ClimaAdapt

Situation Analysis

Andhra Pradesh

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NORWEGIAN EMBASSY

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1 Section I: Background and Introduction

1.1 Introduction

Numerous studies over past decade conclude that the impacts of climate change are beginning to manifest on a global scale and particularly developing countries are relatively more vulnerable than the developed nations. These calls for putting in place mechanisms systematically to ensure / build resilience of the exposed and reduce vulnerability to tackle the challenges posed by climate change and climate variability and sustain the momentum of national development especially of the developing nations. In view of this the primary objective of ClimaAdapt is to improve the resilience of the agriculture and water sectors in the state of Andhra Pradesh through implementation of select adaptation measures, develop methodologies for up scaling of the adaptation and mitigation strategies and capacity building of local stakeholders and agencies involved in climate change adaptation. The program will directly provide inputs to the state climate change adaptation frameworks (specifically to agriculture and water sectors) through a consultative process involving all relevant stakeholders (including state government and their respective agencies, institutions, departments, and non-government organizations, where appropriate). The project will use the Stakeholder Advisory Committee to channel the knowledge and experience gained by ClimaAdapt into the state system which further can be used for arriving at suitable policy and decisions on climate change adaptation.

The project aims to demonstrate selected adaptation measures, build capacity of stakeholders and provide frameworks to upscale various adaptation strategies in Andhra Pradesh. The project areas are located in the Krishna Basin which is known for its rice, cotton and chilly production under irrigated conditions. Two districts namely, Guntur and Nalgonda are the target districts for implementing selected key adaptation measures at systematic level, developing methodologies for up scaling adaptation measures.

1.2 Objectives of the study

The main objective of the present study is to: (i) evaluate the various climate change adaptation programs implemented in the project area so as to provide the evidence-based policy direction for integrating the available research in designing the future adaptation strategies, (ii) draw policy lessons from the analysis after identifying the gaps and priority areas within the selected sectors and (iii) develop baseline indicators and
(iv) select a range of adaptation options for pilot testing in the study area.

1.3 Methodology and the Setting

To meet the objectives the present study undertook a detailed situation analysis with an aim to provide the status report of the project area. Besides this a key list of indicators were identified that will be used to to measure the ClimaAdapt project outcomes, uptake and

spread of the interventions by the targeted communities in the study regions. In this context, it is important that the project interventions must enhance the adaptive capacity of the farmers, improve the nutrient and water use efficiencies in the project areas by minimizing the use of fossil fuel dependent agro inputs, besides contributing to the reduction of the emission of green house gases from agro-ecosystem. Hence adaptation technologies in rice and other crops that enhance the water and nutrient use efficiencies, reduce green house gases like methane and nitrous oxide from agro eco systems, minimize chemical input usage, build up organic matter content of the soil etc have been identified and suggested for promotion in the project area. The increased adoption of theselected technologies in the project areawould provide an indication of the improvement of adaptive capacity and resilience of the farmers residing in the basin which in turn will contribute to their overall welfare and well being. Accordingly the indicators for the project areas would fall into six broad categories: (i) spread and uptake of the selected adaptation technologies, (ii) increased nutrient and water use efficiency, (iii) improved awareness and farmers adaptive capacity, (iv) (v) socioeconomic indicators, (vi) (vii) environmental and (viii) increased awareness and mainstreaming of gender issues. The proxies used to measure the indicators along with the units used are described in detail in section four of the report. The data for the situation analysis is drawn from both secondary as well as primary sources. Figure 1 given below sums up the study areas for the project.

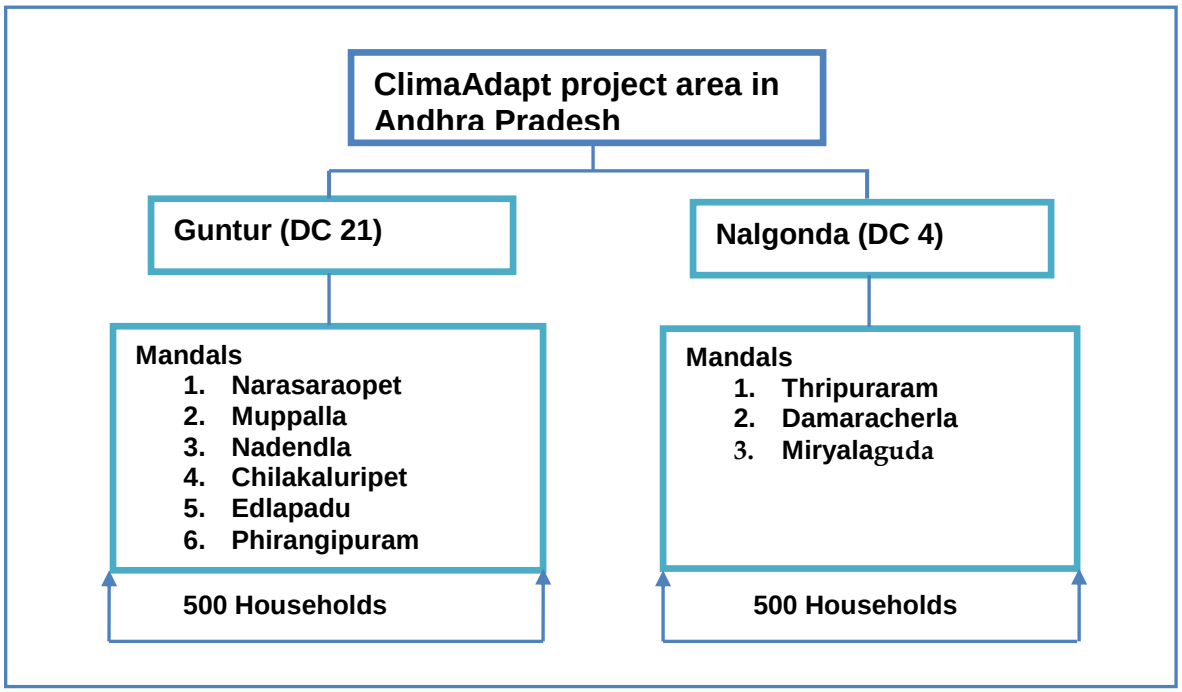


Figure 1: Project areas of ClimaAdapt in Andhra Pradesh

To develop a data base consisting of personal, socio economic and agriculture relateddetails of the farmers in the basin and also to analyze the impact of climate change on farmers' livelihoods and to know how farmers perceive Climate change, interviews were carried out with farmers through structured questionnaires. This is supplemented with inputs drawn from focused group discussions (FGDs), interviews and exploratory visits to the study area and results from earlier projects. For conducting the primary survey, households were chosen from the left and right command areas of the Nagarjuna Sagar reservoir. Around 1000 households in Andhra Pradesh were surveyed as a part of the household surveys out of

which 500 belonged to the Guntur district and the rest 500 belonged to the Nalgonda district. Two FGDs were conducted in the study regions of Andhra Pradesh. These FGDs were conducted through open-ended questions with a minimum of 25 persons in each of these meetings. The thematic components of these FGDs are (i) Climate change perceptions of the local communities, (ii) Capital stock in agriculture (iii) Non-reproducible tangible assets (iv) Existing practices/ traditional methods used to face extreme weather events, (v) Interventions from government and nongovernmental organizations in risk reduction, (vi) Gaps in the existing programs, (vii) Capacity building needs and (viii) Local issues challenging the current agriculture. To sum up the following is the list of data sources for undertaking the analysis for the present study:

- Demographic and agricultural profile from Journals, Books and Reports
- Discussions with Public and private sector officials associated with Agricultural and water resources management
- Temporal data from weather stations
- Focus group Discussions (FGDs)
- Structured Questionnaire to assess perceptions on climate change, socio-economic details, impacts on farming etc.
- Inputs from Climarice 2 project

Further, based on the questionnaires and discussions, a list of project interventions were identified for the study regions. The relevance to the proposed interventions in terms of benefits for the households adopting them also was documented. In view of this a set of indicators were identified for evaluating the effectiveness of the identified project interventions and the overall welfare of the households due to these interventions. However, it should be noted that the results presented in the subsequent sections were derived from the ongoing surveys in the study regions and hence there are some limitations associated with survey data. However, the experience of partners from earlier projects in the region helped to address limitations to a large extent.

2 Section II: Situation Analysis in Andhra Pradesh

2.1 Introduction

As described in the introduction the study areas of ClimaAdapt are located in the Krishna Basin of Andhra Pradesh. Two districts namely, Guntur and Nalgonda are the target districts for implementing selected key adaptation measures at systematic level, developing methodologies for up scaling adaptation measures. This section describes in detail the findings that emerged from the secondary and primary data analysis in the study regions of Andhra Pradesh. As described in the preceding section the study area for the ClimaAdapt project in Andhra Pradesh is spread over two districts: (i) Guntur (DC-21) and (ii) Nalgonda (DC-4). Figure 2 shows the location of the study regions in the state of Andhra Pradesh. First we describe the findings that emerge from the secondary data analysis undertaken for the study sites. The analysis of primary data is represented through a comparison between the two study sites in Andhra Pradesh and is described in subsequent section.

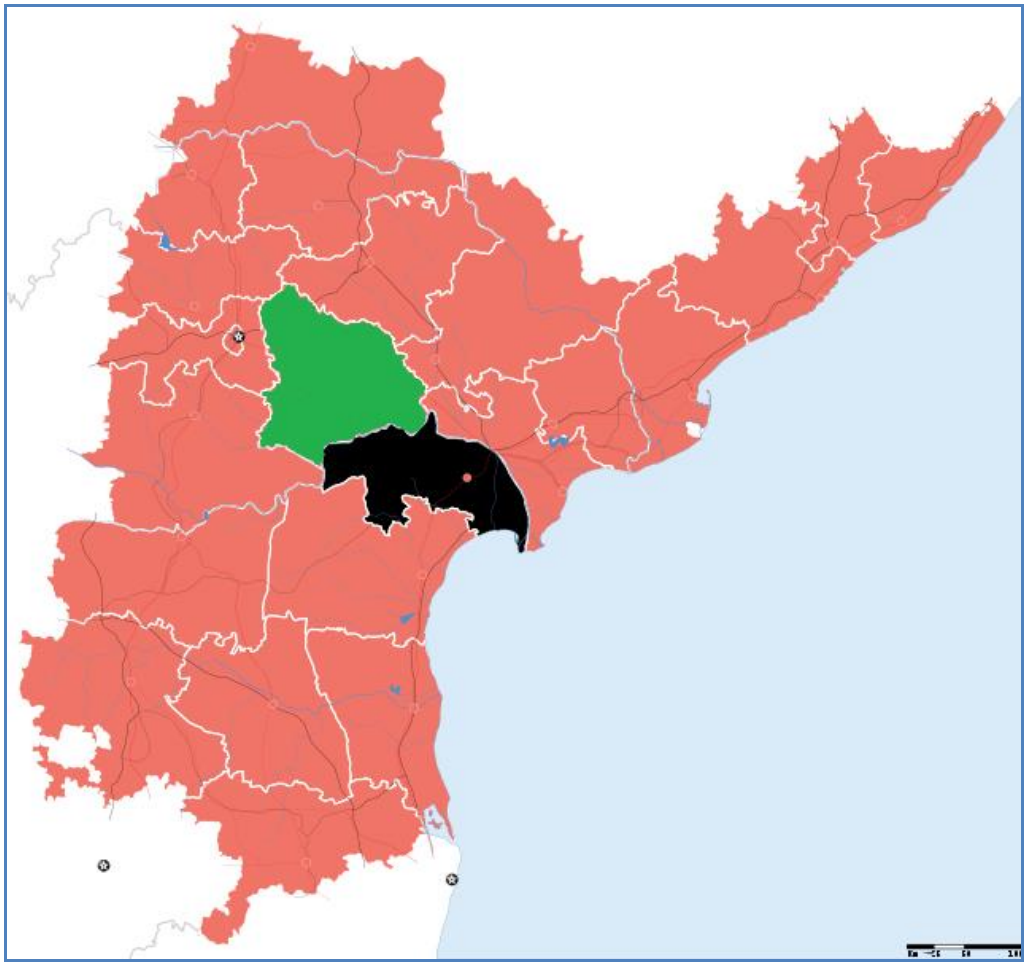


Figure 2: Map of Andhra Pradesh showing the project areas of ClimaAdapt (Black color – Guntur, Green color – Nalgonda)

2.2 Project area

Guntur and Nalgonda district are spread over an area of 11,391 sq. km and 14,200 sq. km. respectively, and have a population of 11, 58,376 and 34,83,648 of which 28.80% and 13.32% is urbanized respectively as per the 2011 census. The Krishna river flows in both the districts. Guntur is divided into 57 mandals (Administrative units) whereas Nalgonda has 59 mandals. Paddy, tobacco, cotton and chillies are the main crops cultivated in Guntur district whereas in Nalgonda the main crops are paddy, pulses, millets and oil seeds. The majority of the cultivated area is irrigated using both canal and ground water. Guntur is one of the largest producers of cotton and chillies in the country. It is also one of the districts having the highest per acre use of pesticides in the country.

The mandals chosen for the situation analysis are Narasaraopet, Muppalla, Nadendla, Chilakaluripet, Edlapadu and Phirangipuram in Guntur district and Thripuraram, Damaracherla and Miryalaguda in Nalgonda district. As per provisional reports of Census of India, population of study area mandals in Guntur in 2011 is 5, 40,641; out of which males and females make 50.31% and 49.68% populations respectively.

2.3 Water User Associations

Water user associations (WUAs) are one of the main end user groups that ClimaAdapt will work with, hence it was important to look at their constitution and role. The Andhra Pradesh Farmers' Management of Irrigation Systems (APFMIS) Act, enacted in 1997, provided the basis for the introduction of Participatory irrigation Management (PIM) and constitution of WUAs as Farmers' Organizations in Andhra Pradesh. The legal framework created out of the APFMIS Act resulted in creation of farmers' organizations at different levels of irrigation system. They were (i) Water Users' Association (WUA): A delineated command area on a hydraulic basis covering a group of outlets or a minor and (ii) Distributary Committee (DC), comprising five or more WUAs. All the presidents of WUAs represented general body of the distributary committee. (iii) Project Committee (PC): An apex committee of the irrigation system and Presidents of the distributary committees in the project area constituted general body of this committee.

The WUA in a major irrigation project is constituted of 12 Territorial Constituencies and hence the Managing Committee has 12 members. 9 WUAs in Guntur district and 5 WUAs in Nalgonda district are chosen as study regions under NSRC (Nagarjunasagar Right Canal) and NSLC (Nagarjunasagar Left Canal) projects respectively. One of the most important functions of WUAs is water regulation, distribution and management. WUA members call for general body meetings (GBMs) of all the water users of the villages representing head, middle and tail end command areas. In the presence of I&CAD (Irrigation & Command Area Development) officials, the General Body Meeting (GBM) mostly discusses and decide the quantity of water available and the crop rotation. All important decisions on water regulations and allocations were being discussed in the presence of all WUA members, I&CAD officials.

However, discrepancies were observed on the functions of WUAs on water distribution and management and actual practice.

By this way of PIM, area under irrigation has been increased. Scheduled water release brought more paddy fields under irrigation for same amount of water. WUA plays major role in technology adoption by releasing timely the required quantity of water (*PIM in AP, Planning Commission*). However representation of women as water users had been observed very less (nearly 10%). There has been negligible ratio of women to men in Managing Committees. Still there is a good enthusiasm among women in participating GBMs. Following interventions are emphasized this way to enhance water management for better crop productivity and socio-economic status of farmers. The points sum up the Interventions through WUA functionalities:

- Stakeholder participation in managing the diversification of water resources
- Bringing in the support of local bodies at right stages
- Meeting the adequate irrigation needs of crop during its critical stages of growth
- Crop based irrigation scheduling based on I&CAD department's mandate
- Participation of women with voting rights in irrigation management
- Membership of women in managing committees

Participatory Irrigation Management in Andhra Pradesh is embodied through Water User Associations (WUAs) and WUA 167-175 fall under study region in Guntur. In the second study area (Nalgonda), population of study area mandals in 2011 is around 2, 65,455; of which males and females are 1,35,549 and 1,29,906 respectively. WUA 23- 27 come under study area mandals in Nalgonda district. Each of these WUAs are divided into 12 constituencies, made by villages as primary units. The following sections describe the profile of Nalgonda district.

2.4 Guntur District

Guntur district has a geographical area of 11,328 sq.kms and falls between Latitudes 15^{o} 44'& 16^{o} 47'North and Longitudes 79^{o}10'& 80^{o}55'East and is one of the Central coastal districts of Andhra Pradesh. It comprises 57 mandals under administrative control of 3 divisions namely Narasaraopet, Guntur and Tenali. The annual minimum and maximum temperatures are 15°C and 47°C respectively. The annual normal rainfall (normal based on 1961-1990) received by the district is 815 mm. Southwest which is spread over the period between June to September contributes 69% and northeast monsoons (from October to December) contributes 30% rainfall. Rest of the rainfall is received during winter and summer months. Mainly Krishna and Gundlakamma rivers with its important tributaries drain the district. Figure 2 shows the location of study area in Guntur district.

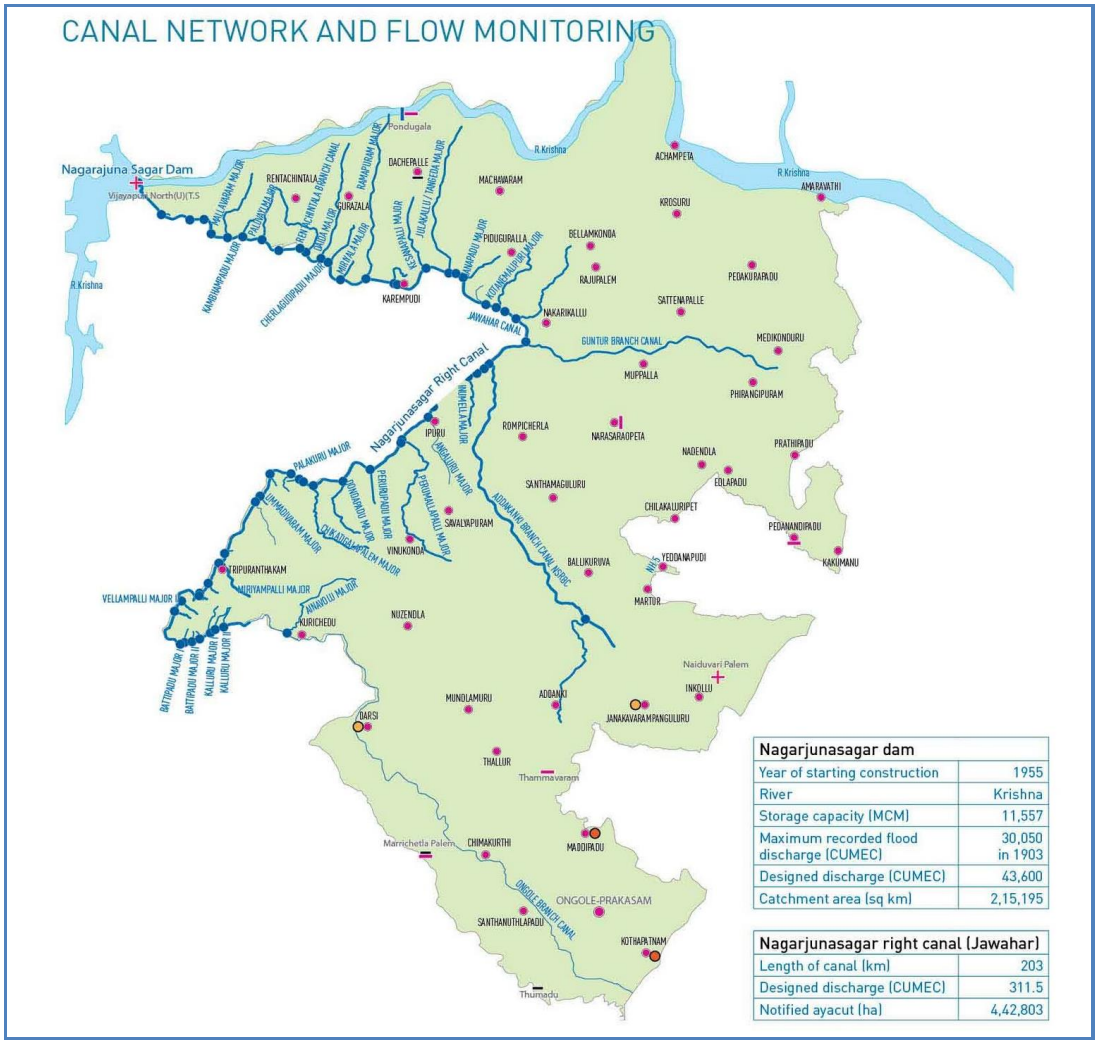


Figure 3: Nagarujunasagar Right canal network and flow monitoring

Figure 4: Study areas in Guntur (23- Muppalla,24- Phirangipuram, 37- Edlapadu, 38- Nadendla, 39- Narasaraopeta, 45- Chilakaluripet)

Rain storms and hurricanes are common in the Guntur region during the rainy season, which starts with the arrival of monsoons in early June. The hurricanes occur commonly between May and November. Guntur is recognized internationally for its chillies, cotton and tobacco.

2.4.1 Soils in Guntur

Major Soils	Area ('000 ha)	Percent (%) of total
Black Cotton Soils	491	72
Red Soils	116	17
Coastal Sandy Soils	61	9
Alluvial Soils	14	2

2.4.2 Rainfall

The district has one Indian Meteorological Observatory (IMD) at Rentachintala, and there are over 40 rain gauge stations in the district. The annual rainfall in the mandals under study has been given in the Figure 5.

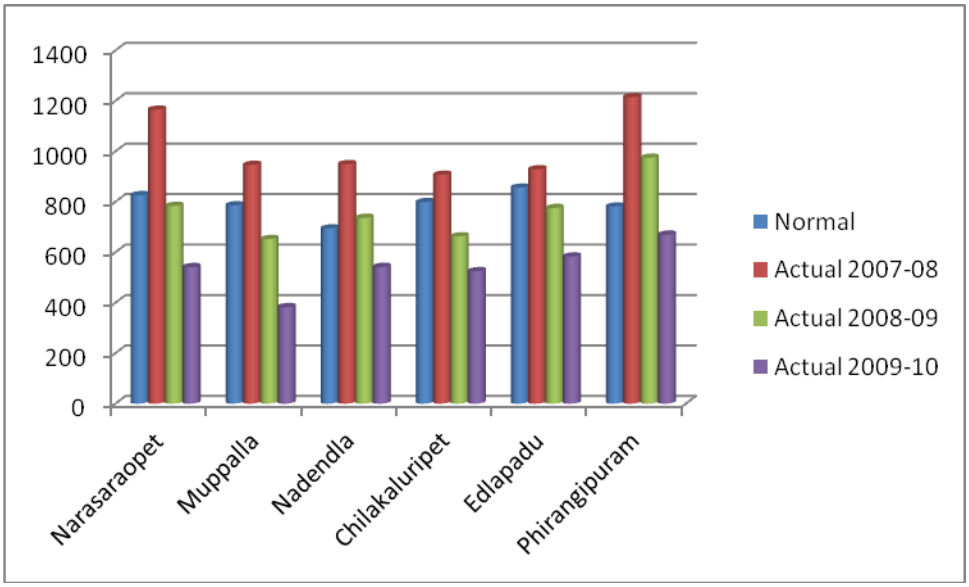


Figure 5: Annual rainfall station wise for mandals in Guntur
Source: Hand book of statistics, Chief Planning Officer, Guntur

The normal rainfall received in the district is 815 mm. The rainfall gradually increases from western part to the eastern part of the district and towards the seacoast in the order of 650 mm to 950 mm. Major portion of the rainfall in the district is received during the south west monsoon between June and September, which contributes about 69% (562 mm) of the annual rainfall and 30% (244 mm) is received during the northeast monsoon (October to December) and summer period. The entire district shows a general annual fall in water table in the range of 0 to 3.0m during the pre-monsoon which can be attributed to the stoppage of canal water in addition to the pre-monsoon ground water withdrawal. This process is entirely reversed with the onset of monsoon and supply of canal water, as revealed by the rise in

water table upto 2.0 m. The rise and fall is recurring and within 0 to 2.0 meter in the areas near to the Nagarjunasagar Right Canal and its branch canals, contrary to the sharp and extreme rise and fall observed in the tail end areas of Nagarjunasagar Right Canal Command Area.

2.4.3 Sources of Irrigation

Guntur district has been gifted with the vast surface and ground water resources. About 356000 ha area is irrigated by canals and has ground water resources of 363000 ham (hectare metres). However the failure of rainfall over successive years since 2001 has resulted in depletion in ground water resources as well as canal water supply for irrigation. This has greatly affected the agricultural production. The supply of spurious seeds, insecticides and fertilizers has further contributed to the failure of the crops. It is reported that around 60 farmers belonging to 29 mandals have committed suicides because of great loses they have incurred in farming over the consecutive years (CGWB, GWI Guntur). It is reported that majority of the affected farmers are those who were engaged in cash crops like chilli, cotton and tobacco forming. Table 1 below shows the details of the major and the minor sources of irrigation in the district.

Table 1: Major and Minor sources of irrigation in Guntur (Area in Hectare)

Major/medium	Name of the project	Registered Ayacut	Actual area irrigated
Major	K.W.D.	202036	173788
	N.S.P. Right Canal	267000	172000
Medium	Guntur Channel	10931	10540

The district has 2 major and 1 medium irrigation projects: the Nagarjunasagar Right Bank Canal Command (NSRCCA), Krishna Western Delta (KWD) Canal System and Guntur Channels Scheme. The total area irrigated by all sources in the district is 4,30,806 ha which works out to be 23.33% of the total area of the district. Out of this about 3,56,328 ha (82.71%) is irrigated through canal network and 1.94% through lift irrigation. 14% area is irrigated through tube wells and filter points and the rest 1.35% area is irrigated through Tanks and other sources. Figure 6 below shows the minor sources of irrigation in the mandals of the study area.

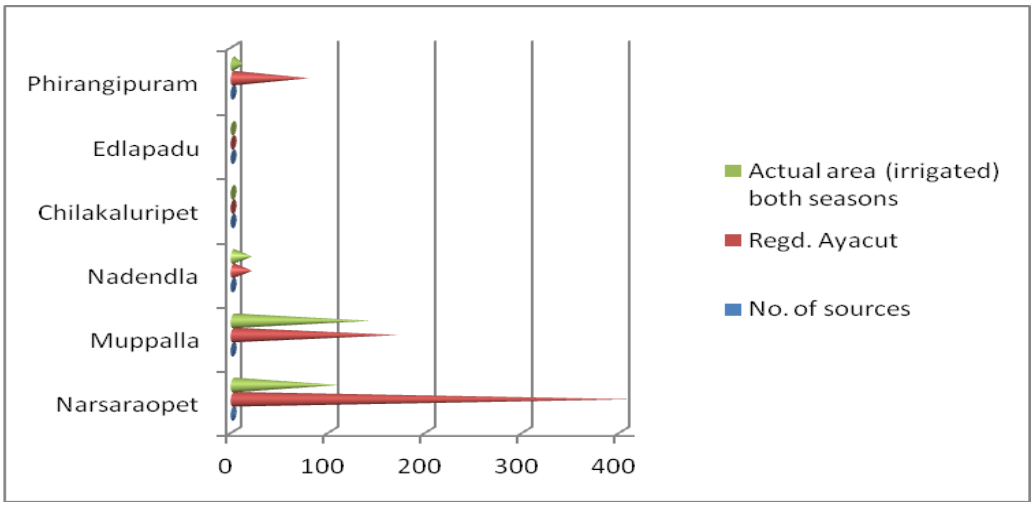


Figure 6: Minor irrigation sources 2009-10 (area in ha)
Source: Hand book of statistics, Chief Planning Officer, Guntur

2.4.4 Cropping Pattern

The major crops grown in the study regions are paddy, chilli, cotton, red gram, black gram, among pulses, cereals like jowar and maize, sorghum, jute, fodder grass, subabul and commercial crops like turmeric, guar gum. Though paddy is always listed first in the predominant crops, Cotton is grown in large area compared to Paddy as observed from the figure and further attested by the analysis of primary survey results. Still in Muppalla and Narsaraopet, lands under Paddy cultivation are more. The details are presented in Figure 7.

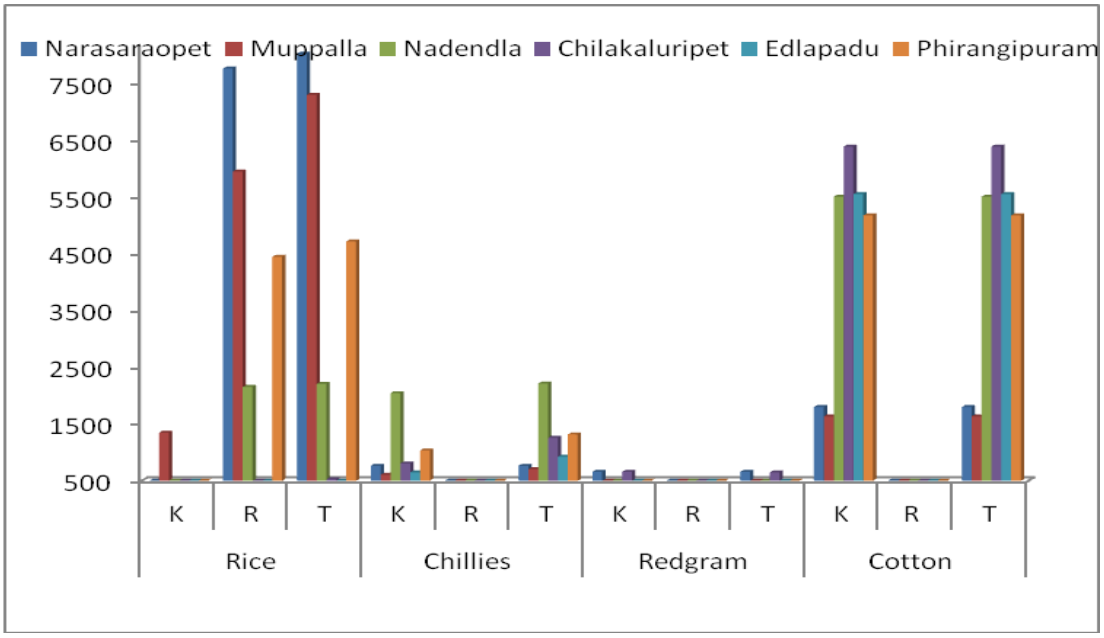


Figure 7: Area under principal crops, season wise (in acres)
K: Kharif ; R: rabi ; T : total

In view of this, more interventions considering cotton as major crop have to be implemented through Capacity Building programs.

2.4.5 Land Holdings

The majority of farmers in the study area are the small and the marginal farmers. The share of semi medium farmers is lower as compared to the marginal and small farmers. Similarly the medium and large farmers are even fewer across all the mandals of the study area in this district. Figure 8 below shows the distribution of the farmers in the study area mandals according to their land holdings.

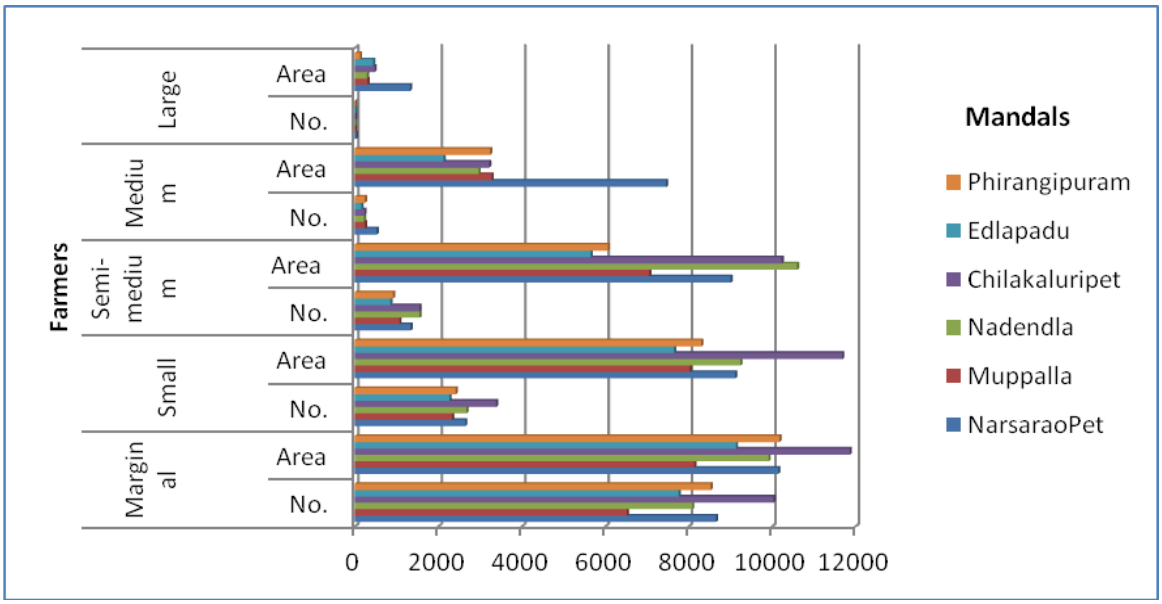


Figure 8: Category wise land Holdings 2005 census (in acres) in Guntur

2.4.6 Consumption of Chemical Fertilizers

Farmers go for indiscriminate use of chemical fertilizers, which has a lasting impact on the crop, on consumers' health and on soil fertility in the long run. Use of fertilizers in agriculture is recognized as a potential source of water pollution. High Nitrate -Nitrogen (NO_3-N) concentrations found in surface and ground water is currently receiving attention. A certain portion of (NO_3-N) pollution comes from the use of agricultural fertilizers which can enter directly from the fields into the streams or underground sources. Fertilizer consumption metrics of the study regions have been given in Figure 9 which indicates the extensive usage of fertilizers in Muppalla mandal with respect to gross cropped area and Edlapadu.

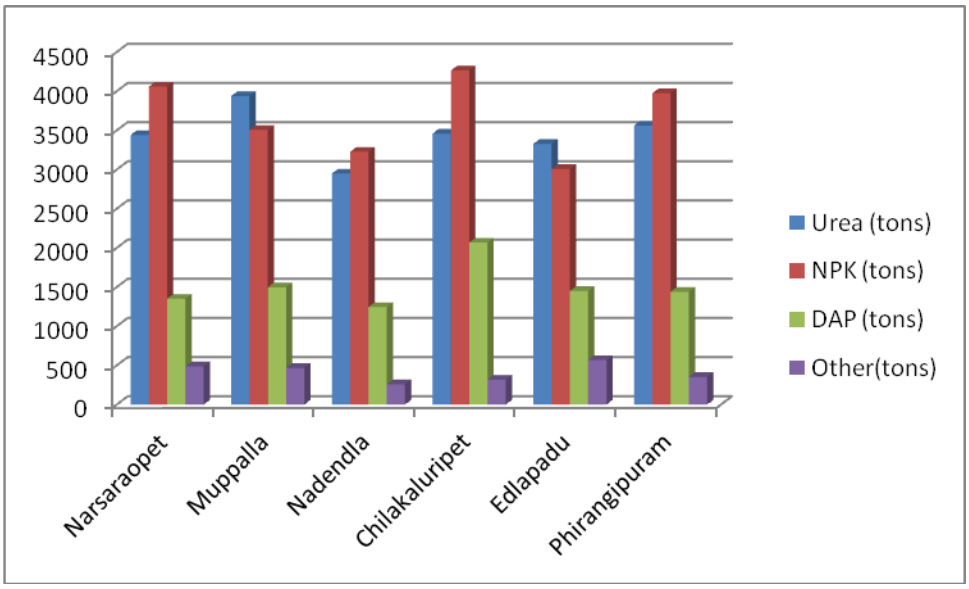


Figure 9: Fertilizer consumption across mandals in Guntur
Source: Hand book of statistics, Chief Planning Officer, Guntur

From the above figures it was found that the consumption of fertilizers is in the quantitatively higher and therefore villages in the mandals could be sensitized for substantiation on cost effective green manure production and application.

2.4.7 Livestock and Poultry

One of the purpose of situation analysis is to provide also an indication of the status of agriculture and the multiple impacts on the key resources like water, fisheries, agricultural and horticultural crops, livestock etc., that contribute to the food security of the region. In view of this table 2 shows the population of different livestock in the mandals of Guntur.

Table 2: Distribution of Livestock in mandals of Guntur

Mandals	Cattle	Buffaloes	Sheep	Goats	Pigs	Poultry
Narsaraopet	1838	12811	16659	2173	301	647762
Muppalla	1162	13253	5504	1007	43	144625
Nadendla	1243	8855	12310	787	172	20877
Chilakaluripet	4312	16086	17250	1632	310	333350
Edlapadu	1154	5368	9673	3906	561	194490
Phirangipuram	3654	6925	12107	2290	508	21834

It is found that mixed crop and livestock farming systems is the system of livestock rearing practiced by the peasants in this region. These systems closely complement each other with animals providing energy for crops and fields in the form of draft animal power and manure and in turn getting their nutrition and energy from agricultural wastes and by products. From the latest livestock census (2007), each mandal has been recorded with higher population of

one or the other livestock though not with all as listed in the Table 6. It has been observed that poultry could act as major income diversification for the farmers especially in Narsaraopet and Chilakaluripet. Effectuation of integrating animals systematically into crop rearing systems is demanded in the villages under study.

2.4.8 Ground water recharge

The sources of recharge to the ground water body in the district are rainfall, seepage from canals, return seepage from surface water irrigation, seepage from tanks/lakes/ponds and negligible portion through influent seepage (CGWB, Guntur). Leaving the flood plain and palaeo-channel areas, the ground water utilization in the large parts of the district is very limited because of the intensive canal irrigation, especially by the Nagarjunasagar Right Canal Command Area (NSRCCA), Krishna Western Delta (KWD) canal system and the Guntur Channel Scheme in these areas. In the tail end areas of the canal system, upland areas, flood plain, palaeo/buried channel areas, the ground water is being tapped both for domestic and irrigation purposes. These areas include the mandals in the study regions like Chilakaluripet, Narsaraopet where the ground water is developed through open wells, energized dug, dug-cum-bore wells, shallow tube wells and filter-point wells. The details are presented in Figure 10 below.

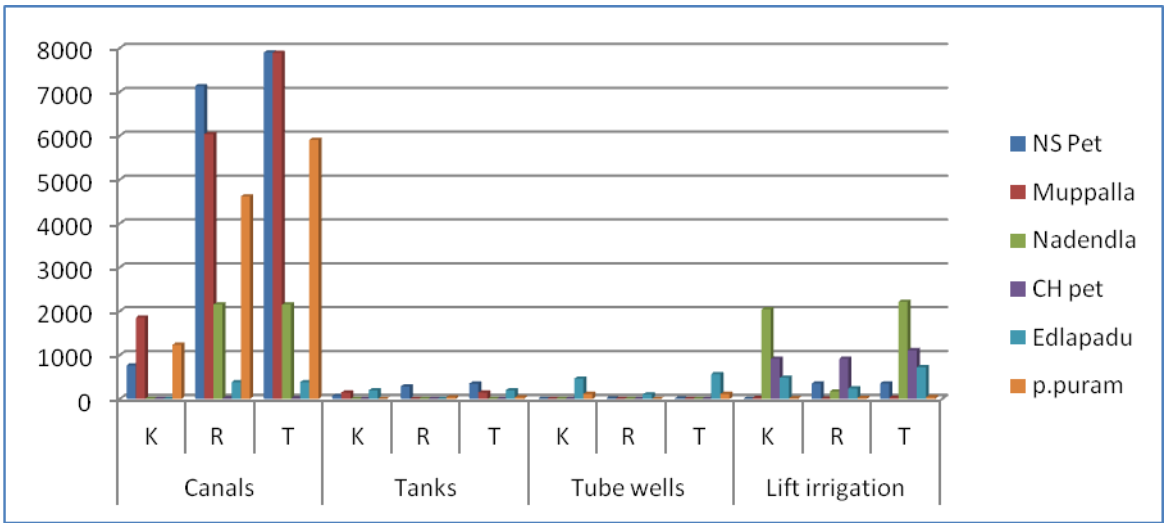


Figure 10: Season wise gross irrigated area 2009-10 (in ha) K: Kharif ; R: rabi ; T : total

Awareness on water use efficiency in agriculture had been substantiated by various capacity building programs conducted by the state, district and village level training centers and the extent of operation of such methods have been depicted in Figure 11.

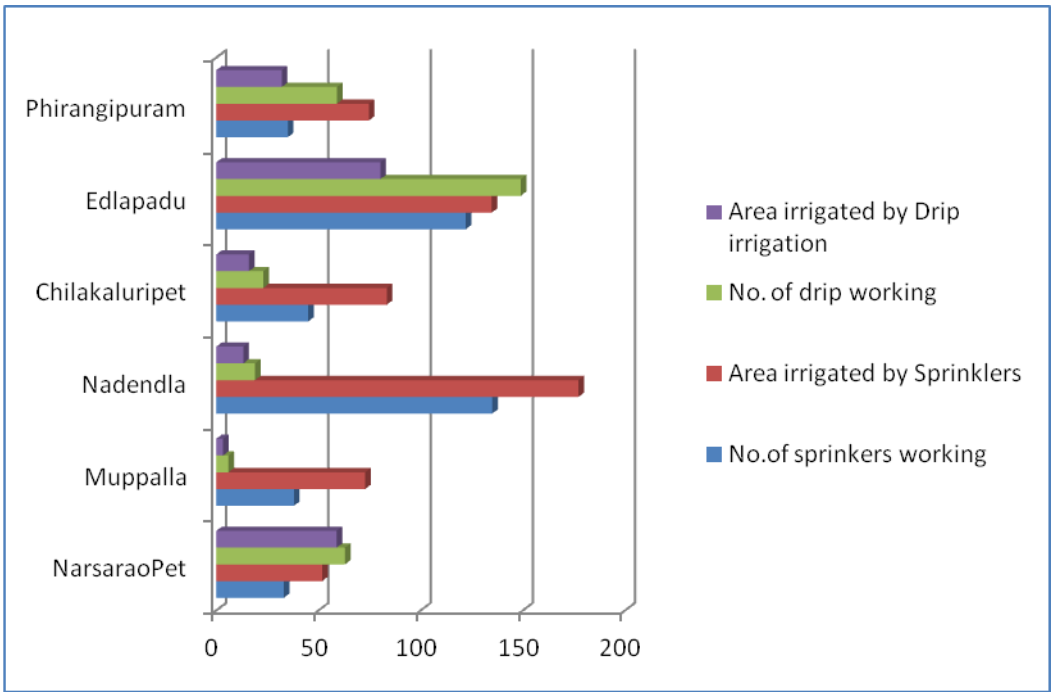


Figure 11: Area under sprinklers and Drip irrigation 2009-10 (area in ha)

2.4.9 Implementation of National Agriculture Insurance Scheme

Under National Agricultural Insurance Scheme (NAIS), Paddy (Rice), Jowar, Bajra, Maize, Black Gram, Green Gram, Red Gram, Groundnut (Irrig), Groundnut (Un Irrig), Castor, Soyabean, Sunflower, Sugarcane (Plant), Sugarcane (Ratoon), Cotton (Irrig), Cotton (Un Irrig), Red Chillies (Irrig), Red Chillies (Un Irrig), Banana, Turmeric, Tomato are the crops covered under Kharif season. Crops covered under Rabi season in the previous years include Rice, Jowar(UI), Maize, Blackgram, Greengram, Bengalgram, Groundnut, Sunflower, Red Chilies, Onion. Table 3 shows the details in the scheme pertaining to the present study region.

Table 3: Details of NAIS scheme in Guntur study region

Mandals	No. of units planned	No. of experiments	
		Planned	Conducted
Narsaraopet	15	120	96
Muppalla	9	72	72
Nadendla	7	56	56
Chilakaluripet	5	40	32
Edlapadu	3	26	26
Phirangipuram	13	104	104

2.4.9. Capacity Building Institutions

With this backdrop table 4 lists the capacity building institutions that exist in Guntur District and can play a crucial role in creating awareness and undertaking trainings to reduce the

vulnerability of water sector in the regions and improve resilience of the households through successful intervention of adaptation options to deal with climate change.

Table 4: Trainings and capacity building institutions in Guntur district

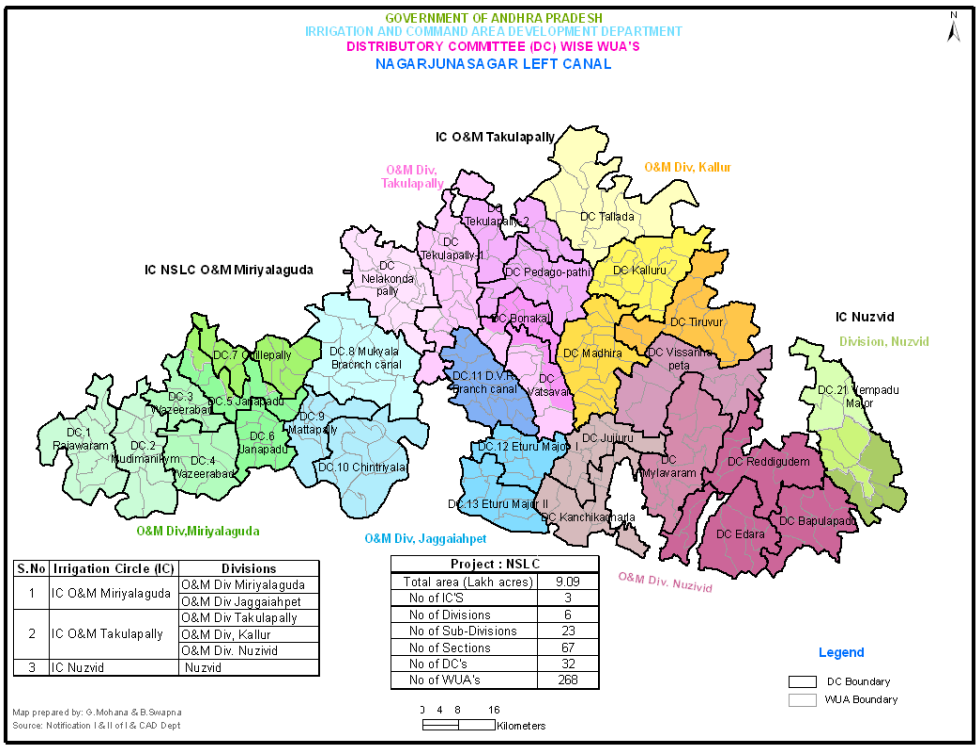
Name of the institution	Agency / Department	Location	Areas of capacity building	Capacity building activities	Other activities
Field training center (FTC)	NSRC, O&M circle, Lingamguntla, Narsaraopet WALAMTARI	Guntur	Training on Irrigation management; climate change; water storage and water saving	Training to farmers, WUA members, DC members and other irrigation staff	Conducing field visits, field research activities
Farmers Training Center (FTC)	Dept. of Agriculture, Govt. of Andhra Pradesh	Guntur	Agriculture technology, new agril programmes, crop management, pest and disease management, other agricultural related trainings	Farmers and village level agril extension workers	-
Krishi Vignana Kenda	ICAR-ANGRAU	NG Ranga Krishi Vigyan Kendra, Vinayashram, Kavuru	Onfarm demonstrations, field trails, trainings to farmers on agriculture and agricultural based rural self employment activities	Farmers, Rural youth, Field level agriculture staff, Progressive farmers	-
Agricultural Research station	ANGRAU	Regional Agricultural Research Station, Lam	Farmers capacity building activities mainly on rice cultivation	Farmers, Dept. of Agril. field staff etc.	Research on Rice, maize, chillies etc

ATMA	Dept. of Agriculture, Govt. of Andhra Pradesh	Guntur	Capacity Building/ Skill up-gradation of farmers and extension functionaries.	Farmers, Dept. of Agriculture staff, Field level workers, Line department	Agricultural development activities

2.5 Nalgonda District

Nalgonda is in the Southern part of the Telangana Region between 16-25' and 17-50' of the Northern Latitude and 78-40' and 80-05' of Eastern longitude covering an area of 14,240 Sq. kms. The district is drained by rivers Krishna, Musi, Aler, Dindi, Hallia, Kongal, Peddavagu. Krishna, the prominent river in this district enters at Yeleshwaram in Deverakonsa taluka. It enters Krishna district after traversing a distance of about 85 kilometers. Musi river, a tributary of the Krishna is next in importance in this region. It enters from the North West direction and after travelling 64 kilometers in an easterly course falls into the Krishna near Vadapalle. The rivers Peddavagu and Dindi are the other important rivers which fall into the Krishna. The Hallia is a small river originating in the hills west of Narayanpur and flows for 72 kilometers in a South East direction, finally falls into the Krishna river. The Aler river flows in Bhongir taluk before joining the Musi river. Total forest cover in the whole Nalgonda district accounts for 1,04,806 hectares which accounts for just 7% of the total area of revenue district. Southern tropical thorn forests is the most common type of forest in Nalgonda which is found in blocks of Devarakonda, Miryalaguda ranges and some in Ramannapet range, Chityal, Kurmapalli etc. Figure 12 below shows the location of the study village in Nalgonda district.

Figure 12: Map of Nalgonda district map showing mandals selected for the study (Mandals 42, 41 and 50)



S.No	Irrigation Circle (IC)	Divisions
1	IC O&M Miriyalaguda	O&M Div Miriyalaguda
		O&M Div Jaggaiahpet
2	IC O&M Takulapally	O&M Div Takulapally
		O&M Div, Kallur
		O&M Div. Nuzvid
3	IC Nuzvid	Nuzvid

Project : NSLC	
Total area (Lakh acres)	9.09
No of IC'S	3
No of Divisions	6
No of Sub-Divisions	23
No of Sections	67
No of DC's	32
No of WUA's	268

Figure 13: Nagarjuna sagar Left canal Distributory Committee (DC) Wise WUAs

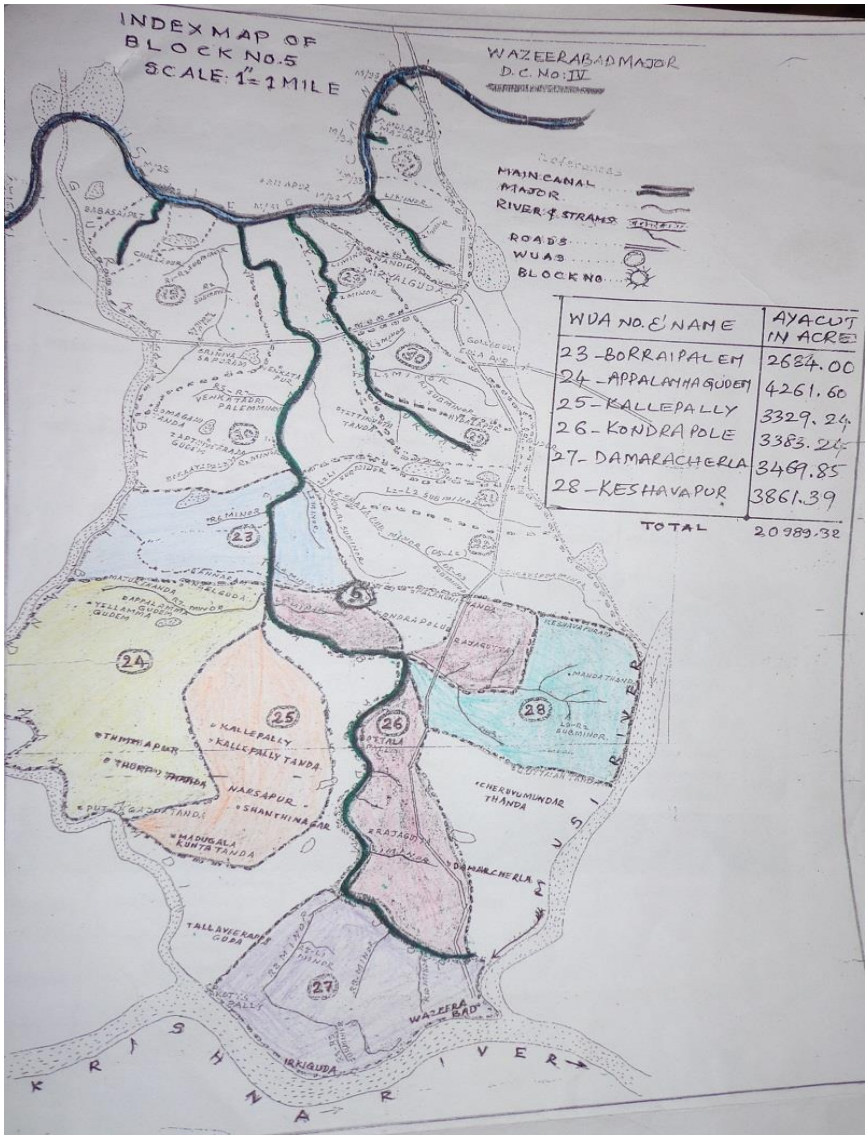


Figure 14: DC 4 Wazeerabad Major II canal and WUAs

2.5.1 Soil Types

The Soils of the district are mostly consisting of Red Soil. The fertile black cotton soil forms only 9 percent and occurs on the banks of Krishna and isolated patches here and there. Among the red soils 47% is dubba soil (Loamy sands), which has a very low moisture retaining capacity, and the rest is chalka soil, forming 44 %.

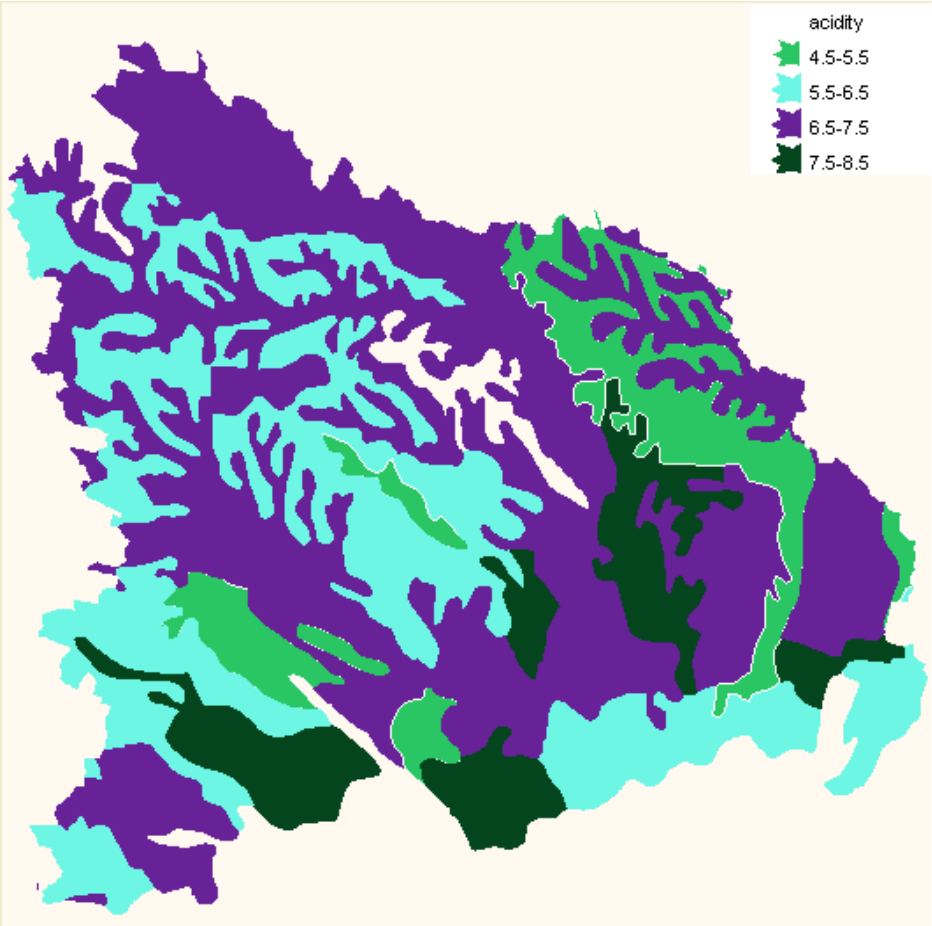


Figure 15: Soil Map - Nalgonda

2.5.2 Climate and Rainfall

The district witnesses a pleasant climate from August to October and very hot during April and May, the temperature ranging from 97F to 110F. The Rainfall of Nalgonda District is 546.4 Millimetres for the year 2006-07 as against the 753.3 Millimetres of Normal Rainfall. Figure 16 shows the normal and the actual rainfall for the study mandals of Nalgonda.

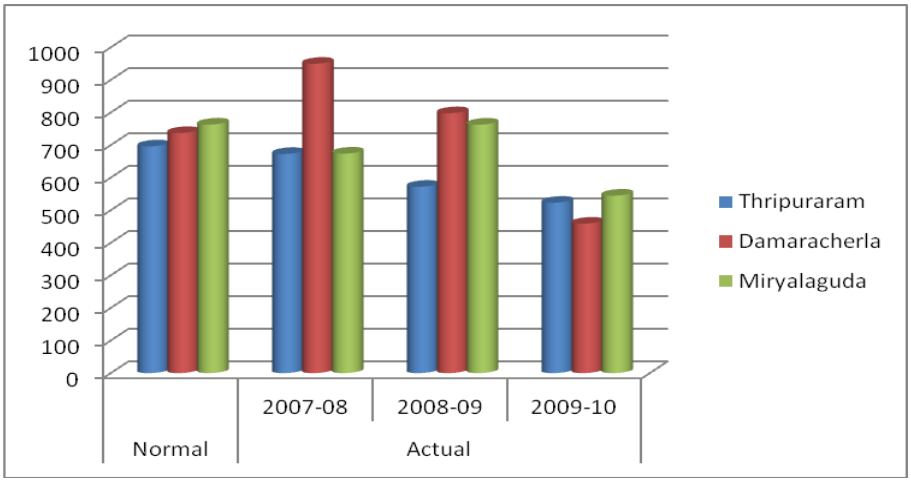


Figure 16: Annual rainfall station –wise
Source: Hand book of statistics, Chief Planning Officer, Nalgonda

A detailed climate and hydrology scenario report (Deliverable 1.4) for the area has been prepared based on work done in Climarice 2 and is available on the project website (http://climaadapt.org/reports/) Hence this report will not go into the details here. The report provides detailed scenarios for 2030 and 2050. It shows more frequent occurrence of extreme events, including droughts and floods in the project area and this will have impacts on the agriculture and food production in the coming years.

2.5.3 Major Crops

The Major crops grown in Kharif season are Paddy, Groundut, Cotton, Castor, Redgram, Jowar, Greengram, Bajra, Maize, Sesamum, Chillies and during Rabi Paddy, Jowar, Maize, Greengram, Horsegram, Black gram, Bengal gram, Groundnut Sunflower, Chillies and Coriander. Miryalaguda (study area) is famous for rice mills, most of the economy growing through rice business. Figure 17 shows the area under principal crops for the study mandals in the district.

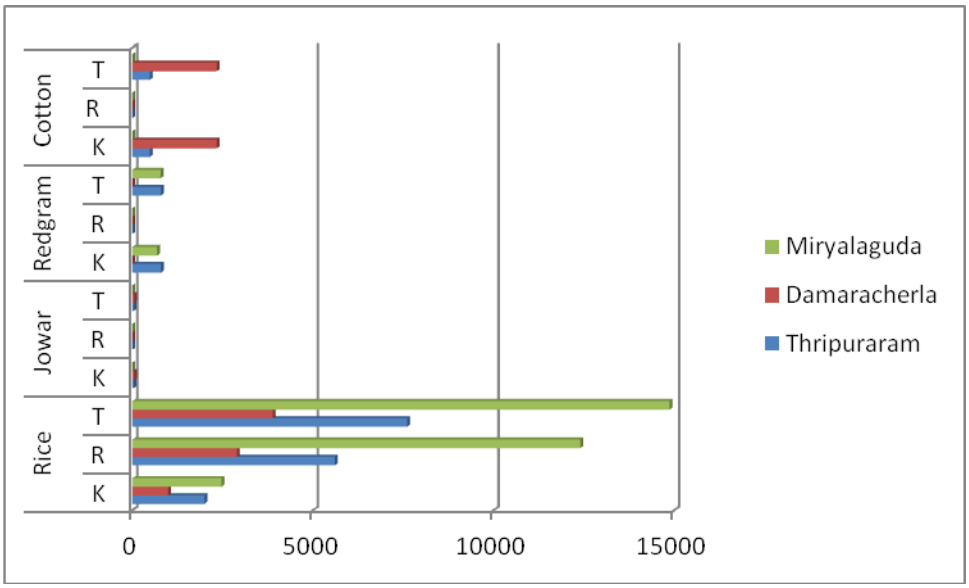


Figure 17: Area under principal crops, season wise 2009-10 (in acres)
K: Kharif ; R: Rabi ; T : total; Source: Hand book of statistics, Chief Planning Officer, Nalgonda

2.5.4 Irrigation Details

The Musi River, a tributary of Krishna, originates in Anantha Hills approximately 90 km to the west of Hyderabad and flows from west to east. The Musi River is 110 km long and joins the Krishna River at Wazirabad in Nalgonda district in Andhra Pradesh. There are seven surface irrigation projects in the district viz; Nagarjunasagar, Musi, Dindi, Asifnagar, Pendlipalkala, Shaligowraram and Bheemanpally projects. There are 4404 tanks including 421 large Tanks. With regard to groundwater abstraction about 55556 borewells and about 109380 dug wells exist in the district. Paddy is the staple food crop, which is mostly cultivated under canals, tanks and wells. Figure 18 shows the source wise irrigation details for the region.

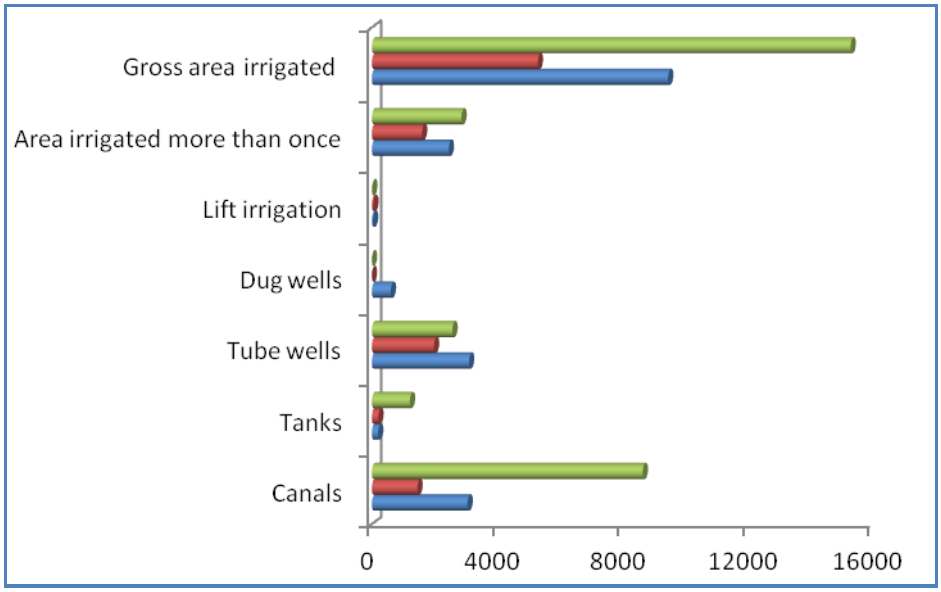


Figure 18: Sources-wise net area irrigated in the study area mandals (area in acres)

Irrigation tanks of Nagarjuna Sagar Left Canal (NSLC) are spread over all the mandals in Nalgonda & Khammam districts. Figure 19 shows the irrigated area under minor irrigation in the study area mandals of Nalgonda.

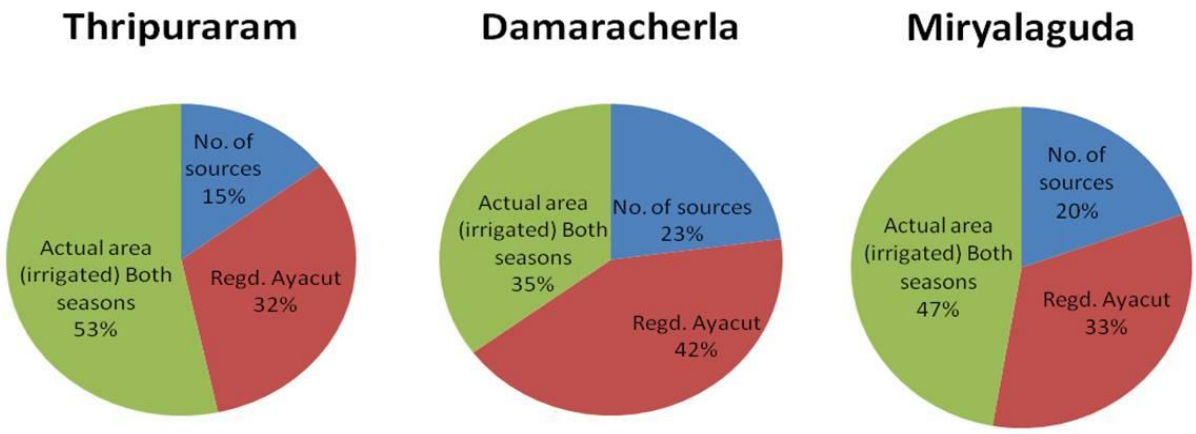


Figure 19: Minor irrigation sources 2009-10 (area in ha)
Source: Hand book of statistics, Chief Planning Officer, Nalgonda

2.5.5 Land holdings

As in the case of Guntur, in Nalgonda study regions also, the majority of farmers in the study area are the small and the marginal farmers. Though the average number of small and medium farmers are similar in both the regions, large farmers are more in Nalgonda study areas compared to that of Guntur. The sources of irrigation also influence the number of land holdings in the respective mandals in both the districts. Figure 17 below shows the distribution of the farmers in the district according to their land holdings.

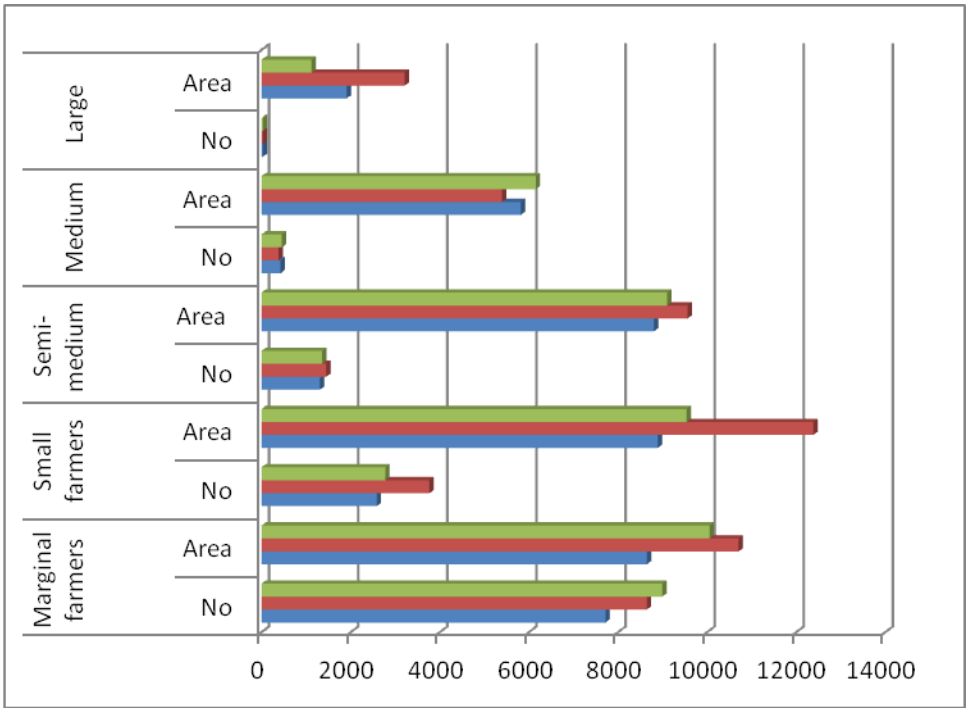


Figure 20: Category wise land Holdings 2005 census (in acres)
Source: Hand book of statistics, Chief Planning Officer, Nalgonda

2.5.6 Consumption of Chemical Fertilizers

As compared to Guntur district the consumption of chemical fertilizers in Nalgonda is even more. For the given cropped area in a village in Nalgonda, average consumption rate is nearly 4-6 times higher than that in Guntur. Continuous irrigation with uncontrolled use of fertilizers has been charged for the fluoride contamination in groundwater sources. Production of phosphate fertilizers in unprotected environments also leads to fluoride exposures in these regions. Awareness on these lines and educating on the utilization levels of fertilizers based on soil quality is substantive. By choosing better alternatives such as biofertilizers and biopesticides, dependency on fertilizer imports also could be reduced. Fertilizer consumption metrics of the study regions have been given in the Figure 18 which indicates the extensive usage of fertilizers.

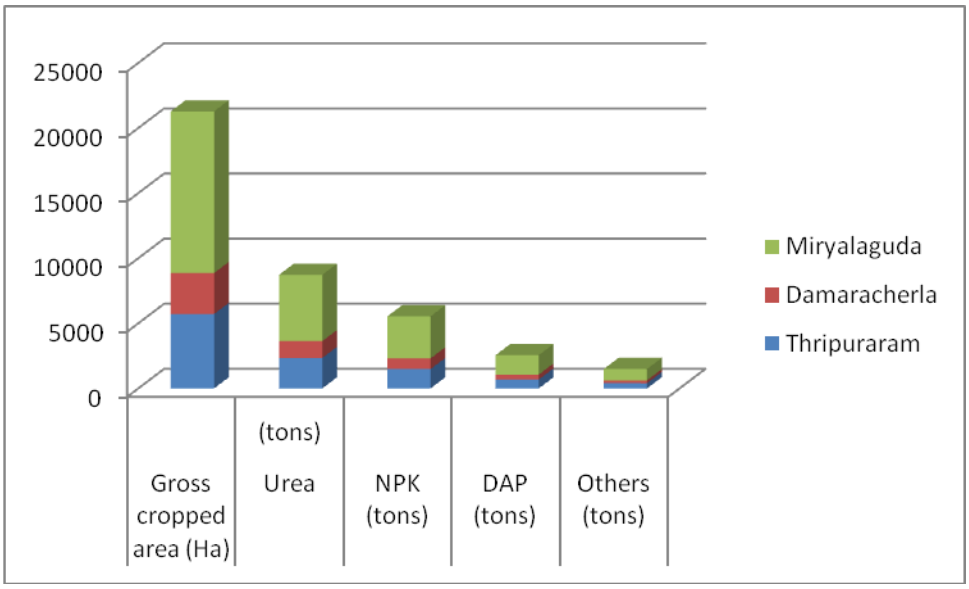


Figure 21: Consumption of chemical fertilizers (2009-10) in the study regions of Nalgonda; Source: Hand book of statistics, Chief Planning Officer, Nalgonda

2.5.7 Livestock and Poultry

Figure 22 below shows the presence of different livestock in the study regions of Nalgonda. From the table it can be seen that the presence of livestock is more in this region as compared to Guntur.

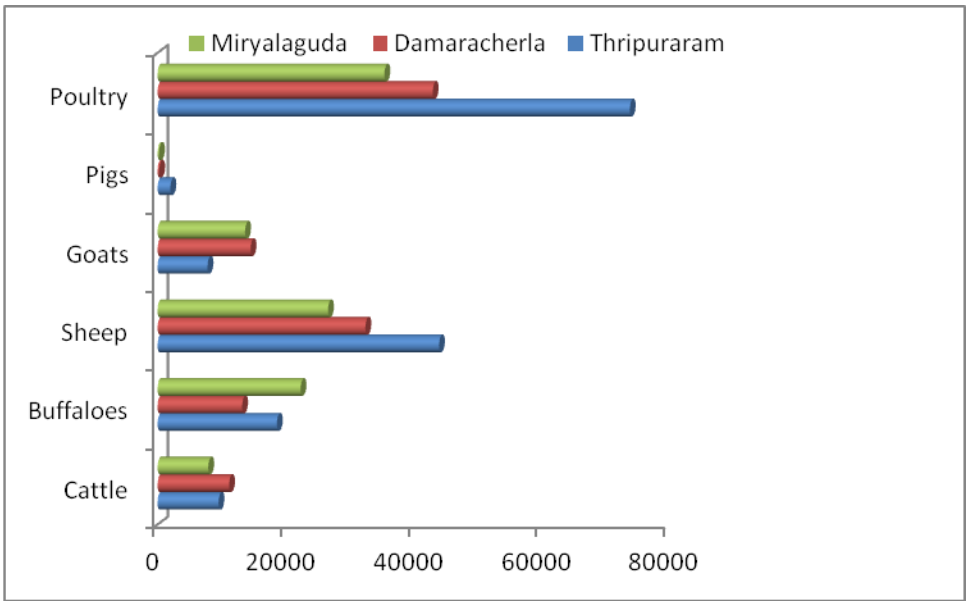


Figure 22: Livestock and poultry population – Live stock census 2007

Livestock offer a medium of income diversification and as iterated before mixed crop and livestock farming systems closely complement each other with animals providing energy for crops and fields in the form of draft animal power and manure and in turn getting their nutrition and energy from agricultural wastes and by products.

2.5.8 Implementation of National Agriculture Insurance Scheme

Under National Agricultural Insurance Scheme (NAIS), Paddy (Rice), Jowar, Bajra, Maize, Black Gram, Green Gram, Red Gram, Groundnut (Irrig), Groundnut (Un Irrig), Castor, Soyabean, Sunflower, Sugarcane (Plant), Sugarcane (Ratoon), Cotton (Irrig), Cotton (Un Irrig), Red Chillies (Irrig), Red Chillies (Un Irrig), Banana, Turmeric, Tomato are the crops covered under Kharif season. Crops covered under Rabi season include Rice, Jowar(UI), Maize, Blackgram, Greengram, Bengalgram, Groundnut, Sunflower, Red Chilies, Onion. Table 5 shows the details of the scheme pertaining to the study region of Nalgonda.

Table 5: Implementation of NAIS- 2009-10 in mandals of Nalgonda

Mandal	No. of units planned	No. of experiments	
		Planned	Conducted
Thripuraram	17	136	136
Damaracherla	9	72	72
Miryalaguda	24	192	192

Source: Hand book of statistics, Chief Planning Officer, Nalgonda

2.5.9 Land Use

51.52% of land constitutes total cropped area with respect to total geographic region of the district whereas in Nalgonda, 48.55% area constitutes cropped lands. The soils occurring in Nalgonda are black cotton, alkaline and alluvial soils, of which red soils constitute 85% of the area. Black soil is found over the lime stone area, in the southeastern part of the district. The Soils of Guntur District are broadly divided into 4 types as Red Gravelly soils which occupy the major portion of the district, Black cotton soils on the banks of Krishna, sandy alluvial soils on the coastline and saline swampy soils in the tidal waves penetrated regions

2.5.10 Operational Agricultural Schemes

With regards to the existence of agricultural schemes in the Nalgonda district it was found that the following are some of the schemes that are operational in the district: (a) Small farmers development agencies (SFDA), (b) Marginal farmers and Agricultural Labourers Development agencies (MFALDA), (c) Crop Insurance Scheme (NAIS) for Paddy, (d) Integrated Scheme of Oilseeds, Pulses, Oil Palm and Maize (ISOPOM), (e) ICDP – Coarse Cereals Under Work Plan For Macro Management Of Agriculture and (f) Technology Mission on Cotton Agricultural Technology Management Agency (ATMA).

2.6 Findings from Household Surveys and FGDs: The Distribution of Farm Households

2.6.1 Guntur (DC-21 Study Area)

(i) Marginal farmers (0-2 acres): 116 households

- Cotton, Chilli, Paddy, Jowar, Maize, Black gram, Subabul, Turmeric, Fodder Grass are the crops cultivated in Kharif season by these farmers.
- 35% of marginal farmers cultivate Paddy with an average yield of 25 bags/acre. 16 % of these farmers cultivate cotton, maize, black gram and turmeric in this season or as rotation to paddy crop. Black and chalka soils are predominant in these fields.
- 5% of farmers cultivate Chilli in Kharif season with an average yield of 12 quintals.
- 53% of marginal farmers cultivate cotton in Kharif season with an average yield of 8.5 quintals/acre. 25% of cotton growing marginal farmers cultivate chillies too with an average yield of 12-15 quintals.
- 16% of marginal farmers cultivating cotton are depending on wells (also for chillies) and few are proceeding for rainfed irrigation.
- Nearly 90% of farmers cultivate cotton in black and chalka soils. 3.4% of farmers grow maize with an average yield of 10.5 quintals. Few of them grow Jowar also in parallel or in rotation. 2-3 marginal farmers grow subabul with an average yield of 9 quintals.
- Chilli, Jute, Sesame, Turmeric (15 bags/acre yield), black gram and fodder grass are cultivated by farmers (around 1 % each crop) in Rabi season.
- Very few farmers cultivate black gram in Rabi season with an average yield of 10 quintals/acre.

Table: 6: Farming details of Marginal farmers

	Paddy		Chilli in Kharif	Cotton		Maize	Chilli/ Jute/ Sesame/ Turmeric (Rabi)	Black gram (Rabi)
		Cotton/Maize/ Black Gram/ Turmeric			Chilli			
% of farmers	35% →	16%	5%	53% →	25%	3%	1 % each	1%
Yield/acre	25 bags		12 q	8.5 q	12-15 q	10.5 q	15 bags	10 q
Soils	Black and chalka Soils							
Irrigation	Nagarjuna Sagar Right Canal			16 % wells, few based on rainfed irrigation		Nagarjuna Sagar Right Canal		

(ii) Small farmers (2-5 acres): 135 households

- Cotton, Paddy, Chillies, Maize, and turmeric are the major crops cultivated in Kharif season by these small farmers. Bengal gram, Red gram and Subabul are also cultivated in this period.
- Pillipesara, Jute, Green gram and Fodder grass are the crops cultivated in Rabi season.
- 50% of people cultivate cotton in Kharif season with an average yield of 12 q. 24% of cotton cultivating farmers grow chilli too with an average yield of 18 quintals.
- Very few farmers cultivate red gram and jowar with an average yield of 15q and 10q respectively. Paddy is less preferred by these farmers (6%) cultivating cotton in Kharif season. Few of them (1-2%) cultivate jute in rotation with cotton. Black, chalka is highly preferred for cultivating these crops. 12 % of farmers cultivating sustain through well based irrigation.
- 6% of marginal farmers grow chilli as main crop with an average yield of 20 quintals, depending on canal water for irrigation. Few of these farmers (2-3) cultivate cotton in rotation with chillies getting an average yield of 15 q.
- 40% of small farmers cultivate paddy in Kharif season as major crop with an average yield of 27 bags. Black and chalka soils are predominant for Paddy cultivation too.Chillies (20 q), cotton (10 q), jowar (15 q), maize (15 bags) and Bengal gram (5 q) are cultivated in rotation also during kharif by farmers cultivating paddy. Pillipesara and green gram are noted Rabi crop by these paddy growing farmers.
- Maize and turmeric are also cultivated by 3 % of farmers (each) in Kharif season itself with an average yield of 10 bags and 8 quintals respectively in black and chalka soils. Pillipesara is cultivated in Rabi season following turmeric.

Table 7: Farming details of Small farmers

	Paddy		Chilli (Kharif)	Cotton (Kharif)		Maize (Kharif)	Turmeric (Kharif)	Red Gram/Jowar
		Chillies/ Cotton/Jowar/ Maize/ Bengal Gram			Chilli			
% of farmers	40% (6%)	←	6%	50%	24%	3%	3 %	Very few
Yield/acre	27 bags	(20 q /10 q/15 q/ 15 bags/5 q)	20 q	12 q	18 q	10 bags	8 q	15 q/10 q
Soils	Black and chalka Soils							
Irrigation	Nagarjuna Sagar Right Canal			12 % well irrigation		Nagarjuna Sagar Right Canal		

(iii) Medium farmers (5-10 acres of land): 158 households

- Paddy, cotton, chillies and maixe are the major crops cultivated by medium farmers. Jute, Sesame, maize, black gram, pillipesara and fodder grass are cultivated in Rabi season by few of these farmers.

- 53% of farmers cultivate cotton as major crop with an average yield of 12 quintals. Nearly 40% of farmers with cotton as major crop cultivate chillies too with its average yield of 18 quintals in black chalka and red soils. Only 5-6% of people prefer Jute (avg yield- 6 qnt), black gram, sesame, pillipesara in rotation with cotton where it is cultivated primarily.
- 42.2 % of medium farmers cultivate paddy as main crop with an average yield of 27 bags. Black and chalka soils are observed mostly. Maize, cotton and sesame are also cultivated by 10% of these farmers whereas sesame, fodder grass, subabul and chilli are cropped in rotation by 7% of these farmers cultivating paddy.
- Less than 5 % of medium farmers cultivate chillies with an average yield of 9-10 q in black chalka soils and few of them cultivate cotton in rotation by rain fed method of irrigation still getting an average yield of 15 qntls through it (cotton). Maize is cultivated by very few medium farmers as primary crop with average yield of 15 bags.

Table: 8: Farming details of Medium farmers

	Paddy			**Chilli (Kharif)**	**Cotton (Kharif)**		**Maize**	**Jute**
		Maize/Cotton/Sesame	Fodder grass/ Subabul/Chilli			Chilli		
% of farmers	42 % →	10%	7%	4-5%	53% →	40%	Very few	5-6%
Yield/acre	27 bags			10 q	12 -15 q	18 q (Black chalka & Red soils)	15 bags	6 q
Soils	Black and Chalka Soils							
Irrigation	Nagarjuna Sagar Right Canal				Few by rainfed irrigation	Nagarjuna Sagar Right Canal		

(iv) Large farmers (10-15 acres of land): 40 households

- Paddy, cotton, Chilli and red gram are the major crops cultivated in Kharif season by large farmers. Maize, red gram, black gram, other pulses, pillipesara, and fodder grass are cultivated mostly in Rabi season by 30 % of farmers.
- 52.5 % of farmers cultivate paddy as the main crop with an average yield around 25 bags/acre. Pulses, sesame and fodder grass are grown in post Rabi and summer seasons by these farmers. 10% of these farmers cultivate maize with average yield of 15 bags. 14 % of paddy growers cultivate cotton and chillies too with an average yield of 10q and 20q/acre respectively.

- 40 % of large farmers cultivate cotton with an average yield of 8 quintals. Nearly half (50%) of them cultivate chillies also with an average yield of 12-15 q. 20% of them cultivate red gram in Kharif/Rabi with average yield of 7q and few cultivate pillipesara in Rabi. Black chalka soil is highly observed in cotton cultivation.
- Pulses are cultivated primarily by 10 % of large farmers. Red gram with average yield of 2q, black gram 5 q/ acre and Jowar with average yield of 4q/acre.

Table: 9: Farming details of Large farmers

	Paddy			Chilli in Kharif	Cotton			Red Gram/Black Gram/ Jowar (Rabi)	Maize/Pillipesara/Fodder Grass (Rabi)
		Maize	Cotton/Chilli			Chilli	Red Gram		
% of farmers	52.5 %	10%	14%	5%	40 %	50 %	20 %	10%	10-15%
Yield/acre	25 bags	15 bags	10 q/20 q	12 q	8q	12-15 q	7 q	3 q/5 q/4 q	
Soils	Black Chalka Soils								
Irrigation	Nagarjuna Sagar Right Canal								

2.6.2 Nalgonda (DC-4 Study Area)

(i) Marginal farmers (0-2 acres): 5 households

- Cultivating paddy by flood irrigation, getting an average yield of 32 bags in Kharif season and 28 bags in Rabi season.
- Ownership of agricultural machineries and tractor is very less. Cattle are also not maintained much by these farmers.

Table: 10: Farming details of Marginal Farmers

	Crops	Averge Yield		Agricultural Machinery			Cattle
		Kharif	Rabi	Sparying Machines	Tractors	Pumpsets	
Marginal farmers (0-2):5	Paddy	32 bags	28 bags	Less than 10%			Very few have buaffaloes
Small farmers (3-5): 216	Paddy (99%)	30 bags	27 bags	80% own/access	71% own/acess	77% own	27% maintain cattle (buffaloes)
	Cotton (Very few in Kharif; 20% in Rabi)	16 q	9 q				
Irrigation	80 % - canal Irrigation (Nagarjunasagar Left Canal) ; 20% - well irrigation in Rabi. In either cases, flood irrigation is followed.						
Soil	Red and black loamy soil types. Red loamy soil type is highly predominant						

(ii) Small farmers (2-5 acres): 216 households

- In Kharif season, Paddy is grown by majority of the farmers (214). 27% of small farmers maintain cattle, mostly buffaloes. 80% own/access spraying machines. 71% own/access to tractors. 77% own pumpset.
- Average yield of Paddy in Kharif season: 30 bags. Average yield of cotton – 16 quintal
- Canal water is depended mostly
- In Rabi, 20% grow cotton (42), very few cultivate red gram and the rest grow Paddy.
- Average yield of paddy in Rabi season – 27 bags
- Average yield of cotton in Rabi- 9q
- Paddy and cotton is grown both in red loamy and black loamy soil types. Red loamy soil type is highly observed in the sample zones.
- 20% of farmers go for well irrigation in Rabi. Rest sustain through canal water. In either cases, flood irrigation is followed.

(iii) Medium farmers (5-10 acres of land): 129 households

- Except one or two farmers everybody have ownership to pump set. 95% have ownership/access to tractors. Very few medium farmers use Power tillers and Ploughing machines. 43% medium farmers use fodders cutting machines and 99% of them have spaying machines.
- 8 % of medium farmers own cattle, 1-2% own sheep/goat.
- 3 % medium farmers grow cotton in Kharif season. Rest grow paddy only in this season.

- Only 2% of farmers are practising borewell irrigation and very few cultivate cotton with rainfed irrigation. Rest all depend on canal water. Flood irrigation is followed majorly.
- In Kharif season, average yield of Paddy is 33 bags whereas average yield of cotton is 15 quintals.
- In Rabi season, 41% grow Maize. 1-2 % grows cotton and chillies with an average yield of 9 quintals and 17 quintals respectively. Rest are cultivating paddy with an average yield of Paddy is 29 bags.
- Canal irrigation is only followed except for few cotton and chilli cultivating farmers who depend on well and borewell in Rabi. In most situations, flood irrigation is only followed.
- 4% of samples reported black soil and cotton cultivation is followed in such farms. Red loamy soil is predominant.

Table: 11: Farming details of Small Farmers

Medium farmers	Crops	% of farmers		Averge Yield		Agricultural Machinery					Cattle
		Kharif	Rabi	Kharif	Rabi	Spraying Machines	Tractors	Pumpsets	Power Tillers/Ploughing machine	Fodder cutting machines	
(6-9 acres) : 129	Paddy	99 %	64 %	33 bags	29 bags	99% own/access	95% own/access	99% own	Very few use	43%	8 % of own cattle; 1-2% own sheep/ goat.
	Cotton	3%	1-2%	15 q	9 q						
	Maize		41 %								
	Chilli		1-2%		17 q						
Irrigation	>95% - canal Irrigation (Nagarjunasagar Left Canal) ; 2% - Borewell irrigation; very few follow rainfed irrigation for cotton. Flood irrigation in all cases										
Soil	4% of samples reported black soil and cotton cultivation is followed in such farms. Red loamy soil is predominant.										

(iv) Large farmers (10-15 acres of land): 40 households

- 60% of farmers grow Paddy in Kharif season with canal as water source and by flood irrigation mode. Red loamy soils are highly considered for paddy cultivation. Average yield of paddy-29 bags.
- Rest 40% are cultivating cotton in Kharif season mostly in black soils with an average yield of 12 quintals. Rainfed irrigation is also followed for cotton.

- In Rabi season, 50% grow Paddy; 50% grow cotton. 5-10% of farmers follow well irrigation for cotton in this season. SRI is adopted by less than 10% of large farmers. Average yields of Paddy and Cotton are 34 bags and 10 quintals respectively.
- Most of the large farmers (90%) have buffaloes/cows. Tractor is owned by 60% of them. Very few own Power tillers (5%). Pump set, Tractors and Spraying Machines are owned by 90% of large farmers.
- Sweet Orange is also cultivated in land (wetland) outside command area.

Table: 12: Farming details of Large Farmers

Large farmers (10-15): 5	Crops	% of farmers		Averge Yield		Agricultural Machinery					Cattle
		Kharif	Rabi	Kharif	Rabi	Spraying Machines	Tractors	Pumpsets	Power Tillers	Fodder cutting machines	
	Paddy	60 %	50 %	29 bags	34 bags	90% own	90% own	90% own	5%	43%	90% have buffaloes/cows
	Cotton	40 %	50 %	12 q	10 q						
	Sweet Orange	Cultivated in wetlands outside command area									
SRI adoption	Less than 10 % of farmers										
Irrigation	80-90% follow canal irrigation (Nagarjunasagar Left Canal) ; 5-10% farmers follow well irrigation in Rabi (cotton); Rainfed irrigation is also followed for cotton. Flood irrigation in all cases										
Soil	Red loamy soils – predominant for paddy; black soils in cotton cropping areas										

2.7 A Comparative Analysis of Availability and Usage of Resource in Nalgonda and Guntur

As described in the previous section, the present study uses data from both secondary as well as primary sources for conducting the situation analysis in the study areas of Andhra Pradesh. The following section describes the findings that emerge from the primary data analysis for the study regions of Andhra Pradesh. Around 1000 households were surveyed in Andhra Pradesh region, out of which 500 households belonged to Guntur district and the rest 500 belonged to Nalgonda district of Andhra Pradesh.

2.7.1 Household Members and Housing Condition

In the surveyed households the proportion of male members was higher than compared to female members in both the study regions. While in Nalgonda, there were around 773 males and 750 females in the total sample of 500 households, in Guntur the sample consisted of around 840 male members and 822 female members. The literacy status of the households in both the districts are quite high as we find that in the entire sample only five percent males and six percent females have education less than primary level in Nalgonda. Similarly, in Guntur around seven percent males and nine percent females have less than primary education. House ownership was high for both the regions with majority of the sample owning houses of different types. Ownership was found to be marginally higher in Guntur as compared to Nalgonda as around 96 percent of the sample stay in their own houses in Guntur compared to 95 percent in Nalgonda. Out of this 25-30 percent are semi-pucca houses in Nalgonda while only 4% percent is semi pucca houses in Guntur. There is a huge variance in the reported value of houses in both the study areas. In Nalgonda, the average value of the house is around Rs. 3.5 lakhs while that in Guntur is around Rs. 1, 73,000.

With regards to access to electricity both regions are well of as more than 90 percent of the households in both the study regions report having access to electricity. However both the regions face problems for access to water. Around 50 percent of the households in Nalgonda depend on public water sources and another 30 percent say that they depend on wells for safe drinking water. The rest 20 percent use wells fitted with pumping facility. Access to water seems to be more problematic in Guntur as around 10 percent of the sample says that they depend on wells for water. The dependence on public sources is low and so also is the dependence on wells with pumping facilities. With regards to presence of sanitation facilities at home it was found that around 14 percent houses in Nalgonda don't have proper sanitation facilities at home whereas the majority (86%) has sanitation facilities at home. The situation in Guntur is similar as 87 percent of the households report having sanitation facility at their home compared to 13 percent saying that they don't have.

- Higher and denser population in Guntur as compared to Nalgonda
- High access to electricity and more dependency on public water sources for drinking water at both the places
- Ownership of houses follow similar pattern in both the places
- Access to water more problematic in Guntur than in Nalgonda
- Access to sanitation facilities is good in both the study regions

2.7.2 Agriculture and Allied Activities

About 90 percent of the surveyed households have access to irrigated agricultural land for farming in both the regions. The total cultivable land for the entire sample works out to be around 885.72 acres in Nalgonda. However the total cultivable land in Guntur is quite higher and stands at 2432.86 acres for the sample. Out of the total cultivable land in Nalgonda a high proportion of land belongs to cultivated wetland (around 802.5 acres). However the share of cultivable wetland in Guntur is lower as compared to Nalgonda and stand at 1589.21 acres. It was also seen from the survey that only a small fraction of land possessed

by households is rain-fed or fallow land in both the regions. Looking at the land holdings of the households we find that majority of the households own land in the range of 2.5 to 5 acres (48.8%) in Nalgonda study area and around 34.75 percent households in Guntur own land in this range. Small farmers (those owning land less than 2.5 acres) are higher in Guntur than compared to Nalgonda. Around 22 percent household in Guntur and 14 percent households in Nalgonda have land ownership below 2.5 acres. Households with ownership of land in the category 5 - 10 acres account to around 32 percent in Nalgonda an 34 percent in Guntur respectively. A few households in the sample are large farmers with land ownership more than 10 acres. While around 5 percent farmers are large farmers in Nalgonda, around 9 percent farmers in Guntur belong to this category.

With regards to agricultural implements a large proportion of the households either own or have access to small equipments like Axe, Hoe, Spade etc. Comparing both the study regions we observe that the ownership and access to agricultural implements show similar patterns in both Nalgonda and Guntur. In Nalgonda, around 74 percent of the households own pump sets and 70 percent own a tractor. Around 41 percent, 14 percent and 75 percent households own ploughs, fodder cutting machines and spraying machines in this region. The average value of agricultural assets like pump sets and tractors in this region stands at Rs. 23,224 and Rs. 4,30,000 respectively. Similarly, the average value of agricultural implements like power tiller, ploughs fodder cutting machines and spraying machines in this region stands at Rs. 20,000 Rs. 10,000, Rs. 25,000 and Rs. 6,000 respectively. In Guntur, around 70 percent of the households own pump sets and 65 percent own a tractor. Around 14 percent and 85 percent households own fodder cutting machines and spraying machines in this region. The average value of agricultural implements like pump sets, tractors, power tiller, ploughs fodder cutting machines and spraying machines in this region is similar with Nalgonda.

With regards to livestock, it is observed from the survey that a small number of households report of owning livestock in various forms. Around 12 percent households in the sample own bigger forms of livestock like cows in Guntur whereas 17 percent of households in the sample of Nalgonda own cows. While the ownership of buffaloes is around 40 percent in Guntur, 18 percent households own the same in Nalgonda. Very few households (in the range 1-2%) in both the districts, report owning livestock like goats and sheep. The average number of livestock per household in these study regions varies in between 1-20.

Paddy is the major crop in both the study regions while cotton is more cultivated in Guntur. Other crops that are cultivated in these two regions are different. While in Nalgonda the other crops that are cultivated in the command areas are Paddy, Red Gram, Cotton, Chillies and Sweet Oranges, in Guntur, the other cultivated crops are Chillies, Cotton, Red Gram, Black Gram, Sorghum, Jute, Fodder Grass, Jowar, Maize, Subabul, Guar Gum and Turmeric. Such crops are also grown outside the command areas in both the districts. Very few households report adopting SRI cultivation in both the study regions. The average value of irrigated land in Nalgonda is around Rs. 4,48,000 and that in Guntur is around Rs. 6.31 lakhs. Similarly, the average value of non-irrigated is Rs. 3,08,400 and Rs. 2,87,500 in Nalgonda and Guntur respectively. A significant proportion of the households in both the regions demand agricultural information from agricultural officers in the region. In Guntur, 17.4 percent of surveyed farmers utilize green manures by planting Dhaincha (Sesbania), to increase soil organic content & moisture and to facilitate Nitrogen uptake.

- Majority of agricultural lands are irrigated in both the regions
- Cultivable land is very high in Guntur as compared to Nalgonda
- Land holding pattern similar in both the study regions with majority of the farmers owning land 2.5 – 5 acres
- Households have access to bigger and smaller agricultural implements (either own it or rent it out)
- Average value of agricultural implements like pump sets, tractors, power tiller, ploughs fodder cutting machines and spraying machines in this Guntur is similar with Nalgonda
- Livestock (bigger as well as small ruminants) one of the sources of income diversification in both places but across a few households only
- Primary crop is Paddy and Cotton has equivalent importance as primary crop in Guntur
- Other crops include Chillies, Red Gram, Black Gram, Sorghum, Jute, Fodder Grass, Jowar, Maize, Subabul, Guar Gum and Turmeric
- Lesser practice of SRI cropping in both regions, although familiar with SRI, Alternate wetting and drying but not practicing it highly
- There is little or no awareness on planting Dhaincha along with rice transplantation. This method proves better water use efficiency and the green manure acts as a source of nutrients and surface mulch.

2.7.3 Household Income Generation and Assets

From the survey it is observed that households in the Nalgonda region are richer as compared to the households in Guntur. While the annual average household income is around Rs. 2, 32,183 in Nalgonda the same stands at Rs. 75,000 for Guntur. Out of this the annual average agriculture income is around Rs. 1, 93 000 for the Nalgonda sample and around Rs. 56, 721 for the Guntur sample. In other words the majority of income for the households in the sample comes from agriculture. Similarly the average annual farm based income in the regions stands at Rs. 48,625 and Rs. 76,500 for Nalgonda and Guntur respectively. A huge difference is observed in the annual non-farm based income in between these two regions. While the annual average non-farm income in Nalgonda is much lower as compared to Guntur and stands at Rs. 27,517. The same for Guntur is around Rs. 92,940. The average number of agricultural days is around 135 in both the regions. The non-agricultural activities in this region are dairy farming, poultry, business of agriculture and agricultural related products. Households in Nalgonda report that their average annual income through non-agricultural activities is around Rs. 1, 44,000. Similarly the average annual income through non-agricultural activities in Guntur such as Dairy farm, Poultry, Apard community services, Rice mill etc is Rs.68000.

With regards to the presence of consumer durables in the households we find that more than 90 percent of the surveyed households have radios and television sets with them in both the regions. Around 72 percent households in Nalgonda and 53 percent households in Guntur own a bicycle. The ownership of motor cycles was reported by 45 percent and 47 percent households in Nalgonda and Guntur respectively. Very few households among the surveyed households own a car (3% in Nalgonda and 9% in Guntur). Similarly the ownership of

computers is also scarce with only 1 percent of the households in Nalgonda and 6 percent households in Guntur owning them.

Analyzing the pattern of borrowing by the households in this region, it was found that the average borrowings was more in Guntur as compared to Nalgonda. In Nalgonda around 71 percent of the households say that they have an outstanding loan and 45 percent say so in Guntur. The average amount of borrowings in Nalgonda is around Rs. 42,246, through 2-6 percent rate of interest from formal institutions. Around 17 percent households report having borrowed from informal sources and the average amount borrowed stands at Rs. 82,000. For the Guntur region it was found that the average borrowings for the sample stood at Rs. 1.52 lakhs with around 0.5 – 12 percent rates of interest in case of from formal institutions. About 28 percent of the households in Guntur depend on informal institutions for borrowing. The interest rates for this borrowing range from a low of 1 percent to a high of 20 percent.

Households also report of making some savings from their income (61% households in Nalgonda and 52% farmers in Guntur say so). The average annual savings is around Rs. 94,600 in Nalgonda and Rs. 82,860 in Guntur. Twenty percent farmers and fifteen percent farmers in Nalgonda and Guntur say that their average annual savings from agriculture is Rs. 62,737 and Rs. 25,687 respectively. The average savings from non-agricultural activities is lower for both the regions (Rs. 30,000 in Nalgonda and Rs. 22,972 in Guntur). Around 19 percent farmers in Nalgonda and 12 percent farmers in Guntur report that they have made some savings from remittances as well and the average annual savings from this source is around Rs. 10,948 and Rs. 9,175 respectively. It is interesting to note that small proportion of women farmers have undertaken the savings in local SHGs (10-15% in Nalgonda and 26% in Guntur). The average savings in these accounts are Rs. 7,000 for the Nalgonda sample and Rs. 9,300 for the Guntur sample.

- Households in Nalgonda richer than compared to households in Guntur
- High proportion of income derived from farm level activities in Guntur than Nalgonda
- Non-farm income in Nalgonda is much lower as compared to Guntur
- Non-agricultural activities in this region are dairy farming, poultry, business of agriculture and agricultural related products, rice mills etc.
- Average borrowings more in Guntur as compared to Nalgonda
- More borrowing from informal institutions at both the places and similar trends in interest rates
- Average savings more in Nalgonda as compared to Guntur
- Savings also done from remittances in both the study districts and savings also made through SHGs

2.7.4 Yield and Irrigation Details

The Nagarjunasagar Right Bank Canal Command (NSRCCA), Krishna Western Delta (KWD) Canal System and Guntur Channels Scheme are the major sources of irrigation in the study region. Drip irrigation is practiced by the farmers living in the study area. In the Nalgonda region less than 5 percent of the sample depends on well /bore well /rain-fed sources and is mostly followed for cultivating Chillies. For the Guntur region, the alternative sources of irrigation such as rain-fed and treating wastewater for irrigation are employed

mostly for cotton and jute crops by nearly 5% of farmers. The average yield for paddy is around 15 quintals per acre during the Kharif season and around 14 quintals per acre for the Rabi season in Nalgonda. With regards to Guntur it was found that there are very few farmers who undertake cropping in the Rabi season and the productivity of paddy during the Kharif season is around 13 quintals per acre resulting from the insufficient rains in making up the canal water for irrigation. For cotton crop and red gram it was found that the average productivity during Kharif season was around 12 quintals per acre and 5 quintals per acre respectively. The yield during the Rabi season for these crops stands at 12 and 4 quintals per acre respectively. Similarly, the yield for red gram in Guntur during the Kharif and Rabi season stand at 13 and 10 quintals per acre respectively. The average yield of Chillies, and Subabul are around 15 and 9 quintals per acre respectively in Guntur. Maize yields are on an average of 10 bags / acre.

- Water Scarcity in both study regions
- Drip irrigation is practiced by the farmers
- Alternative sources of irrigation include wells, bore wells, rain-fed etc.

2.7.5 Climate Change Perceptions and Problems

Households also list out visible impacts of climate change over the years. Although the farmers are not technically aware about the phenomenon of climate change they associate the following problems with regards to climatic aberrations and extremes:

- Irregular rainfall and change in date of sowing
- Late arrival monsoons
- Ground water depletion
- Changes in cropping season observed by farmers
- New pests such as *Helicoverpa Sp*., *Spodoptera*, white fly that transmits Yellow Mosaic Virus affecting crops
- Major constraints expressed by the farmers were non-availability of inputs, lack of government subsidy, less market price for the produce, unavailability of fertilizers, non-availability of labour, no electric supply with proper timings

With regards to adaptation for the above listed impacts the surveyed households highlight that the following activities could be tested and adopted in their respective regions:

- Changing the crop varieties and use of climate resistant crops
- Introduction of Pest tolerant varieties and High yielding varieties in their regions
- Orientation to medium and small farmers regarding climate risk reduction
- Awareness on green manures and bio-fertilizers needs to be increased
- In Nalgonda a small number of farmers (6%) familiar with National Agricultural Insurance Scheme (MNIAS) and a few of them have received compensation for Paddy and Chilli in the range of Rs. 10,000 to Rs. 20, 000 in the past and want the awareness of this to be spread across all farmers
- In Guntur around 20 percent farmers had sought benefits through insurance schemes other than MNIAS and WBCIS yet they are proceeding with less awareness on premium payment and the utilization of benefits utilization through these

- No farmer has seen and visited automatic weather station
- Farmers opted for new variety of crops, making fine soil tilth to conserve water, removal of weeds by herbicides, farmers following alternate wetting and drying of paddy cultivation, no financial management aspects were attempted by farmers towards climate change adaptation

2.7.6 Other Issues

Some other issues were also highlighted by the surveyed farmers in the study region of Andhra Pradesh. Most of them are issues related to agriculture and irrigation. These problems are listed in the points below:

- Conflicts in water distribution among farmers
- Poor cooperation among farmers
- Political influence in water distribution
- Unreliability in Water delivery
- Excessive canal seepage
- Water entitlement variations between head and tail regions
- Over irrigation
- Accumulation of silt in command areas
- Lack of knowledge on the effective utilization of water
- Limited penetration of organic farming in both the regions

In view of the problems highlighted by the farmers in the study region some solutions were also discussed with them during the focused group discussions and interviews. Picture 1 shows one of the ongoing focused group discussion and meeting going on in Kavuri village under DC 21. The following points list some of the activities suggested by the farmers that should be undertaken in the study area:

- Strengthening farmers involvement
- Encouraging crop diversification
- Water scheduling
- Awareness on crop wise water requirement and also water requirement during critical times of the crops
- Need for introduction of short duration crop varieties and good quality seeds

Picture 1: Focused group discussions in Kavooru village under DC 21

Additionally the surveyed farmers in Guntur region highlighted the following activities that need to be undertaken with regards to reducing climate change vulnerability:

- Establishment of seed bank
- Energy utilization through solar panels for various cropping activities
- Exposure to net house technology for vegetable farming
- Support on value addition for Guar gum products for men and women (SHG)
- Soil testing has to be extended and accurate suggestions on its results are needed by the farmers
- For Bt cotton, quality seeds need to be promoted with motivation for planting refuge plants as intercrops also to reduce pest control underlined by the concept of refuge based pest management
- Perception on latest technologies to mitigate climate change: (i) SRI: Farmers opined that SRI helps in reducing seed cost, higher yield and save water, (ii) Alternate cropping: Helps to mitigate delayed water release from canals; Machine transplanting: Saves cost and time, help in reducing labour cost, (iii) INM: increase yield, (iv) WUE methods: Saves crop in critical stage, less water, yield increase; Pest and Disease forecasting: farmers never had experience in following forecast information. They opined it is required now due to climate change; Crop insurance: Lack of awareness, supports when crop fails; Weather based agro advisory services: it give relief at floods, helps to control pest and disease, to plan crop yields, (v) Bio-fertilizers: Decrease environmental pollution, farmers never applied any bio fertilizers till now and (vi) Green manures crops: Farmers were following and opined that yield increase and reduce in fertilizer cost.

2.7.7 Gender Analysis

In Andhra Pradesh, more than 90% of women in farming are involved as agricultural labourers only. 8 in 10 agricultural workers are females as inferred from Focus group discussions in Nalgonda and Guntur. Almost one in every two women belongs to Self-Help Groups (SHGs) or a relevant association in the study area. They consider these groups as opportunities to learn different skills and also to derive income out of it.

A first and crucial condition for enabling and questioning women's participation is the recognition, at all levels, of women as resource users and managers and the acceptance of women's resource and management needs as legitimate (Goetz, 1995). With just 1% of female as farm heads in the study regions in the state, women often continue to be perceived as helpers of their husbands. Men are seen to best represent the water related interests and needs of the household at the level of the community, and complete congruence of interests between men and women is assumed. The paradigmatic subject of the public and economic arena is male, where that of the domestic arena is female.

(i) General Reciprocation to Climate Variability

Farmers were not informed reliably about the variability in climate or water availability in the recent cropping seasons. Sometimes they were advised not to go for irrigated crops due to lack of water availability but still canal water supply had been there in that season which reduced the economic efficiency of farmers resulting from less investments on farms in that period. Change in cropping pattern like early/late sowing, choosing alternate crops, varying crop rotations are some of the reciprocations from farmers, when they receive information on climate change or variability.

(ii) Migration to Other Jobs

When men prefer to migrate to other jobs, women are left with less or no options to leave farm based works. Fallow lands are sometimes turned to barren lands due to non-availability of resources leading to reduction in agricultural workforce and agricultural per capita income.

(iii) Impact on Livelihoods

When conventional approaches are followed by men to recover from the impacts on livelihoods, women try to adapt to the situation by opting for alternate income generating methods. Borrowing money in such situations is also less preferred by women compared to men. Nearly in 70% of households, women contribute up to about half of the cash income in the household earnings directly through agricultural labor or indirectly through household works. It had also been observed that young women play better role in decision making on agricultural activities.

Irrespective of the land ownership, both women and men are involved in decision making process. But in many cases, women follow decision from men though they make part of decision making process. On the other end, though decisions on financial matters are taken

together or in some cases taken lead by women in a family, these decisions are not influencing much the measures to be taken against climate change. In deficient rainfall years, majority of farmers change cropping patterns to water resistant crops and very few shift to livestock activities. Participation of women in Self-help groups or training courses does not discourage them from taking financial decisions in their household. Enrollment in SHGs aids in easier access to credit compared to the impetus it provides to the involvement in decision making at community level. The “Andhra Pradesh Farmers’ Management of Irrigation Systems (APFMIS Act)” of 1997 had not made any specific provisions for the women to be represented in the Managing Committees of WUAs. As WUAs serve as analogues to local bodies, such provisions could ameliorate the participation of women in WUAs and also in Managing Committees.

A separate analysis has been undertaken in the project area to look at Climate change and impacts on gender and how gender can be mainstreamed in adaptation. In addition a Gender strategy has been prepared for ClimaAdapt based on the earlier studies and also preliminary studies undertaken in ClimaAdapt (http://climaadapt.org/reports/).

3 Section III: Interventions for the Study Regions

3.1 Introduction

This section describes some of the interventions that are identified for the study region of Andhra Pradesh as a part of the situation analysis report.

3.2 General Interventions

- AWDI More focus on improving the usage of green manure crops as during the primary surveys it was found that farmers are aware of the benefits of the usage and select farmers are also following it. They were also of the view that this practice improves the yield and reduces fertilizer costs.
- Dissemination of information through VKC on the incidence of pests and crop diseases as farmers are of the view that the occurrence of these might increase due to the changes in weather and climate patterns
- The awareness about crop insurance schemes is very low in the study villages and the farmers are interested to register under weather based crop insurance and this is one good way of minimizing their cultivation risk against weather extremes
- The use of bio fertilizers can also be promoted through the project. The farmers in the study area have never applied these in their farming practices till now and hence it gives an opportunity to demonstrate the use of bio fertilizers and the benefits due to the usage (like decrease in environmental pollution)
- Amending the co-membership status of married women to expend voting rights by all eligible water users
- Orientation of WUAs on various aspects for its functioning where women can play an useful role
- Organizing thrift groups among the women members, acting as an agent for percolation of extension, mobilizing internal resources, etc
- Establishment of seed bank through ClimaAdapt has also been insisted by farmers during survey interactions and FGDs to get quality seeds of Bt cotton

3.3 Specific Interventions

- ✓ Water use efficiency could also be achieved by reduce the irrigation frequency when Methylobacterium (Pink Pigmented Facultative Methylotroph) is applied in different forms at various stages of growth
- ✓ Soil testing based management of fertilizer and nutrients application.
- ✓ Intercropping plants of different cropping periods and growth rate to derive better yields and profits in all seasons
- ✓ Greenhouse technology for vegetables and fruits cultivation encouraged with the enhancement of awareness on subsidies for the same
- ✓ Utilizing the biomass of weeds as mulch and Jute for enhancing soil moisture and erosion control are to be insisted

- ✓ Dhaincha and Pillipesara as green manure in fallow lands as well as intercrops
- ✓ Gaining the Subabul tree products for improving livelihood through wasteland development as it is climate resilient and for noted forage characteristics
- ✓ Promotion of marketing and packaging practices for alternate crops such as Guar for commercial utilization through SHGs.

3.3.1 Bt. Cotton Refuge based Pest Management

Refuge based pest management could be considered as a special case in intercropping techniques by planting non-Bt cotton or other associated refuges like Pigeonpea, Sorghum plants in rows between Bt cotton plants. With Bt cotton cultivation, fertilizer application had already been reduced and by following refuge based pest management, pesticide application also can be controlled. As this mechanism has a genetic basis, keen manifestation to farmers looking for yield improvement in cotton is required.

3.3.2 Suggestions for improving livelihood of women to moderate impacts of Climate Change

- Provide financial support for self employment i.e. cattle farming
- Training classes could be conducted on allied agricultural activities like silk worms rearing, dairy and poultry etc…
- Motivation towards agricultural labor work to women and men who migrate to Govt.'s NREGA scheme and facilitate self employment opportunities from farm outputs
- Awareness about the weather forecasting
- Support in educating in alternate cropping methods, alternate farming techniques
- Training on specific dryland agriculture techniques and value addition of farm products through candle making, sewing, small scale manufacturing units
- Amending the co-membership status of married women to expend voting rights by all eligible water users
- Orientation of WUAs on various aspects for its functioning where women can play an useful role
- Organizing thrift groups among the women members, acting as an agent for percolation of extension, mobilizing internal resources, etc

4 Section IV: Indicators for Evaluating the Identified Project Interventions

As described in the introduction section, the overall goal of the ClimaAdapt program is to improve the adaptive capacity of the agriculture and water sectors. The aim is to achieve this by contributing to the adaptation and mitigation potential in the study regions through select project based interventions. The existing problems concerning rural population cannot be sustained by land alone given the size of this population and its growth dynamics. Additionally, over the past decades there have been increasing concerns about the impacts of climate change on the regions and households. Evidences point out the climate change is going to pose a further stress on the existing resources and endowments thereby creating a further strain on the different sectors of the economy. For example many developing economies are heavily dependent on primary sectors like agriculture for their growth and development and climate change is likely to have a negative impact on this sector given the uncertainties about climate parameters like rainfall, temperature etc. In view of this technological interventions pertaining to agricultural technologies assume significance in the process of production and income generation. The provisions for other components in the production process are taken care of by government agencies and other institutional and market mechanisms. From a developing country perspective, the interventions become more significant given the limits to exploitation of natural resources, demands from ever growing population, constraints regarding factor endowments and growing uncertainties regarding impacts of climate change. The most plausible solution to this problem is the selection and adoption of modern technologies relevant to rural areas. Along with finance, infrastructure and human resources, technology is a crucial input in the process of production and hence is important in the process of overall development of a region and socioeconomic wellbeing of the people.

As described the overall goal of this integrated program is to improve the adaptive capacity of the agriculture and water by contributing to the adaptation and mitigation strategies and so the project interventions must enhance the nutrient and water use efficiencies in the project areas by minimizing the fossil fuel dependent agro inputs, besides reducing the emission of green house gases from agro eco system. Hence technologies that enhance the water & nutrient use efficiencies, reduce green house gases like methane and nitrous oxide from agro eco systems, minimize chemical input usage, build up organic matter content of the soil etc have been identified and suggested for promotion in the project area. Increased adoption of these eco friendly technologies due to project intervention would be a good sign of positive impact of the project in the basin. Other indicators are also included which aim to capture the overall welfare of the households residing in the study regions and also the feasibility of undertaking the selected interventions.

With regards to the present study regions in is important that the project interventions must enhance the nutrient and water use efficiencies in the project areas by minimizing the use of fossil fuel dependent agro inputs, besides reducing the emission of green house gases from agro eco system. Hence technologies that enhance the water and nutrient use efficiencies, reduce green house gases like methane and nitrous oxide from agro eco systems, minimize

chemical input usage, build up organic matter content of the soil etc have been identified and suggested for promotion in the project area. The identified technological interventions have been classified as eco friendly technologies and hence increased adoption of these technologies in the study region over the project period would indicate improvement of adaptive capacity and building of resilience for the farmers residing in the basin which in turn will contribute to their overall welfare and well being. The effective interventions should aim to:

- Reduce Climate Change Impacts by building Resilience and Adaptive Capacity
- Create Value Additions
- Improve Efficiency and Reduction of Wastage
- Provide Avenues for Employment Generation
- Address Environmental Problems

With this background and the on the basis of situation analysis undertaken in the study regions table 13 shows the indicators identified in the present project for documenting the effectiveness of project based interventions. The first column lists the indicators for capturing the use and effectiveness of the identified interventions. Column two lists the different measurable proxies that can be used to quantify the impact of the interventions. The third column lists the possible impacts and the outcomes and the fourth column describes the units that can be used to measure the indicators.

Table 13: Log frame for Indicators

Sl. No	**Interventions**	**Output Indicator**	**Outcome Indicator (Units)**	**Impact Indicator**
1		▪ Water Use Efficiency ▪ Production ▪ Yield ▪ Soil Organic Matter ▪ Water Holding Capacity ▪ Soil Fertility	▪ Number of Farmers Adopted (Nos. / %) ▪ Per capita consumption expenditure (Rs.) ▪ Average Total Income (Rs.) ▪ Share of Agricultural Income (Rs.) ▪ Income derived from other sources (Rs.) ▪ Gini coefficient (Index) ▪ Cost of Inputs (Rs.) ▪ Cost of Production (Rs.)	▪ Climate Change Resilient Agriculture ▪ Enhanced Adaptive capacity to deal with natural disaster risks and climate change
2	Alternate Wetting and Drying /Direct sowing of rice			
3	Green manure cultivation prior to first monsoon			
4	New varieties in Paddy and Cotton			
5	Microbial fertilisers cultivation (e.g. Azolla / Blue Green Algae)			
6	Need based fertilizer application			
7	Micronutrient application			

8	WUE	▪ Application Efficiency of Water ▪ Units Established	▪ Number of Farmers Adopted (Nos. / %) ▪ Acreage Area (km^2) ▪ Net area under Cultivation (acres) ▪ Quantum of Water Saved (liters)	▪ Enhanced WUE which is one among the main adaptation strategies in water sector ▪ Methodology used by AP Govt in other areas
9	Pest and disease risk assessment			
10	Weather based crop insurance	▪ Crop loss	▪ Compensation Received (Rs.)	▪ Risk reduction in Agricultural Production ▪ Enhanced Adaptive capacity to deal with natural disaster risks and climate change
11	Gender	▪ Gender Empowerment and Mainstreaming	▪ Percentage of population (men & women) with access to education (%) ▪ Percentage of Women Farmers (%) ▪ Percentage of women in Water User Associations (%) ▪ On and Off Farm Practices (Nos. / %)	▪ Change in Equity and Welfare ▪ Income Diversification and Stability ▪ Drudgery Reduction
12	Capacity Building	▪ Intervention, coordination and capacity to respond to !improved climate related information	▪ Number of Trainings Organized (Nos.)	▪ Farm Productivity Enhancement Measures ▪ Technology Transfer ▪ Climate Resilient Package Practices for Training of Trainers (TOTs)
13	Village Resource Centre (VRC)	▪ Number of Centers Established	▪ People Visited (Nos.) ▪ Kind of Information	▪ Awareness on Climate Risk ▪ Acceptance of

			sought (Scale) ▪ Applications of Information (Nos.)	Farming Practices ▪ Changes in Adaptive Capacity
14	Local Institutions	▪ Water User Associations	▪ Operation and Maintenance Costs for WUAs (Rs.) ▪ Timeliness and Equity of Water Delivery (%) ▪ Distribution Efficiency in Head/Middle/Tail Region (Nos.) ▪ No. of Penalties in WUAs (Nos.)	▪ Water Distribution Pattern and Sharing Benefits on and off agriculture
15	Policy	▪ Stakeholder Advisory Committee/ Uptake of Policy Inputs at various levels	▪ Number of Meetings held ▪ Knowledge sharing Events ▪ Briefs / Reports Brought out	▪ Inputs toState Policy ▪ Linkage with state programs