriculture can identify compact areas within the district where this concept may be promoted. Training on seed production and seed preservation as well as supply of required quantity of breeder/foundation seeds should be given to farmers who opt to participate in the programme.
- **On farm varietal selections**: So far, the State Agricultural University as well as the international research organisation ICRISAT have released a number of

groundnut varieties specifically suitable for Anantapur. However, by and large, farmers are unaware of the new varieties and age old varieties, TMV2 released in the year 1942, continues to dominate the scene. This factor is reflected in TMV2 dominating the seed indent for breeder and foundation seeds in the district. It is therefore necessary that for promoting new varieties, on-farm varietal selections are conducted by the scientists on the farmers' fields, in participation with the farmers. On-farm varietal selections will have to be carried out on a massive scale across the four different rainfall zones of the district. Farmers will then have a chance to scrutinise the new varieties and their first-hand experience of the performance of the new varieties may translate into effective demand for new varieties. This will have an influence on the relative share of different varieties in the breeder and foundation seed indent in the formal seed production system organised by the state.

- **Community Seed-Storage Structures:** A major source of seed supply for farmers in Anantapur district is the seeds retained over their previous harvest. The problem of seed storage is significant, as the seed rate of groundnut is quite high and it is also a bulky crop. Farmers face not only space constraints but also pest infestations on the stored groundnut seeds. Development of suitable community seed storage structures is necessary to enable farmers to retain a portion of their produce for seed purpose.
- **Addressing some concerns in the existing system of seed production and supply:** First, diversion of crop grown for seed purpose to other uses is an issue that needs to be addressed. Production of foundation seed and certified seed for groundnut is undertaken by public sector seed agencies in Andhra Pradesh. The seed-producing agencies turn out foundation and certified seeds on farmers' fields by adopting a system of participatory cultivation with farmers. Though there is a buy-back agreement built into the contract between the farmers and the seed agencies, farmers often do not sell their entire produce to seed agencies. The delay in declaring procurement price of groundnut seeds by the agencies appears to be a major factor behind diversion of seeds for other purposes. Timely announcement of procurement price by the seed agencies is therefore necessary to prevent farmers from diverting groundnut grown for seed purposes. Second, the absence of state seed farms dedicated to groundnut in the district need to be addressed to improve seed supply in the formal system.

2.2. Integrated Nutrient Management

The district of Anantapur provides enormous scope for adopting integrated nutrient management which entails a nutrient supply system with the blend of both organic and inorganic sources. The soils of Anantapur are poor in organic carbon content, low in available nitrogen, and are highly erodable. While the application of manure shall improve the soil texture and meet the nitrogen requirement of the soils, application of inorganic fertilisers will address the dearth of other nutrients, such as, potassium, phosphorous and other micro nutrients in the soils. An integrated nutrient management approach that helps in sustaining and improving soil health and texture is therefore an ideal approach for Anantapur district.

The district has a total of 13.5-lakh bovine population, according to the Livestock Census of 2007. The district also has a significant population of goats and sheep. About 12 percent of the total sheep population and 9 percent of the total goat population of Andhra Pradesh are in Anantapur district, as seen in 2007. Further the bovine, sheep, and goat populations are growing at a high, positive rate, and between 2003 and 2007 the bovine population grew at an annual compound growth rate of 5 percent, sheep at 14 percent and goat at 16 percent. This factor implies that the district has the required number of animal population to meet the manure requirement for the entire cultivable area of the district. Assuming that a bovine produces 5.5 kg of animal dung per day and given that 7.5 tons of farm yard manure is the average annual requirement per hectare of cropped area to improve the soil quality, the manure requirement of the district can be comfortably met with the available bovine population. However, our interaction with farmers showed that not all farmers apply farm yard manure on their fields. Usually farmers who do not own any cattle are not in the practice of applying farm-yard manure. To overcome this problem, it is necessary to think of various ways by which farmers may have access to farm-yard manure, compost, etc. One possibility could be the **promotion of composting as an enterprise** that can be taken up by self help groups that dot the rural areas of Andhra Pradesh.

As regards chemical fertilisers, our interviews with the farmers in the two survey villages have clearly shown that application of macro-nutrients is invariably much less than the recommended dosage while there is a near absence of micro nutrients that are recommended for groundnut crop such as calcium and sulphur. Calcium is needed for proper shell formation and filling and sulphur enhances the oil content in groundnut. It is therefore imperative that some **provision is made for supply**

of gypsum (which would take care of the sulphur and calcium requirement) to farmers.

Detailed **village plans for nutrient requirement** will have to be drawn that take into account the inherent deficiencies in the soil as well as the current cultivation practices of the farmers. This plan should specify the supply requirement of both organic (manure, bio-fertilisers) as well as the inorganic (gypsum, etc.) nutrient sources for all the villages of the district. The plan should also have details of how the overall nutrient supply requirement for every individual village can be met. For instance, the number of compost-producing enterprises that need to be promoted locally, the quantum and type of chemical fertilisers that need to be sourced etc. are to be specified in the plan.

Individual field-based data on soil quality is a prerequisite to practice integrated nutrient management in an effective manner. This can be achieved only if every individual farmer is provided with a **soil health card**. As on 2009, there are only eighty-four soil testing laboratories in the entire state of Andhra Pradesh. Each district has one soil testing laboratory in the district headquarters as well as in the market yards. However, out of fifty-six soil testing laboratories established in the market yards across the state, nearly fifteen were not functional.[22] There are four mobile vans equipped to test the soils, and on average, each van covers about four to five districts of the state. In the district of Anantapur, over a decade, 1997–98 to 2007–08, 2.3-lakh samples have been analysed. That is, even assuming that one soil sample per operational holding was analysed, nearly 3.6-lakh holdings are yet to be covered in Anantapur district. Thus there is a huge backlog, which calls for immediate steps to be taken. It is absolutely essential that large number of mobile soil testing vans as well as laboratories in the market yard be introduced in order to enhance accessibility for soil test among farmers. In our survey village Thoppudurthi, even with the active interest taken by the *Adarsha Ryuthus*, only less than 1 percent of operational holdings have a soil health card. Though soil testing is recommended for every preseasonal sampling, at least it can be done per annum per holding.

22 Information collected in the Directorate of Agriculture, Hyderabad during March 2009.

Andhra Pradesh Model of Low External Input Sustainable Agriculture: Community Managed Sustainable Agriculture (CMSA) – A DRDA-SERP Initiative[23]

Society for Elimination of Rural Poverty (SERP) is an autonomous body established in Andhra Pradesh, under the Public Societies Act in the year 2000, with the Chief Minister as the Chairperson of the organization. SERP is the implementing agency for Indira Kranthi Patham (IKP), the World Bank funded poverty alleviation programmes of the District Rural Development Agency in Andhra Pradesh. Community Managed Sustainable Agriculture (CMSA) is one of the livelihood initiatives implemented under IKP from the year 2005-06 in Andhra Pradesh[24]. The main objective of CMSA is to reduce the cost of cultivation and to bring sustainability to agriculture based livelihoods, with special focus on small and marginal farmers, tenants, agricultural labourers, and women. CMSA stresses on evolving ecological alternatives in agriculture which makes best use of local resources and is seen as a paradigm shift from input intensive agriculture. CMSA advocates a set of practices that blends traditional knowledge of the farmers' with modern science. The major components of CMSA advocacy relate to non-pesticide management (NPM), soil health enhancement, and promotion of suitable cropping systems.

Components of Community Managed Sustainable Agriculture (CMSA) Programme:

SERP promotes non-pesticide management (NPM) or pesticide free initiative as the strategy for crop protection. The principle underlying NPM is that pests can be managed by understanding their behaviour and lifecycle. This involves use of traditionally evolved management techniques like hand picking and crushing insects, crop rotation, spraying of neem extract or garlic extract etc to ward off pests, while at the same time taking advantage of the physical and biological regulatory mechanism naturally present in the environment. The physical regulatory mechanism includes fluctuations in temperature and rainfall which sometimes helps in regulating the pest

23 We have relied on data given to us by SERP, Anantapur and Hyderabad; interactions with officials implementing CMSA; field visits arranged for us.

24 The other initiatives under IKP are Institutional and human capacity building, Microfinance and SHG bank linkages, financial access and pavala vaddi incentive, community investment fund, dairy intervention, land purchase/accessibility, collective marketing, food security, jobs for rural youth, gender, disability, health and nutrition, education, insurance & pension schemes

density and the biological regulatory mechanism present in nature is the predator-pest relationship. NPM uses locally available resources like dung, crop residue etc. To facilitate better accessibility to NPM products, shops are set up in villages wherein farmers could buy these products. It is proposed to have at least 1 NPM shop per village. The strategy evolved for pest management under NPM also includes the following: a) agronomic practices such as deep summer ploughing, raising border crops, intercrops, providing alleys in paddy, cutting of the tips in paddy at the time of transplantation b) use of traps like community bonfires, yellow and white plates, light traps, pheromone traps, delta traps in groundnut; c) seed treatment with ash, cow urine etc; d) providing enabling environment like bird perches, and trap crops. The above practices are called as 'non-negotiable' and are mandatory for all NPM farmers. The application of botanical extracts is to be looked upon as an option of last resort. The farmers are trained on the concept of ecosystems, identification of pests and predators in various stages of life cycle of the pest, and developing of pest calendars for the village depicting the seasonal occurrence of pests across the crops. Shifting to non-pesticide management is expected to reduce the overall cost of cultivation of the crops.

The second component in sustainable agricultural practices advocated by SERP consists of a comprehensive strategy to improve soil health and productivity with reduced fertiliser usage. Soil fertility enhancement is attempted either by application of crop residue or farm yard manure or both to the soils. In order to do this, biomass plantation on the bunds and common lands; farm biomass production plans; promoting composting techniques like Nadep, vermicomposting; promoting plantation of Glyrecedia and subabul around the compost pit; application of dung based inoculants, annual and perennial green manure crops, green leaf manure, tank silt application; using bio-fertilisers like *Azolla*, blue green algae, *Azospirillam, Azatobacter* and vesicular-arbuscular mycorrhizal fungi; and also liquid manures like *Panchagavya, Amrutapani* and *Jeevamrutham;* and mulching with straw and crop residue to replenish the soils are attempted.

The third initiative under sustainable agricultural practices is promotion of crop models which makes optimum use of space and sunlight. These crop models aim to promote best cropping systems by increasing crop and genetic diversity. It helps in controlling the pest and disease build up due to monoculture. Crops that are less water intensive and suitable to the local soil such as perennial red gram and castor are promoted. In addition to this, crop models are promoted viz. a) 36 x 36 model and b) 2 plots of (36 x 36 model). The minimum area required for the 36 x 36 crop model is $1/4^{th}$ of an acre.

Seven different crops are grown on this model. The crops raised include tubers-grown below ground level, leafy vegetables and creepers raised at ground level, pulses and cereals raised at a medium height, and tall growing trees like mango, sapota, drumstick, and tamarind. The second crop model, namely the 2(36 x 36) crop model requires a minimum of ½ an acre. SRI paddy is raised on one portion of the ½ acre, and mixed crops are raised on the other portion.

Achievements of Community Managed Sustainable Agriculture (CMSA) Programme:

In the year 2008-09, the sustainable practices advocated by SERP was practiced by 316,000 farmers covering an area of 13.79 lakh acres, in 3171 villages spread over 18 districts of the state of Andhra Pradesh[25]. Area covered by CMSA practices in Andhra Pradesh accounts for 5 per cent of the gross cropped area of the State. In the year 2009-10, SERP is implementing IKP in all the 22 rural districts of Andhra Pradesh.

Anantapur leads the other districts in terms of the reach and coverage under the programme. Anantapur has one of the highest numbers of villages covered under the programme, and also the largest acreage under CMSA. As on September 30, 2009, CMSA is practiced by about 70,666 farmers, covering an area of 2,16,300 acres in 30 mandals and 730 villages. That is, nearly one fifth of the gross cropped area of the district is covered by the programmes of SERP. As regards individual programmes under CMSA, it is seen that 412 farmers have adopted the (36 x 36) crop models in Anantapur district. Around 1908 farmers had taken up perennial red gram and castor plantation, 4534 farmers had taken up bund plantation in their fields, while 2203 farmers had adopted mulching practices, and 306 farm ponds have been constructed as part of CMSA. In order to improve soil productivity tank silt was applied on 2088 acres. As on September 30, 2009 in Anantapur district, there are 379 Nadep compost pits, and 300 vermicompost pits. The average output from Nade[compost is 50 quintals, and that from a vermicompost pit is 25 quintals per annum. Hence, the total amount of compost produced from the available number of Nadep and vermicompost pits in Anantapur is 26,450 quintals per annum. Given that the per acre requirement of compost is 2 quintals, per annum, the existing Nadep and vermicompost units would supply compost enough to cover 13225 acres, which is only 6 per cent of the total area under

25 The districts are Guntur, Nellore, Chitoor, Kadappa, Anantapur, Kurnool, Adilabad, Karim Nagar, Khammam, Mahbubnagar, Medak, Nalgonda, Nizamabad, Rangareddy, Warangal, Vishakapatinam, Srikakulam, Vizianagaram. In 2009-10, SERP is implementing IKP in all the 22 rural districts of A.P.

CMSA in the district as on September 30, 2009. The amount of *Panchagavya* produced is 7004 litres, this at the rate of 1litre/acre, would be enough to cover only 7004 acres that is 3 per cent of the area under CMSA in the district. The quantity of *ghanajeevamruth* produced up till September 2009 is 70857 quintals, which at the recommended rate of 1 quintal/acre, is enough to cover 70857 acres, which is roughly one third of the area under CMSA in the district. In terms of the outlets, namely the NPM shops that supply NPM products ready made to the farmers, the district as on September 30, 2009, has 166 shops, which is only 23 per cent of the required number of shops in the district, at the recommended rate of 1 NPM shop/village.

While the programme, Community Managed Sustainable Agriculture, is undoubtedly, a positive step towards promoting sustainable agricultural practices among the small and marginal farmers of Andhra Pradesh, there is still a long way to go with regard to the coverage of the programme. Though, Anantapur is one of the leading districts in terms of number of farmers covered and acreage brought under CMSA in the state of Andhra Pradesh, when one considers the number of units producing the recommended inputs for sustainable agricultural practices and the quantum of production of these inputs and compare it with the number of farmers who have taken up various components under this programme in the district, it is clear that there is a gap between supply and demand of inputs as elaborated earlier. The prevalent gap between supply and demand for organic inputs possibly poses a constraint in expansion of the programme. Moreover, while the problems of agricultural production are related to a complex set of factors, the CMSA programme deals only with one dimension, viz. reducing the cost of production. Income earned by farmers depends not only on costs but also on prices received for their produce. In other words, several aspects in the macro economy such as prices for agricultural output, subsidy given for organic farming, credit availability for farmers, extent of research and extension in agriculture, terms of trade between agriculture and industry etc determine agricultural prospects. Given this, any programme that deals only with few dimensions of the overall issue may not be adopted on a large scale by farmers. Therefore, it is crucial that the state adopts suitable policies that would actively promote adoption of sustainable agricultural practices on a large scale by farmers[26]. Implementation of a comprehensive agricultural policy by the state, which focuses on sustainable agricultural practices as well as addresses various related concerns, is the need of the day.

26 Suitable policies will have to cover a range of issues dealing with output prices, input prices, supply of inputs, credit, subsidy, research and extension etc

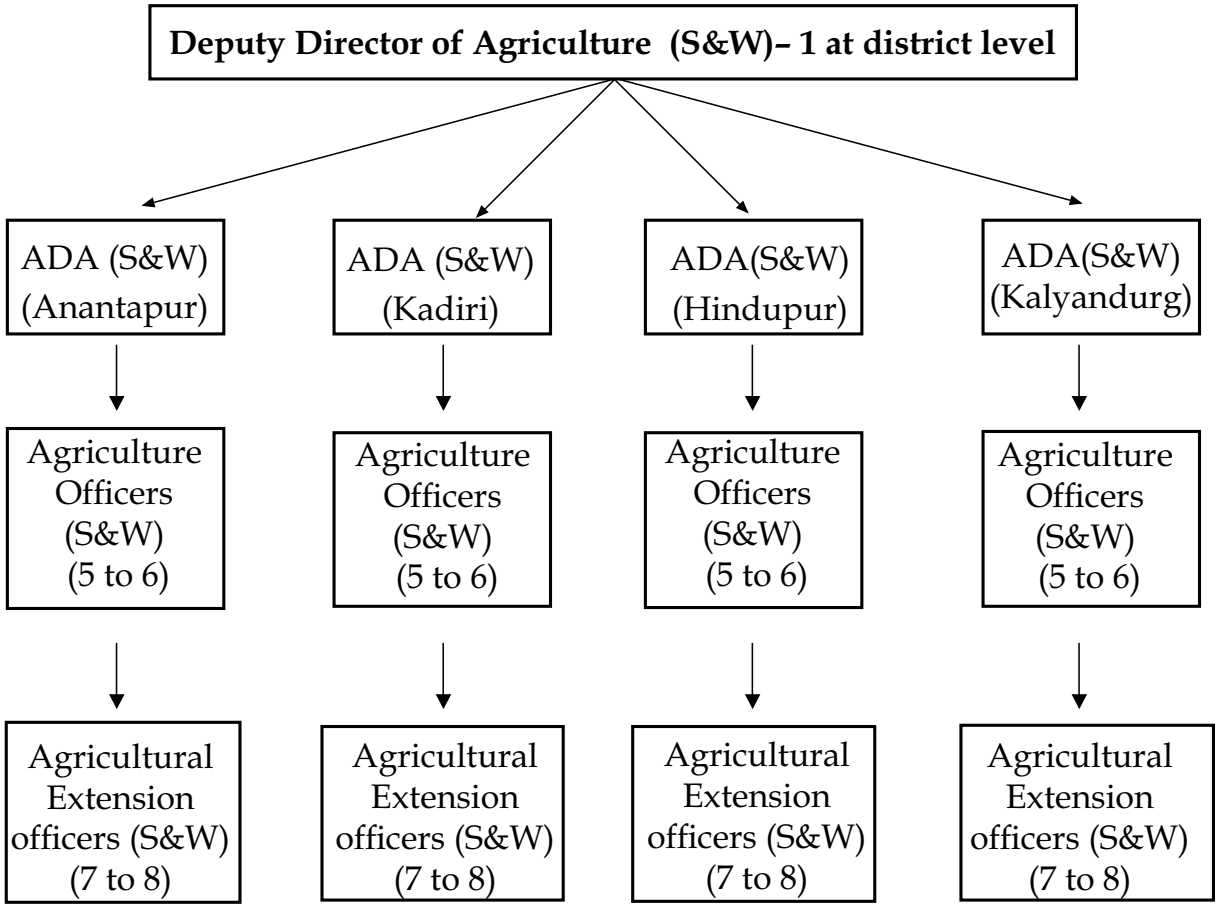
2.3. Soil and Water Conservation

The magnitude of soil and water erosion that happens in Anantapur district calls for massive efforts for conservation of soil and water resources here. The district needs a combination of short, medium, and long-term measures of soil and water conservation and drought proofing(Central Research Institute for Dryland Agriculture, 2002, 2004a, and 2004b). Short-term measures are usually temporary in nature and need to be remade or taken up afresh periodically. Short-term treatments such as contour farming, compartmental bunds, broad bed and furrows, ridge and furrows, conservation furrows, and the practice of mulching are taken up at the individual farmer's field. Medium-term measures include inter-bund treatments and building conventional bunds along the field boundaries. These help in minimising the velocity of surface flow of water on land, and helps retain soil and water. Long-term measures are taken up with the purpose of intercepting runoff, increasing infiltration time of rain water, checking soil erosion, regulating overland flow, and reducing peak flows. While short-term measures are taken up to some extent by individual farmers, the medium- and long-term measures require higher investment and cannot be taken up by individual farmers.

In the district of Anantapur soil and water conservation activities are carried out by District Watershed Management Agency (DWMA), Soil and Water conservation wing of the Department of Agriculture, as well as some non-governmental organisations. Major watershed activities that are carried out by (DWMA) are construction of check dams, farm ponds, and afforestation on endowment lands. As on 2007, 468 watersheds have been completed by DWMA in the district and nearly one-third of geographical area of the district, namely, 605,665 hectare, is treated under watersheds according to data furnished by DWMA. As DWMA is the implementing agency for NREGS, under the *Indiramma Cheruvulu* scheme until 2008, in 749 tanks repair work was undertaken. Some tanks were also converted into percolation tanks.

The watershed activities of Soil and Water Conservation wing are carried out under the National Watershed Development Projects for Rainfed Agriculture scheme (NWDPRA). The Soil and Water Conservation wing of the Department of Agriculture in Anantapur has four divisions comprising of Anantapur, Kadiri, Hindupur, and Kalyandurg. From 1950's till 1985 the department had 1 Deputy Director of Agriculture (S&W) at the district level (Flow Chart 1). Under him there were 4 Assistant Director of Agriculture (S&W) one each for each division. Each

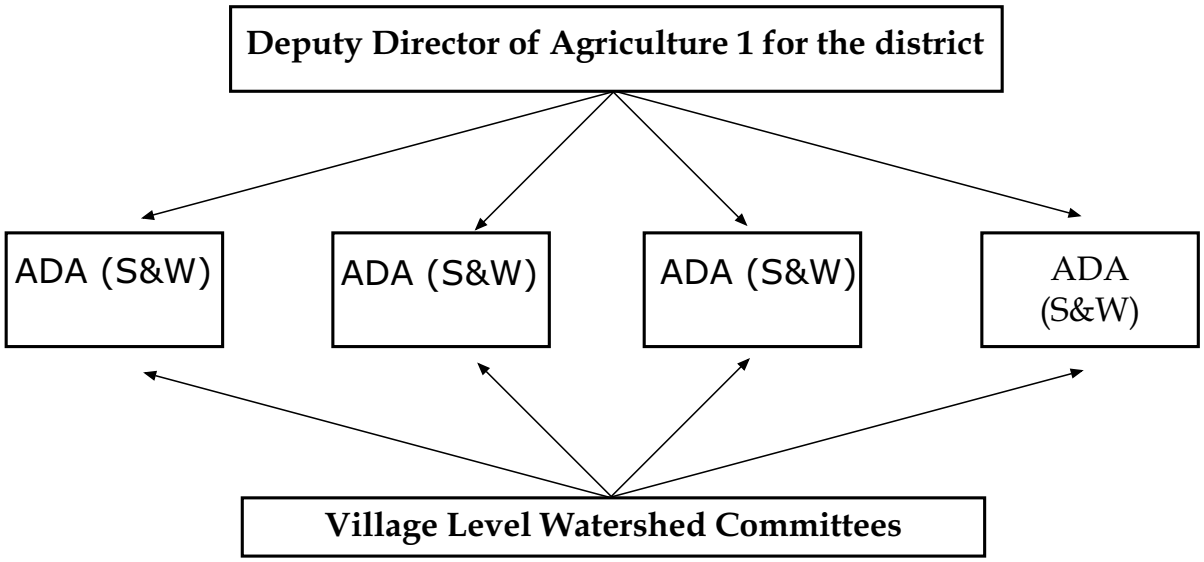
Flow Chart 1. Structure of the Soil and Water Conservation Wing (S&W) of the Department of Agriculture from 1950 till 1985



Assistant Director of Agriculture had 5 to 6 Agricultural Officers (S&W) under him in each division. That is, the district as a whole had 20 to 24 Agricultural Officers looking after the Soil & Water Conservation Works exclusively. Under each Agricultural officer there were 7 to 8 Agricultural Extension Officers who were solely responsible for soil and water conservation works alone. Thus the district had a total of 140 to 192 Agricultural Extension Officers (S&W), working at the village level, whose sole responsibility was to carry out soil and water conservation works.

Post 1985, changes were made in the staff structure dealing with Soil and Water conservation activities (Flow Chart 2). Agricultural Officers (S&W), and Agricultural Extension Officers (S&W) dealing exclusively with S&W conservation were removed. The Soil and Water Conservation Wing of the Department of Agriculture had one Deputy Director of Agriculture (S&W), four Assistant Director of Agriculture (S&W)- one each for the divisions, namely, Anantapur, Kalyandurg,

Flow Chart 2. Structure of the Soil and Water Conservation Wing of the Department of Agriculture Post 1985



Kadiri, and Hindurpur. The Department set up village level Watershed Committees, and it was these committees that came up with the kind of work that need to be carried out in their watersheds. The field level activities were to be carried out by the villagers themselves. The change in staff structure is clear form the following diagrams.

The change in the staff structure had significant implication for the quantum and type of activities undertaken as regards soil and water conservation activities by the Department of Agriculture. Earlier, the department used to take up a lot of activities in the individual famers' fields. They also used to strictly follow the ridge to valley approach of treatment of watersheds. Social forestry and grassland development activities were taken up in the upper reaches. Continuous contour trenching, and graded bunds, check dams, gabion structures, etc were taken up in the middle reaches, and farm ponds, field bunds, & rock fill dams, were taken up in the lower reaches. According to the officials of the Soil & Water conservation Wing of the Department of Agriculture, post 1985, the type of activity taken up and level of activity has come down. This opinion is shared by many knowledgeable persons who are closely following the agricultural development of the district. The ridge to valley approach of treating a watershed is no longer adhered to, and the majority of the work carried out under NWDPRA, by the Soil and Water Conservation Department, in Anantapur post 1985 is construction of low cost structures like field bunds, rock fill dams, and checkdams - essentially lower reach activities. The

total area treated under NWDPRA programme in Anantapur district during the period 1992-2007 is 29,097 hectares. This means that only a mere 1.5% of the total geographical area of the district has been treated under NWDPRA programme over a period of 15 years, starting from 1992. In other words, just about 2000 ha per annum has received soil and water treatment under this programme.

While the change in staff structure pertaining to Soil and Water conservation activities in the Department of Agriculture was brought about as a result of an establishment of a separate agency-DWMA, it is clear that the extent of conservation of soil and water, by various agencies, is lower than what is required. According to data provided by Rural Development Trust, one of the leading NGOs in the district, they have taken up soil and water conservation works on 1,34,500 hectares over a period of 1987 to 2007, which accounts for about 7 per cent of the total geographical area of the district. As regards soil conservation activities in the district, in 2006–07, about 7,460 hectare of lands were covered under various government schemes (GoAP, Various years). That is, at present, less than one percent of the net sown area of the district is covered by soil conservation activities annually.

It is therefore absolutely essential that soil and water conservation activities are undertaken on a mission-mode approach to revive agriculture in Anantapur district. The importance given to these activities are not adequate, considering the magnitude of the problem in the district.

2.4. Irrigation

Just about 11 percent of net sown area in Anantapur district receives irrigation in 2005–06. It is therefore imperative that in addition to the ongoing major and medium irrigation projects, the local irrigation sources are revived. Considering that the survey on water bodies spearheaded by the District Collector in 2004 clearly showed that more than 70 percent of water bodies that existed have fallen under disrepair in the district, it is very important that the state takes on the responsibility of repair and maintenance of water bodies. A massive **programme to repair and restore minor water bodies and tanks** is needed. When detailed planning for repair and maintenance of tanks is attempted, it is important to take note of the following:

- Wherever tanks are not converted into percolation tanks, it is necessary to first desilt the tanks; Along with desiltation of tanks, feeder channels as well as supply channels are to be constructed. This is necessary because there are instances

where check dams have been constructed indiscriminately, obstructing the flow of water in to the tank. Therefore, unless the inlet and outlet channels are both taken care of, tank irrigation can not be revived.

- Wherever tank bunds are breached, strengthening of bunds should be undertaken;

The rapid increase in bore-well irrigation resulted in depletion of ground water levels as well as drying up of open wells in the district. As mentioned earlier, only twelve out of sixty-three *mandals* in Anantapur district are in the 'safe' category with regard to groundwater utilisation. This calls for **stringent regulation** on (a) indiscriminate drilling of bore wells and (b) cultivation of water-intensive crops such as citrus and paddy and instead promote less water-intensive crops such as *ragi.*

2.5. Strengthening the Technology Delivery System

The importance of an effective agricultural extension system in a district like Anantapur, where there are several natural and physical constraints for agricultural growth need no emphasis.

- Many of the sanctioned posts of Agricultural Extension Officers remain vacant in the district. Steps should be taken to **fill up the vacant posts of the Agricultural Extension Officers** who have the mandate to visit the villages and transfer appropriate technologies.
- Our analysis shows that even if all the 139 sanctioned Agricultural Extension Officer posts in the district of Anantapur were filled, it would be far from adequate to meet the specified norm of 1,000 farm families per Agricultural Extension Officer. It is estimated that Anantapur district would require more than 500 Agricultural Extension Officer if every officer is to cater only to 1,000 farm families. Prof Jayati Ghosh in the *Report of the Commission on Farmer's Welfare* notes, 'Andhra Pradesh has far fewer extension workers than states at comparable levels of agricultural development…….There must be a substantial increase in staff devoted to agricultural extension'.(GoAP 2004, p. 67 and 70) With the given sanctioned staff strength in the Department of Agriculture in Anantapur district, the number of villages assigned to an individual Extension Officer is around six to seven while Jayati Ghosh recommends that three villages per extension officer would be an ideal ratio. Efforts are therefore necessary to **increase the total number of sanctioned posts** of the field-level extension staff in the district.

- The ***adarsha ryuthus*** **should only complement the public extension system** and should not be looked upon as a substitute for field-level Extension Officers. Youngsters with aptitude and those meeting the minimum eligibility standards prescribed by the Government should be selected as *Adarsha Ryuthus*.
- Several inappropriate cultivation practices being adopted by farmers, as elaborated in Section 1.8, clearly indicates the need for strengthening the agricultural extension system in the district.

2.6. Village Level Agromet Observatory

Establishment of village level mini agromet observatory will help farmers to take weather-based farm decisions. While in India IMD gives integrated weather forecasts at district level, it can not be applied to the village level. We have observed that even within one village there are variations in rainfall pattern leading to different levels of incidence of peanut stem necrosis disease. Therefore, weather data collected through agromet observatory could be used to recommend some location specific thumb rules in the cultivation practices and also crop pest and disease management in groundnut in Anantapur. Farmers may be selected from each village to be trained as climate managers to run the observatory, interpret the data, and disseminate seasonal advisories.

2.7. Public Expenditure on Agricultural Research and Education

Analysing the plan-expenditure under various heads for the state of Andhra Pradesh over 1990–91 to 2004–05, it is clear that there is an upward shift in the pattern of expenditure on agriculture and allied activities in the recent years (Figure 16). While this is a good sign and is absolutely essential to revive agriculture in the state, it is disturbing to find that within agriculture what is spent on research and education has declined to 2 percent in 2001–02 from 13 percent in 1995–96 (Figure 17). After 2001–02 this percentage has further declined and is lower than 2 percent by 2004–05. This pattern needs to be reversed if we have to move towards a break through in dry land agricultural technology.

Figure 16 Expenditure on Agricultural and Allied Services as a % of Total Plan Expenditure - Andhra Pradesh

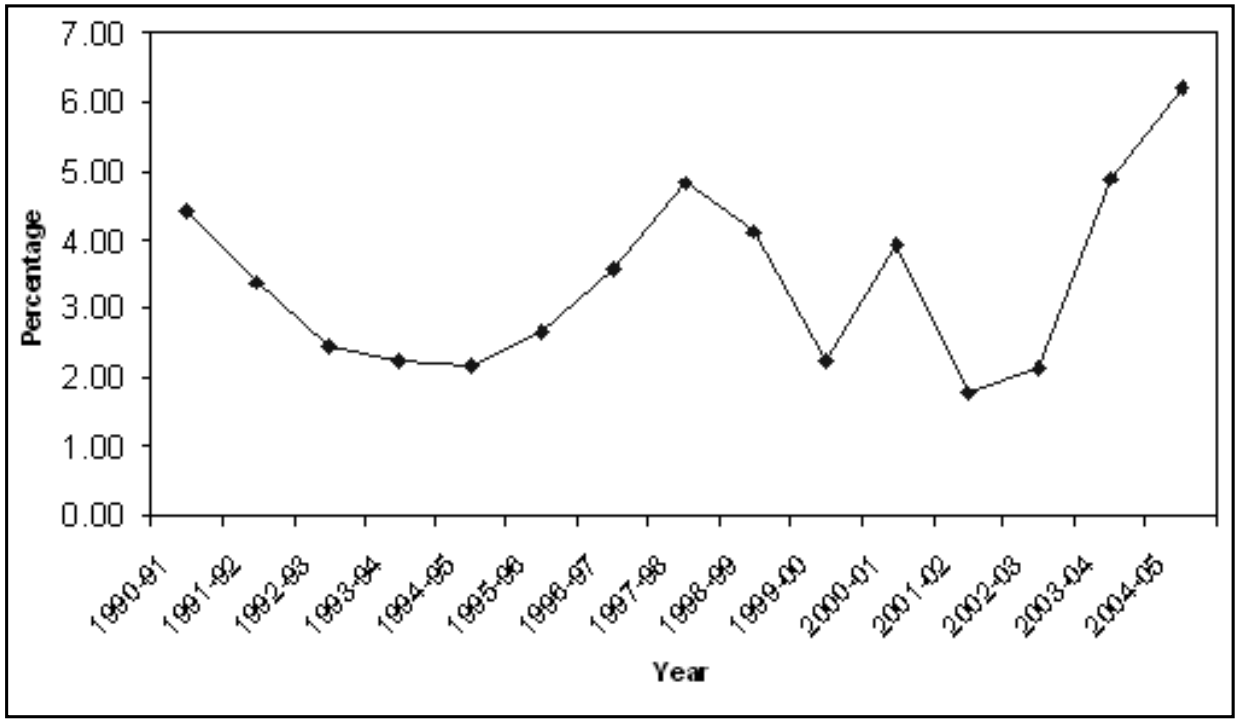
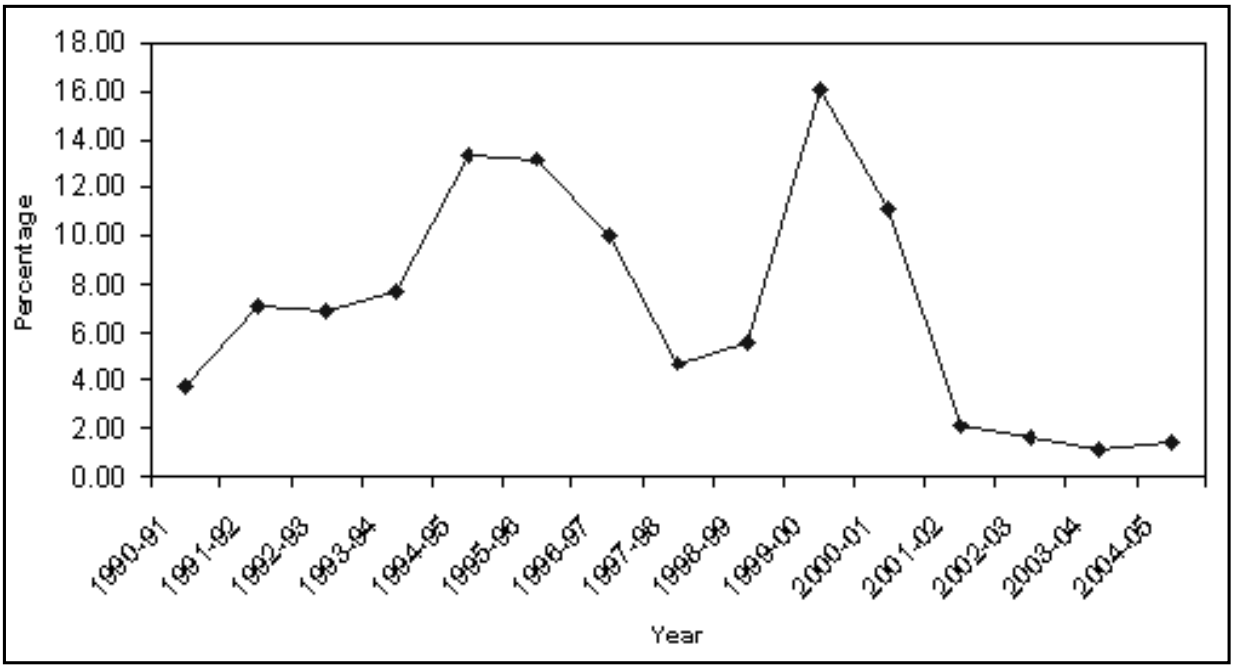


Figure 17 Expenditure on Agricultural Research and Education as a % of Expenditure on Agriculture & Allied Services - Andhra Pradesh



Source: *GoAP various years (a)*

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Annexures

Annexure 1

Survey Villages

Thopudurthi Village

Thopudurthi village falls in Atmakur *mandal* of Anantapur, a *mandal* which receives one of the lowest average annual rainfalls in the district. According to the Census of 2001, the total geographical area of the village is 5,091.86 acres with 552 households and a total population of 2,715 persons. Scheduled castes constitute 15 percent of the total population, and scheduled tribes account for 1 percent of the total population. The village has one scheduled caste settlement and two backward caste settlements.

The nearest town to the village is Anantapur, and it is located 23 km away from the village. The village has basic amenities like power supply for all purposes, agriculture and domestic, three *Anganwadis,* one primary school, two adult literacy centres, a primary health subcentre, a veterinary dispensary, and an agricultural credit society. The village has a post office and a village telephone connection. There are thirteen drinking water borewells and one overhead drinking water tank. The village is connected by bus services and the bus stop is located within the village. The village has good roads.

The village had around seven or eight spring channels during the early 1970s. Each spring channel had lands measuring thirty-five to forty acre in its command. The cropping pattern in the village in the early 1970s consisted of rain-fed groundnut, *sorghum,* and sesame intercropped with a mixed row of red gram, green gram, and cowpea in *kharif.* While in *rabi, sorghum,* pearl millet, and paddy were taken under irrigated condition. These spring channels eventually went dry. The drying up of these spring channels and the erratic rainfall pattern triggered the rampant digging of bore wells in the village. The RCC bore well scheme introduced by former Chief Minister, late Shri N T Rama Rao's Government during the 1980s gave further impetus to this.

At present, the major source of irrigation in the village is ground water. The bore wells in the village are 100–150-feet deep. The major crop growing season in the village is *kharif,* and the major crop taken is rain-fed groundnut intercropped with red gram and cowpea. The ruling variety of groundnut grown in Thopudurthi

village is TMV-2. The other crops taken are irrigated paddy, and to a small extent, irrigated sunflower. The Agricultural Extension Officer visits the village regularly, and there are three *adarsha ryuthus* in the village. Farmers' field school *(polambadi)* is being conducted regularly, and the level of extension activity is of a relatively high order in the village. This is reflected in the better awareness level of the farmers in the village, with regard to the latest schemes, the modern implements of cultivation, and the non-pesticide management strategies like raising of border crops adopted by them.

Thirumaldeverpally Village

Thirumaldeverpally village is located in the Kothacheruvu *mandal* of Anantapur, which receives more than the average annual rainfall of the district. The revenue village Thirumaldeverpally consists of the main village Thirumaldeverpally and the hamlet Mylepally. Thirumaldeverpally has a total geographical area of 1,217.7 acre with 174 households and a total population of 855, according to the census of 2001. Scheduled castes account for 2 percent and Scheduled Tribes account for 20 percent of the total population of the village.

The village is quite remote and the approach road is barely motorable. It is located 2 kms off the Kothacheruvu–Dhamavaram main road. The nearest town Dharmavaram is located 26 km away from the village. The village is about 65 km away from the district headquarters Anantapur. Census 2001 notes that Thirumaldeverpally has three primary schools and one middle school, and two adult literacy centres. The village has power supply for all purposes—agriculture and domestic. The approach to the village consists of mud roads. The village has drinking water facility and there is a hand pump available within the village. The nearest primary health centre is located at a distance of 5–10 kms from the village. There are no credit societies in the nearby vicinity, but there is a commercial bank available within 5–10 kms from the village. The village does not have post and telegraph facility, but there is a telephone connection available for communication. The village has a tank, named Irupanna, and tank water is occasionally available for irrigation.

Currently, the major crop growing season in Thirumaldeverpally village is *kharif* and the major crop raised is rain-fed groundnut. JL-24 is the popular groundnut variety grown in Thirumaldeverpally village. The other major crops in the village are rain-fed pulses such as red gram and irrigated paddy. There was a near absence of any kind of extension activity in the village. The post of the village extension

officer and the *mandal* agricultural officer for the Kothacheruvu *mandal* were vacant even as late as March 2009. The village had 1 *adarsha ryuthu* who resides in the hamlet Mylepally. In the absence of any village extension officer or *mandal* agricultural officer there was dearth of information flow form the Department of Agriculture to the farmers. There was no farmers' field school being conducted. The near absence of the extension activity is reflected in the low awareness level of these farmers with regard to modern simple implements used in cultivation, and in their erroneous practices such as growing the alternate host plant of a major virus, tobacco streak ilavirus, that is attacking the groundnut plant, as a border crop in the groundnut field etc.

Annexure 2

Checklist used for Farmers Interview in Villages in Anantapur District

- **Basic Details of Households**

  No of members, age, occupation, literacy level etc.

- **Details of Operational Holding (OH)**
  - Details of land owned, leased in , leased out
  - Number of parcels in which the OH is distributed
  - The category of soil on their OH. (Red/Black)
- **Livestock Details**
  - Number of bullocks/cows/buffaloes/calves
  - Details of livestock maintenance
  - Source of livestock feed (husk/crop residue/straw/natural grazing)
  - Method of animal dung collection and storage
  - Details of milk production and usage/sale of milk
- **Details of Farm Implements and Machines Owned**
- **Crop Details**
  - Cropping pattern
  - Acreage under each crop
- **Cultivation Practice / Agronomic Practice under Major Crops**
  - **Land Preparation**
    - Time of land preparation (month , before /after the receipt of howers)
    - Method of land preparation (number /depth of ploughing and no of harrowing)
    - Power used for ploughing (bullock/tractor)
    - Amount and method of FYM application
  - **Sowing**
    - Variety of seed sown
    - Time of sowing (after/before first shower)
    - Method of sowing (seed drill/hand dibbling)

- Seed rate
- Spacing

- **Intercropping**
  - Crop taken as intercrop
  - Seed rate
  - Intercrop ratio
- **Nutrient Management**
  - Name of fertilisers
  - Quantity of fertilisers
  - Method of application
  - Time of application
- **Weed Management**
  - Type of weed management (manual/chemical**)**
  - Number of harrowing done before/after weeding operation
  - Name of weedicide/herbicide (in the case of chemical weeding)
  - Quantity of herbicide used
  - Time of application
  - Dilution ratio
  - Method of application
- **Pest and Disease Management**
  - Name of pesticide used
  - The disease/pest for which it was used
  - Quantity of pesticide used
  - Dilution rate
  - Number of rounds of pesticide spray
  - Time of application of the pesticide spray

- **Irrigation Details**
  - Time/stage of growth of plant when irrigation given
  - Number of wettings given
  - Interval between two wettings
- **Harvesting**
  - Time of harvesting
  - Method of harvesting
  - Use of machinery in harvesting
  - Post-harvest handling of produce (transport and storage from the field)
  - Yield of the main produce / acre
  - Time of harvesting of the intercrop
  - Yield of the intercrop

- **Marketing**
  - Knowledge on price (fellow farmers / newspapers /APMC markets)
  - Details of the decision-making process for selling
  - The quantity to be sold
  - The process of choosing the buyer for the produce
  - Deciding the place of transaction (Selling to private traders outside the village/APMC market/ selling to private traders who comes to the village to collect the produce)
  - Quantity of intercrop set aside as marketable surplus
  - Price at which the produce is sold
  - Price at which the intercrop produce is sold
- **Farmer's perception of the level of agricultural extension activity in the villages**
- **Benefits the farmer accrued from the Government Packages / Schemes**
  - The kind of benefit accrued (subsidised seeds / compost pit / cart etc)
- **Any other remarks**

Annexure 3

Basic Details of Farmers Interviewed in Anantapur District

General Profile of Farmers of Thopudurthi Village				
Name of Farmer	**Size of operational holding (in acre)**	**Number of Borewell**	**Details of cropping pattern (2008–09)**	**Type of soil**
Farmer 1	**2.5**	None	Main Crop: Groundnut. Intercrop: red gram & bajra. Border Crop: Bajra.	Red soil.
Farmer 2	**2.5**	None	Main Crop: Groundnut. Intercrop: Red gram & cowpea.	Red soil
Farmer 3	**10**	None	On Own land: Main crop: Groundnut. Intercrop: redgram + cowpea+ castor+ green gram. Border crop: Jowar. On leased-in land: Main crop: Groundnut. Intercrop: red gram. Border crop: Jowar.	Red soil
Farmer 4	**5**		Main Crop: Groundnut. Intercrop: Red gram	Red soil
Farmer 5	**5.24**	None	Main Crop: Groundnut. Intercrop: Red gram, cowpea, & castor.	Red soil
Farmer 6	**7**	None	Main crop: Groundnut. Intercrop: Red gram.	Red soil.

Source: *Field Survey, Thopudurthi Village, January 2009*

General Profile of Farmers of Thopudurthi Village				
Name of Farmer	**Size of operational holding (in acre)**	**Number of Borewell**	**Details of cropping pattern (2008–09)**	**Type of soil**
Farmer 7	**7.22**	1	On 5.22 acre plot: Main crop: Groundnut. Intercrop: red gram & green gram.On 2 acres plot: Kharif: Ragi-1/2 acre, sunflower-1/2 acre, groundnut-1acre. Rabi: paddy-1 acre.	5.22 acres red soil. 2 acres black soil.
Farmer 8	**10.4**	1	On dry land: Main Crop: Groundnut. Intercrop: Red gram & cowpea mixed row. On Wet land: Paddy.	10 acres red soil. 40 cents black soil.
Farmer 9	**11**	1	Citrus-2 acres. Kharif: Groundnut – 6 acres, 1-acre paddy. Intercrop: red gram, castor, cowpea. Rabi: Groundnut-2 fodder jowar-3 acre, paddy-1acre, wheat - 10 cents.	Red soil & Black soil.
Farmer 10	**15**	2	On 4.70, 3,3, & 2 acres: Main crop: Groundnut. Intercrop: redgram & castor. On 2.5 acres plot: Kharif: Paddy-1 acre, Sunflower-1.5 acre. Rabi: Paddy-1 acre.	12.70 acres Red soil & 2.5 acre plot Black soil.
Farmer 11	**23.5**	1	On 20 acres. Main Crop: Groundnut. Intercrop: Red gram. On 3.5 acres. Kharif: Paddy. Rabi: Paddy.	20 acres Red soi. 3.5 acres Black soil.

Source: *Field Survey, Thopudurthi Village. January 2009.*

General Profile of the Farmers in Thirumaldeverpally Village				
Name of Farmer	**Size of operational holding (in acre)**	**Number of Borewell**	**Details of cropping pattern (2008–09)**	**Type of Soil**
Farmer 1	**2**	None	Main Crop: Groundnut. Intercrop: Red gram & cowpea	Red soil
Farmer 2	**2**	None	Main Crop: Groundnut. Intercrop: Red gram & cowpea	Red soil
Farmer 3	**2**	None	Main Crop: Groundnut. Intercrop: Red gram. Border Crop: cowpea	Red soil
Farmer 4	**2**	None	Main crop: Groundnut. Intercrop: Red gram. Border crop: Cowpea & green gram	2 acre red soil. 1 acre black soil
Farmer 5	**2**	1 In-well bore	Main Crop: Groundnut. Intercrop: Red gram. Border crop: Jowar, cowpea & green gram. Jasmine	1.72 acres red soil. 0.28 cents black soil (tank command)
Farmer 6	**4**	1	On 3 acre plot, Main Crop: Groundnut. Intercrop: Red gram. Border crop: Jowar & cowpea. On 1 acre plot: Paddy.	
Farmer 7	**4.2**	1	Groundnut is sown in between the mango sapling rows in both kharif and rabi.	3.2 acres of black soil. 3 acres of red soil

Source: *Field Survey, Thirumaldeverpally Village, February 2009*

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