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Socioeconomic Profiles, Production and Resource Use Patterns in Selected Semi-arid Indian Watershed Villages

International Crops Research Institute for the Semi-Arid Tropics

Andhra Pradesh Rural Livelihoods Programme

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Abstract

The collaborative watershed research and development project between ICRISAT and the Andhra Pradesh Rural Livelihoods Programme (APRLP) was initiated with an overall objective of alleviating poverty through watershed-based interventions that enhance agricultural productivity and the sustainability of rural livelihoods. The initial phase of the project focused on participatory technology evaluation in selected watersheds for development of best practices and upscalable implementation models. Characterization of the biophysical and socioeconomic systems is an important aspect of this work. A detailed baseline socioeconomic farm household survey was conducted in 2003 in selected watershed villages of Mahabubnagar, Nalgonda and Kurnool districts. This report analyzes the socioeconomic conditions and resource endowment patterns of the watershed farmers. The report provides a snapshot of the structure of production in the villages, constraints and potential for increased productivity, social and political networks, and the distribution of assets across social groups. The net household incomes from diverse sources including crop, livestock and off-farm and their contribution to total household income in the selected villages are presented. The report also analyzes the income inequalities and the effect of different income sources on household income inequalities in the watershed villages using inequality decomposition techniques.

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Contents

1. Introduction

Background

Hunger, poverty, and deprivation remain acute constraints to sustainable development in many dryland areas of South Asia (ADB 2000). Increasing population growth only exacerbates the already depressing scenario in these marginal areas. The causes of poverty could be demographic, social, ecological degradation, water scarcity or lack of access to land and other natural resources.

Development in semi-arid regions is constrained by various socioeconomic, technological and institutional factors. Majority of the farmers in these regions are poor, illiterate and are not in a position to afford high cost and high input technologies. Lack of timely and limited availability of institutional credit to the rainfed farmers vitiates the situation even more. Increasing poverty coupled with frequent droughts has increased the strain on the natural resource base. Over exploitation of natural resources including depletion of forest cover and biodiversity resulting from increasing human and livestock pressure, has caused degradation of land, water and other essential ecosystem services in India (Samra and Narain 1995).

In India, rainfed areas constitute about 65% of arable land that are characterized by low productivity and about 70% of the population in this region is dependent on agriculture. These areas were bypassed with respect to investment on infrastructure and technology intervention as compared to irrigated areas due to a general misperception that investments in these areas would be less productive (Joshi et al. 2004). But an analysis into the government investments in India by Fan and Hazell (1999) showed that rainfed areas (less favored areas) offer greater growth for an additional unit of investment apart from having a much larger impact on poverty alleviation as compared to irrigated areas. As growth opportunities in more favorable zones are exhausted, the need to improve the productivity of less favored regions (rainfed areas) has become more compelling on the grounds of equity, efficiency and sustainability (Shiferaw et al. 2003).

Inequalities in the distribution of land, water and access to other natural resources have significant effect on poverty alleviation strategies and have to be taken into account when designing programs. Livelihood strategies of households vary depending on the extent of inequalities in a village. Tenant farmers and landless laborers are more in areas with more concentrated landholdings resulting in complementary livelihood activities such as livestock production and seasonal migration. Millennium development goals (1996–2015) include eradication of extreme poverty and hunger while ensuring environmental sustainability. The growing scarcity and competition for water, however, stands as a major threat to future advances in poverty alleviation.

Watershed development offers a unique approach to address these issues. A watershed is a hydrological unit that can serve as a biophysical unit and as a socioeconomic and socio-political unit for planning and implementing resource management activities (Springate-Baginski et al. 2002). Watershed development aims to ensure availability of drinking water, fuelwood and fodder and raise income and employment for farmers, landless laborers, women and other vulnerable groups through improvements in agricultural production and productivity in the areas with marginal lands that are prone to soil erosion and moisture stress (Hanumantha Rao 2000). The watershed program envisages a great opportunity for improving the productivity, profitability and sustainability of dry farming areas through social mobilization. Integrated watershed management (IWM) forms an important strategy to attain these goals in the semi-arid regions, which are socioeconomically and environmentally vulnerable (Wani et al. 2003).

About the study region

The state of Andhra Pradesh in India is situated in the tropical region between 12°14' and 19°54' N and 76°46' and 84°50' E. It is the fifth largest state in the country both in terms of geographical area and population comprising 23 districts, 1,105 revenue mandals and 29,994 villages spreading over 276,814 km^2. The total state population was 66.5 million according to the 1991 census. The sex ratio of females to 1000 males was 972 (1991 census). The population density of the state increased from 193 in 1981 to 242 persons km^{-2} in 1991.

Andhra Pradesh is classified into three regions, viz, Rayalaseema, Telangana and Coastal Andhra based on social and cultural factors. The state has a tropical climate with moderate diffusion to subtropical weather. Humid to semi-humid conditions prevail in the coastal area while arid to semi-arid situations are frequent in the interior parts of the state, particularly Rayalaseema and some districts of Telangana. Droughts are quite common in the interior parts of the state especially in the Southern Telangana and Rayalaseema regions. On an average, at least one drought is reported every five years.

The rainfall seasons in Andhra Pradesh are the Southwest monsoon period (June to September) and Northwest monsoon period (October to December). The total rainfall in the state in 2002–03 was only 612 mm as compared to 940 mm in normal years (decreased by about 35%). Figure 1 compares the actual monthly rainfall during the monsoon periods in 2002 with the rainfall during normal years (calculated as average of last 5 years). It can be seen that the rainfall was erratic, especially during the critical months of July to September where it was very low than the normal. The gross cropped area during 2002–03 declined by about 9.4% (from 12.7 million ha to 11.5 million ha). Consequently, the production of food grains decreased to 10.65 million t during 2002–03 from 14.83 million t in 2001–02 (a decrease of 28.2%).

To combat the frequent recurrence of drought in the state, the Drought Prone Area Programme (DPAP) was introduced during the year 1975, as a centrally sponsored scheme with a matching state funding share of 50%. The Integrated Wasteland Development Programme was introduced during 1991 with 100% central government assistance. The Department of Panchayati Raj and Rural Development under the central government implemented both programs.

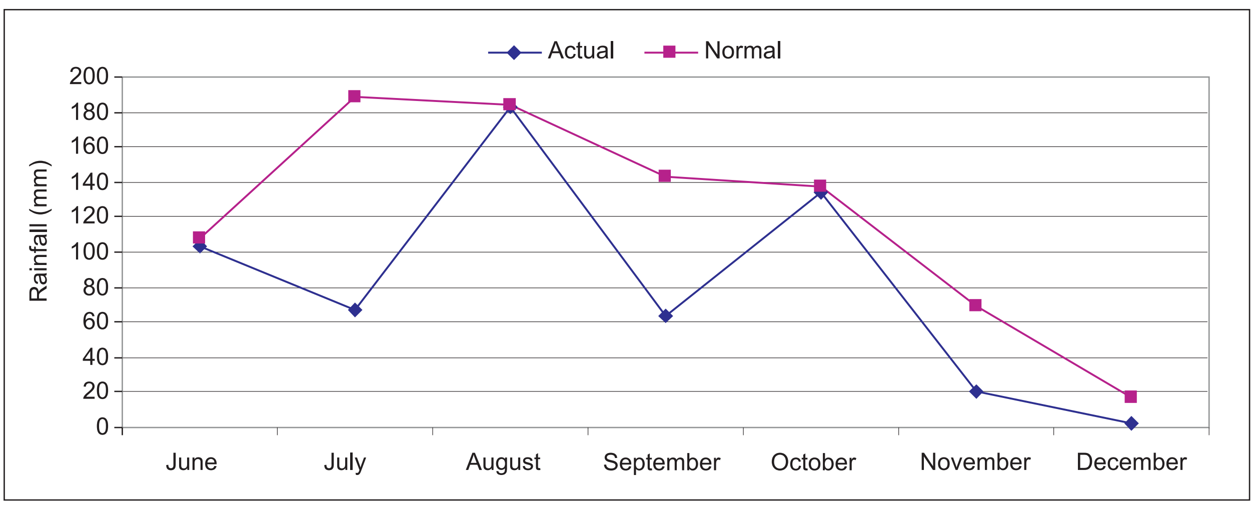

Figure 1. Monsoon rainfall in Andhra Pradesh during 2002.

A program was launched during 1997 for development of wastelands, degraded lands (ie, drylands which are being cultivated under rainfed conditions) and degraded reserve forests in Andhra Pradesh over a period of 10 years. It was envisaged to develop 10 million ha of degraded lands and wastelands, with an outlay of about US$ 0.88 billion from 1997 to 2007 at the rate of 1 million ha every year. About 2.7 million ha have already been covered through 5,472 watersheds, which is the largest number in the whole country (GoAP 2000).

The Andhra Pradesh Rural Livelihoods Programme (APRLP) was initiated by the state government in partnership with and the support of the Department for International Development (DFID), UK to reduce poverty through effective and sustainable livelihoods approach in the districts of Anantapur, Kurnool, Mahabubnagar, Nalgonda and Prakasam. The sustainable rural livelihood strategy was integrated with the IWM approach by supporting capacity building, livelihood support and convergence of other schemes and services (collectively called "watershed plus") (Montagu and Reddy 2002).

The selection of APRLP watershed habitations involved a revised nine-point selection criteria that included small and marginal farmers, scheduled caste/scheduled tribe (SC/ST) holdings, women self-help groups (SHGs) in a watershed, status of groundwater, Andhra Pradesh State Remote Sensing Application Centre (APSRAC) prioritization, livestock holdings, migration in the area, contiguity with treated/proposed watershed, and availability of fallow/wasteland and common property resources (CPR) for the poor and landless. Compared to the previous watershed activities, the focus of current watershed development activities expanded to include not only geo-hydrological details like sedimentation, evapo-transpiration and rainfall but also socioeconomic indexes like poverty, illiteracy, migration for wage labor, availability of drinking water, etc. There is also a new stress on the willingness of the community to involve themselves in all stages of watershed development. The concept of watershed development has moved from being a land-and-water program to that of community-centric program (APRLP guidelines). Integrated watershed management aims to improve the livelihood of farmers by increasing their income earning capacity through offering improved production and resource management practices required for sustainable agricultural intensification (Wani et al. 2002). The important issues for watershed programs in rainfed areas typically aim to enhance crop production, increase household incomes and minimize degradation of natural resource base. Objectives of watershed programs combine a range of targets, which include production objectives, equity objectives and sustainability objectives (Turton et al. 1998).

The integrated watershed development program focuses on resource conservation, productivity growth and income diversification to reduce household vulnerability to drought. In general, the watershed program activities include construction of check-dams (water storage structures), gully control structures, gabion structures, field bunds and percolation tanks. The government supported watershed development program normally lacks the much needed technical support for building up the capacities of the primary and secondary stakeholders. This gap of resource pool is an important factor for bringing down the success probability of a watershed program. The IWM includes the critical elements of community mobilization, institutional development, capacity building and convergence of activities to restore ecological balance and enhanced livelihoods opportunities.

APRLP-ICRISAT partnership

The APRLP and ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) collaboration was initiated in April 2002 with an overall objective to increase the impact of the

DFID-APRLP watershed program in rural India to alleviate poverty through enhanced agricultural productivity and improved livelihoods opportunities.

ICRISAT and the national agricultural research system (NARS) and development partners have developed and evaluated the consortium model for integrated watershed development (Wani et al. 2002). The details of the consortium model and the results of its evaluation were recently reported (Wani et al. 2003). The priority of the consortium was to provide technical support for efficient water storage, soil conservation and efficient use of the conserved and available natural resources in the watershed to increase productivity, minimize land degradation and improve livelihoods.

Some of the on-farm technological interventions include introduction of new improved varieties, broad-bed and furrow (BBF) land form and contour planting to stimulate in-situ soil and water conservation; tropicultor usage for planting, balanced fertilizer application and intercultural operations; and in-situ generation of organic matter through *Gliricidia* planting on field bunds. Apart from these, activities such as vermicomposting for producing biofertilizers, production of biopesticides using nuclear polyhedrosis virus (NPV), integrated nutrient management (INM) and integrated pest management (IPM) were being promoted in the watershed villages. The focus was also on scaling-up the innovative farmer-participatory consortium model from the selected villages to other neighboring villages.

The successful experience of ICRISAT regarding the innovative model with a consortium of actors, as opposed to interventions undertaken by a single organization, for technical backstopping in Adarsha watershed of Kothapally in Ranga Reddy district was used as a prototype model that can be adapted for other watersheds under the APRLP collaboration.

The ICRISAT-led consortium for technical backstopping is composed of the District Water Management Agency (DWMA), Central Research Institute for Dryland Agriculture (CRIDA), Acharya NG Ranga Agricultural University (ANGRAU), Krishi Vignan Kendras (KVKs), National Remote Sensing Agency (NRSA), APRLP, non-governmental organizations (NGOs), community-based organizations (CBOs) and watershed farmers. The consortium is working to test and develop technological, policy and institutional options for IWM in selected watersheds (Wani et al. 2003). All the stakeholders work in partnership with one another and with farmers and the watershed association to conserve rainwater, improve land and water productivity and enhance the sustainability of the resource base.

In the process of scaling-out the model, in each district 3–4 nucleus watersheds were selected as demonstration sites for putting together the IWM interventions. The nucleus watersheds selected are with different project implementing agencies (PIAs) so as to enable lateral/horizontal scaling on its own through the watersheds under each of the PIAs. The nucleus watersheds selected for this study in the districts of Mahabubnagar, Nalgonda and Kurnool are shown in Figure 2. The rainfall in these watersheds ranges between 500 and 800 mm.

Each nucleus watershed had four satellite (outreach) watershed villages and the farmers and SHG members from the nucleus watersheds became the facilitators of spillovers to the targeted satellite watersheds (Wani et al. 2002). The nucleus watersheds and their associated satellite villages are listed in Table 1.

Objectives of the study

The outcome and impact of a watershed program is likely to depend on various factors that include physical characteristics of the watershed, nature of property rights (existing institutions), social

Table 1. Selected nucleus watersheds and associated satellite villages in Andhra Pradesh.

District	Mandal	Nuclear watershed	PIA	Satellite watershed villages
Mahabubnagar	Jadcherla	Malleboinpally	Govt. Dept.	Gollapally Allur Gangapur Booreddypally
	Wanaparthy	Mentapally	SDDPA	Peddagudam Kadukuntla Chandapur Dattaipally
	Nagarkurnool	Sripuram	Govt. Dept.	Uyyalawada Naganoor Nallavelli Wanapatla
	Mahabubnagar	Appaipally	BAIF	Koduru Machenapally Nandipet Gudibanda
Nalgonda	Chintapally	Tirumalapuram	DASM	Nasarlapally G Gowraram Nelvalpally Theadedu
	Yadagirigutta	Kacharam	ADDRESS	Dharmareddygudem Saduvally Kamatamvarigudem Pamukunta
	Atmakoor (S)	Nemmikal	DISHA	Pathasuryapet Gattikal Naseempet Atmakoor
Kurnool	Banaganapally	Nandavaram	Govt. Dept.	Tambadapalli Rollakothuru Beeravolu Jillela
	Devanakonda	Kanugulavanka	RAIDS	Gundalakonda MK Kottala K Venkatapuram Burakunta, Gudimiralla
	Devanakonda	Karivemula	APARD	Jillelabudakala Obhulapuram Madhapuram Karidikonda

structure (size of community, history of collective action, extent and nature of social capital, etc.) and organization of the community (Turton et al. 1998). Regular impact monitoring and evaluation is critical for adaptive management of a watershed program that will enhance the capacity to attain stated objectives. Baseline data on biophysical and socioeconomic conditions in the watershed provides a useful check that would help compare future changes in cropping patterns, productivity and livelihood strategies of households after controlling other exogenous changes. There is a need to understand more about the baseline conditions that affect the process and outcome of micro-watershed development.

Characterization of the watershed project villages through a baseline survey provides researchers and policy makers with a snapshot of the socioeconomic aspects, land characteristics, constraints and potential for increased productivity, social and political networks, cropping patterns, livelihood strategies and crop and livestock production activities. Knowledge of baseline conditions is necessary to identify the relationship between biophysical and socioeconomic characteristics and identify factors that condition the success of IWM interventions. This would also help in continued monitoring and evaluation of socioeconomic and environmental impacts of the watershed program.

As part of the project, a detailed baseline socioeconomic farm household survey was conducted in 2003 in selected nucleus watershed villages of Mahabubnagar, Nalgonda and Kurnool districts of Andhra Pradesh to identify the major socioeconomic, biophysical constraints for sustainable crop production in each village. The purpose of this study was to characterize and assess the baseline biophysical and socioeconomic conditions in these selected watersheds. The report documents the socioeconomic conditions and resource endowment patterns of the watershed farmers, along with net incomes for different household groups from alternative income sources (crop, livestock and off-farm). This would be a suitable benchmark for monitoring changes and to assess the impacts of watershed activities in the future. The specific objectives of this research report are to:

1. Understand better the production system and identify constraints, potential opportunities, farmer needs and priorities for IWM;
2. Identify the major livelihood strategies for different household groups and implications for the project;
3. Assess the level of inequality (in endowment of assets and income), social heterogeneity, access to resources in the community and implications for the project;
4. Generate baseline data for impact monitoring and evaluation.

Sample characteristics

The data was collected for the 2002–03 production year using a pre-tested structured questionnaire. A random sampling procedure was used to select the households in two watershed villages from each of the three districts (Mahabubnagar, Nalgonda and Kurnool). The watershed area and the number of households constituting the representative sample in the respective watersheds are given in Table 2.

Table 2. Watershed area and sample households in selected watershed project villages in Andhra Pradesh.

Watershed	Watershed area (ha)	Total households in watershed area	No. of sample households
Malleboinapally	524	230	60
Mentapally	425	235	65
Tirumalapuram	518	72	72
Kacharam	662	324	90
Nandavaram	500	330	63
Kanugulavanka	500	250	70

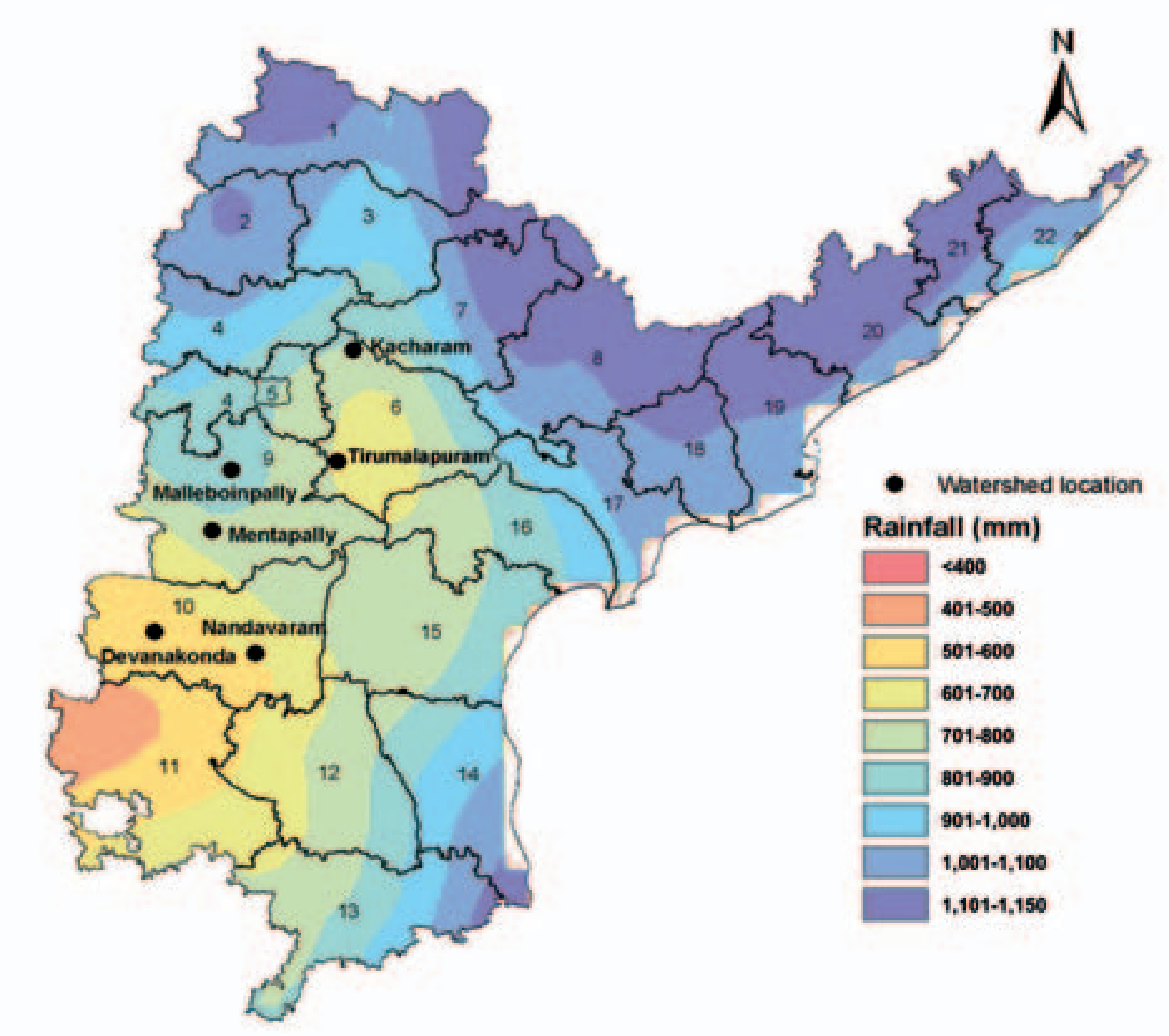

Figure 2. Location of the selected nucleus watershed areas and rainfall zones in Andhra Pradesh. (Note: 6 = Nalgonda district; 9 = Mahabubnagar district; 10 = Kurnool district.)

The sample households were selected such that the land distribution and caste distribution closely matched that of the land and caste distribution of the entire village. Depending on the size of the village, the sample size varied between 19 and 100% of the total households in the watershed communities. Apart from the household survey, additional information was also collected through participatory methods such as focus group discussions, key informants and transect walks within the village.

Structure of the study

The research report is organized as follows. Sections two, three and four present district-wise results from analysis of sample survey data in the selected watershed villages. The analysis provides insights into the socioeconomic conditions in the watershed villages including demographics, social heterogeneity, distribution of resources, access rights, crop and livestock production activities, adoption of new technologies, yield and productivity levels, household vulnerability and incidence of droughts, diversification of income sources, natural resource conditions (eg, groundwater and CPR). Section five examines the income inequalities that exists within the study villages and analyzes how the different sources of income contribute to changes in household income inequalities. Section six provides a summary of the key results and policy implications for sustainable improvement of livelihoods and the agricultural resource base through the integrated community-based watershed management interventions in the study areas.

2. Socioeconomic Profiles and Resource Use Patterns in Watersheds of Mahabubnagar District

This section characterizes and assesses the baseline biophysical and socioeconomic conditions in the selected watersheds of Malleboinpaly in Jadcherla mandal and Mentapally in Wanaparthy mandal of Mahabubnagar district.

District profile

The principal food grain crops in the Mahabubnagar district are rice, sorghum, finger millet and pearl millet while the principal commercial crops are groundnut and castor. Pigeonpea and green gram were the major pulse crops. Mahabubnagar district had the largest acreage in the state under sorghum and castor during the 2002–03 cropping season (Fig. 3). It accounted for 71% of the total castor production in the state.

In Mahabubnagar district, the total rainfall in 2002–03 was only 536 mm as compared to 604 mm in normal years (decreased by about 24%). The rainfall data during the monsoon months in Mahabubnagar district is shown in Figure 4. The figure compares the actual monthly rainfall during the monsoon periods in 2002 with the rainfall during normal years (calculated as average of last 5 years). The rainfall was erratic, especially during July and September and was much less than the normal.

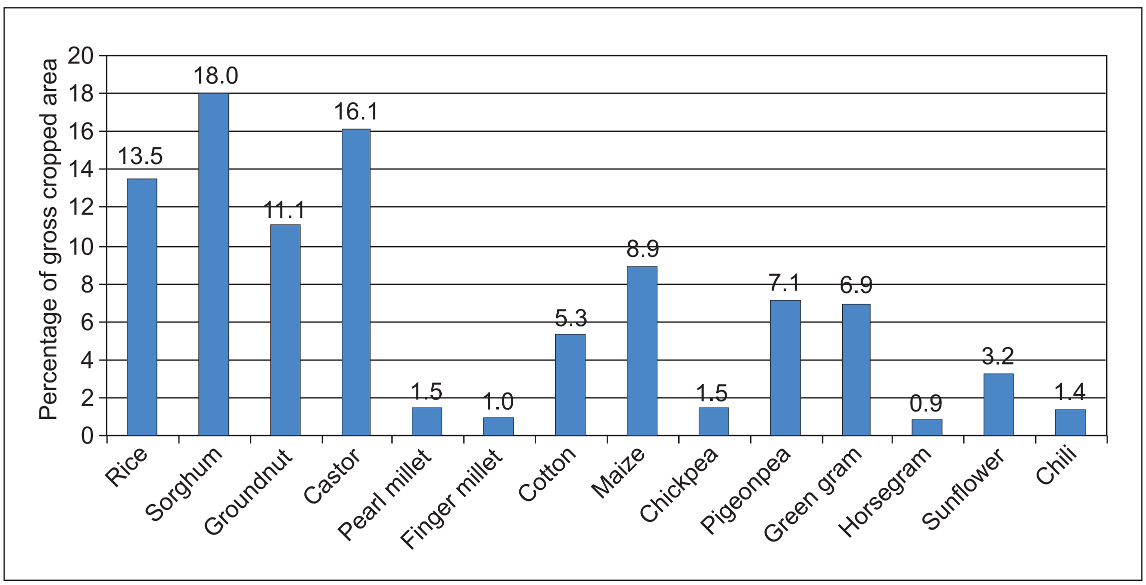

Figure 3. Area under major crops in 2002–03 in Mahabubnagar district.

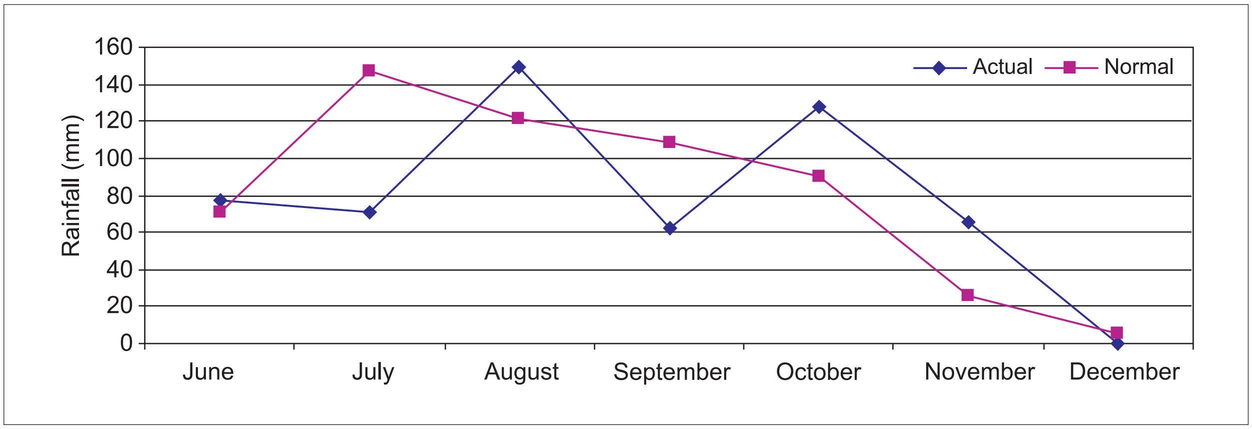

Figure 4. Monsoon rainfall during 2002 in Mahabubnagar district.

In Mahabubnagar district, significant changes in cropping pattern were noticed in 2002, which was considered as a drought year. Paddy accounted for about 8% of total cropped area, sorghum accounted for 12% and cotton 4% of total cropped area in *kharif* (rainy season) 2002 (see Table 3 for more information). The same crops accounted for 12%, 17% and 9% of total cropped area, respectively in normal years. There was a decline in the areas sown under paddy, sorghum and cotton in *kharif* 2002 as compared to normal years (Fig. 5). There was considerable increase in the area under maize (an increase of 18,803 ha) and castor (an increase of 40,521 ha). In *kharif* 2002, maize and castor accounted for 8.78% and 31% of total cropped area, respectively whereas in normal years they accounted for 4.76% and 20.71% of total cropped area, respectively.

Table 3. Normal and actual area sown (ha) and deviations of major crops in Mahabubnagar district during *kharif* 2002.

	Jadcherla mandal			Wanaparthy mandal			Mahabubnagar district		
Crop	Normal	Actual	Change	Normal	Actual	Change	Normal	Actual	Change
Paddy	1826 (14.14)[1]	546 (4.72)	–1280	1197 (17.52)	1318 (15.56)	121	82174 (12.00)	47236 (8.07)	–34938
Sorghum	3078 (23.84)	2502 (21.62)	–576	1400 (20.49)	914 (10.79)	– 486	118351 (17.28)	70165 (11.99)	–48186
Finger millet	171 (1.32)	964 (8.33)	793	139 (2.03)	192 (2.27)	53	10345 (1.51)	10433 (1.78)	88
Maize	768 (5.95)	1046 (9.04)	278	218 (3.19)	1115 (13.16)	897	32587 (4.76)	51390 (8.78)	18803
Pigeonpea	919 (7.12)	677 (5.85)	–242	459 (6.72)	680 (8.03)	221	54038 (7.89)	43276 (7.40)	–10762
Castor	3341 (25.87)	4554 (39.34)	1213	2528 (36.99)	3326 (39.27)	798	141835 (20.71)	182356 (31.17)	40521
Cotton	1873 (14.50)	465 (4.02)	–1408	48 (0.70)	4 (0.05)	–44	62086 (9.07)	22706 (3.88)	–39380
Chili	126 (0.98)	164 (1.42)	38	18 (0.26)	18 (0.21)	0	9381 (1.37)	14566 (2.49)	5185
Total cropped area	12913 (100)	11575 (100)	–1338	6834 (100)	8470 (100)	1636	684891 (100)	584980 (100)	–99911

1. Figures in parentheses indicate percentage values and do not add up to total since only major crops were considered.
Source: Joint Director of Agriculture, Mahabubnagar.

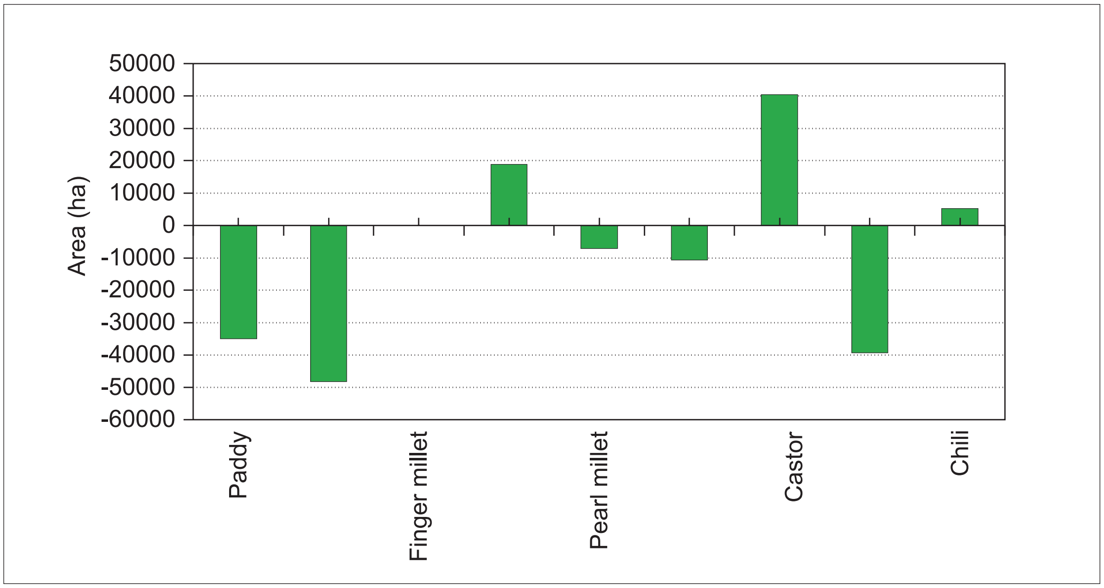

Figure 5. Cropping pattern in kharif *2002 as compared to normal years in Mahabubnagar district.*

In Jadcherla mandal, similar pattern was observed (Fig. 6). Maize and castor constituted about 9% and 39% of total cropped area, respectively in *kharif* 2002 whereas in normal years these accounted for about 6% and 26% of cropped area, respectively. In Wanaparthy mandal, there were considerable gains in area under maize and castor and there was also a small increase in area under paddy (121 ha). In particular maize accounted for about 13% of total cropped area in *kharif* 2002 as compared to only 3% of total cropped area in normal years.

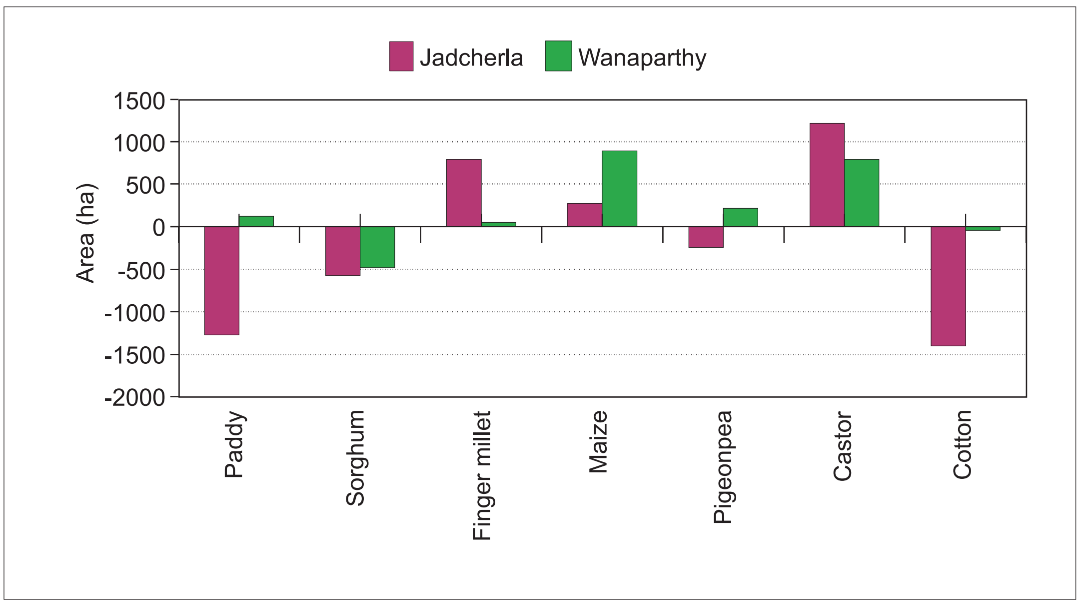

Figure 6. Cropping pattern changes in kharif *2002 as compared with normal years in two mandals in Mahabubnagar district.*

General characteristics of the watershed villages

Malleboinpally (Jadcherla mandal) and Mentapally (Wanaparthy mandal) in Mahabubnagar district are the selected nuclear watershed villages for this study (Fig. 7). Malleboinpally is located between 78°09' latitude and 16°77' longitude and Mentapally, between 77°95' latitude and 16°31' longitude. Malleboinpally village is located 5 km from Jadcherla (mandal headquarters) and 12 km from Mahabubnagar (district headquarters). Apart from the village itself, surrounding hamlets (*thandas*) namely, Pochammagadda *thanda*, Mangalikunta *thanda* and Kotha *thanda* also come under this village panchayat. The village is spread over an area of about 524 ha. Cultivable land accounts for 61.4% of the total village area (524 ha) that includes both dryland and irrigated areas (Table 4).

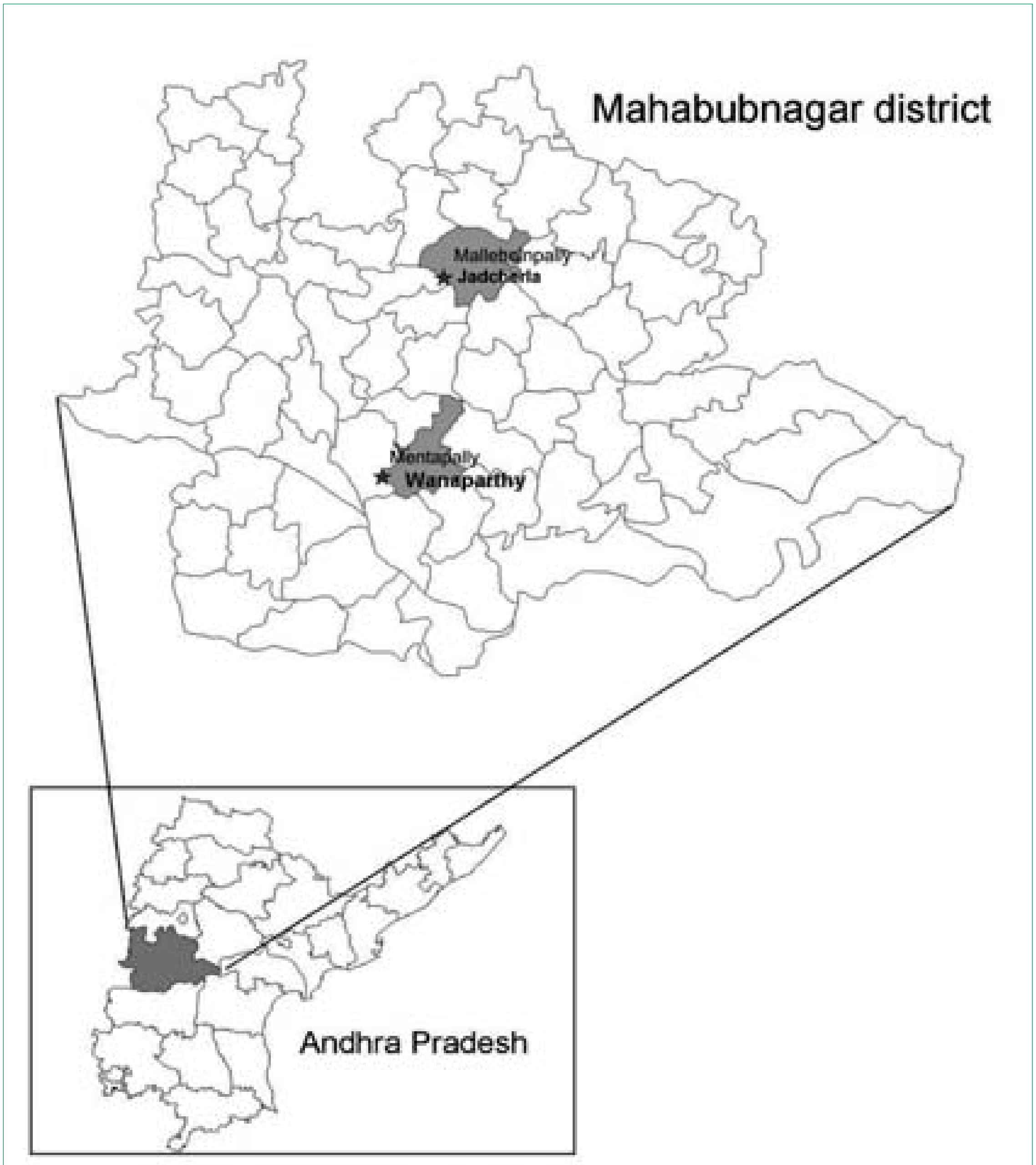

Figure 7. Location of selected watershed villages of Mahabubnagar district.

Table 4. Land resources in the selected watershed villages in Mahabubnagar district.

Characteristics	Malleboinpally	Mentapally
Total cultivated land (ha)	321.8 (61.4)[1]	295.5 (69.4)
- Irrigated cultivated area (ha)	27.1	44.5
- Dryland cultivated area (ha)	294.7	251
Permanent fallow (private) (ha)	80.9 (15.4)	121.5 (28.6)
CPR and forest area (ha)	91.1 (17.4)	4.1 (0.9)
Other land (settlements, etc) (ha)	30.4 (5.8)	4.1 (0.9)
Total village area (ha)	524.3 (100)	425.1 (100)

1. Figures in parentheses are percentage values.

Out of the total cultivated area of 321.8 ha in Malleboinpally, nearly 91.5% was dryland and remaining 8.5% was irrigated. The major soil types (in local terminology) in the village were *dubba*, *erra* and *nalla* apart from other mixed soils. *Dubba* is a mixture of soil and sand, with a higher percentage of sand and a soil depth of 30–60 cm; *erra* are the red soils with depth between 45 and 90 cm; and *nalla* are the black soils with a depth of about 60 cm (Dvorak 1988). The major crops grown in 2002–03 were maize, castor and sorghum with pigeonpea as intercrop and maize being the most preferred crop. Livestock in 2002–03 consisted of approximately 212 buffaloes, 142 cattle, 800 sheep and 365 goats.

Mentapally is located 12 km from Wanaparthy (mandal headquarters). The village area is about 425 ha. Cultivable area was about 295.5 ha which accounts for 69.52% of total area. Dryland cultivation accounted for 84.92% of the total cultivated area and the remaining 15.08% consisted of irrigated land. The major soils in Mentapally are *dubba* or *tuvva* followed by *erra* and *nalla*.

The major crops grown in 2002–03 were castor, sorghum, and maize with pigeonpea as intercrop in *kharif*. Paddy was also grown depending on availability of water. Groundnut and paddy were the major *rabi* (postrainy season) crops. The livestock holdings in Mentapally were relatively low with 220 cattle, 60 buffaloes, 20 sheep and 45 goats.

Demographic characteristics

In Malleboinpally, the average age of the household head for the sample households was about 46 years with an average education of 4.25 years (Table 5). The average family size for the Malleboinpally sample was 5.63 persons with a standard deviation of 2.34. The family size varied between a minimum of 2 and a maximum of 13. Seventy percent of the sample households had a family size of 6 or less. About 38% of the households had a family size of 4 or less.

The work force was computed as a weighted sum of individuals in the age groups of 11–15 years, 16–55 years and 56–65 years with values of 0.25, 1.00 and 0.25, respectively (Shiferaw et al. 2002). The average weighted work force for Malleboinpally was 4.13 persons per household. About 22.57% of the sample population can be considered as dependents based on age criteria (less than 10 years and those above 65 years).

The dependency ratio was computed as the ratio of non-working members to working family members (Shiferaw et al. 2002). The average dependency ratio of 0.45 indicates that every working family member supported 0.45 persons.

Table 5. Demographic characteristics of Malleboinpally[1].

Characteristics	Mean	SD	Minimum	Maximum
Age of household head (yr)	46.20	12.42	23	72
Education of household head (yr)	4.25	5.08	0	19
Education of family (yr)	3.97	4.41	0	16
Persons below 5 years	0.52	0.77	0	3
Persons 6–10 years	0.60	0.76	0	3
Persons 11–15 years	0.65	0.90	0	3
Persons 16–55 years	3.38	1.61	0	7
Persons 56–65 years	0.37	0.55	0	2
Persons above 65 years	0.17	0.38	0	1
Family size	5.63	2.34	2	13
Total work force	4.13	1.71	1	9
Dependents	1.55	1.37	0	5
Dependency ratio	0.45	0.51	0	3

1. Sample size (n) = 60; SD = Standard deviation.

In Mentapally, the average age of household head was about 49 years with an average education of 2.63 years (Table 6). Even though education levels of the household heads were poor in both Malleboinpally and Mentapally, almost all the households were sending their children to the primary schools in the villages. The average family size of Mentapally was 5.64 persons with a standard deviation of 2.02. Family size ranged between 2 and 12. Seventy-two percent of the households had a family size of 6 or less. About 27.7% of households had a family size of 4 or less.

Bulk of the sample population comprised of individuals in the age group of 16–55 years (52.45%) which makes up for the major work force. The average weighted work force was 3.18. Nearly 29% of the population consisted of dependents. The majority of the dependents were children of below 11 years age. The average dependency ratio was 0.32.

Table 6. Demographic characteristics of Mentapally[1].

Characterisitics	Mean	SD	Minimum	Maximum
Age of household head (yr)	48.83	12.41	23	75
Education of household head (yr)	2.63	4.09	0	12
Education of family (yr)	3.15	4.16	0	17
Persons below 5 years	0.57	0.73	0	2
Persons 6–10 years	0.77	0.88	0	3
Persons 11–15 years	0.68	0.75	0	3
Persons 16–55 years	2.97	1.24	0	6
Persons 56–65 years	0.38	0.55	0	2
Persons above 65 years	0.29	0.63	0	3
Family size	5.65	2.03	2	12
Total work force	3.18	1.28	0	6.5
Dependents	1.06	1.10	0	5
Dependency ratio	0.32	0.38	0	2

1. Sample size (n) = 65; SD = Standard deviation.

Household activities

A detailed look into the distribution or combination of activities undertaken by the household members provides an insight into the distribution of workloads, major activities in the village and role of men and women in the household activities.

In general, women were involved in multiple tasks that include household chores apart from income generating activities whereas men were exclusively involved in income generating activities. In Malleboinpally, about 54% of total sample women performed household chores and 46% of them were involved in on-farm activities. Thirty-five percent of the sample women worked as hired labor (Fig. 8). Similarly in Mentapally, 45.5% of sample women performed household chores, about 44% were involved in on-farm activities on their own land and 40.5% worked as hired labor (Fig. 9).

Men were mainly involved in on-farm activities, off-farm work and other income generating occupations. In Malleboinpally, the dominant activities for men were on-farm activities (about 42% of total men in the sample), hired labor (19%) and off-farm work (about 17% of total men in the sample) (Fig. 8). In Mentapally, almost 44% of total men in the sample were involved in on-farm work and 27% of men worked as hired labor (Fig. 9).

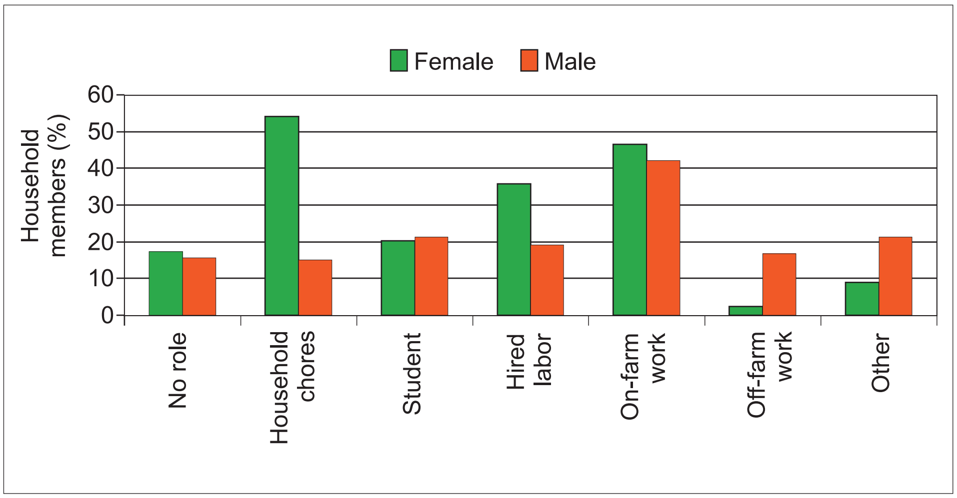

Figure 8. Major household activities in Malleboinpally.

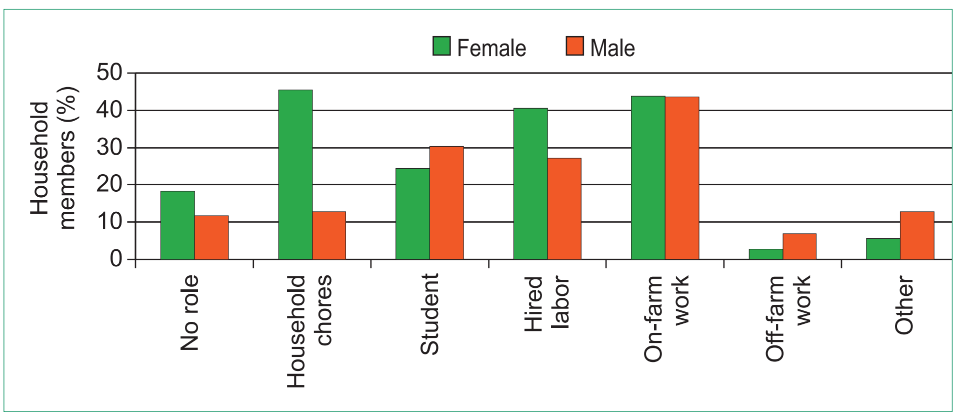

Figure 9. Major household activities in Mentapally.

Diversification of income generating activities was noticed in both the watershed villages. A larger percentage of household members combined on-farm activities with one or more income generating activities to sustain the household needs and to overcome the drought conditions in the 2002 cropping season.

In Malleboinpally, there was an almost equal distribution of male and female students (21% and 20%, respectively) whereas in Mentapally, there was higher percentage of male students (30%) as compared to female students (24%). The household members with no role include small children and aged members. Owning of land assets gives the aged members the leeway to be looked after by the younger generation. It was observed that the immediate consequence of transfer of land property to the younger generation was abandonment of the old members in the household through family splits and therefore making them vulnerable to poverty due to changing patterns of family organization (Kabeer 2002).

Caste composition

Caste has been a dominant social factor historically and even in the present day. Even though caste has negative connotations it can still have a positive spin off when considered as a social capital. Caste has an important role from the perspective of social networking and social mobilization. It has implications for collective action in watershed development depending on the heterogeneity and homogeneity of the caste composition in the specific village**.** The scope for collective action may be more in villages where community composition is more homogeneous.

Traditionally, Reddys and Kammas are the politically dominant communities in Andhra Pradesh and specifically Reddys are dominant in the Telangana and Rayalaseema regions (Srinivasulu 2002). These are also the semi-arid tropical regions and areas of interest for the current study. In Malleboinpally, about 54% of the total households in the village belong to backward caste (BC) (Fig. 10). There were about 15 castes in Malleboinpally. The major castes in Malleboinpally were Madiga, Reddy, Kurva and Tenugu. The Madigas account for 23.5% of total households in the village, Reddys account for 20.3%, Tenugu 22.6%, Kurva about 15% and other minor castes constitute about 9% of total village households. The Madigas belong to the category of SC, Kurva and Tenugu were considered as BC and Reddys belong to forward caste (OC). The sample was composed of Madiga (23%), Reddy (20%),

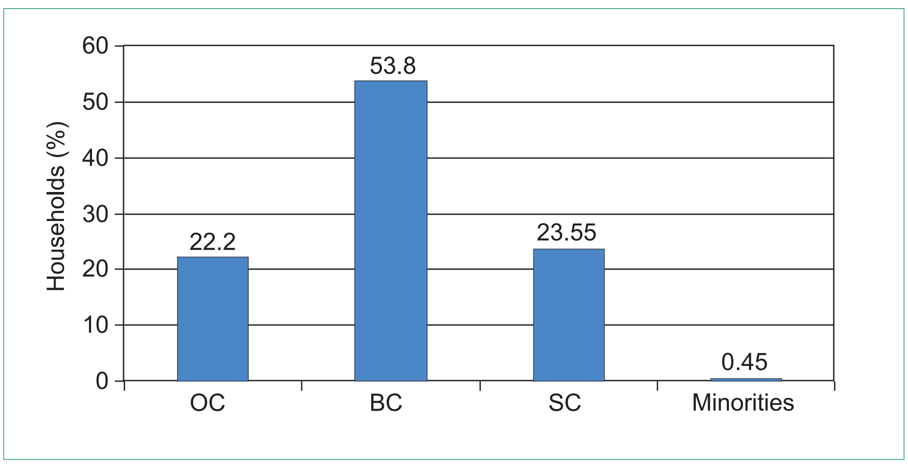

Figure 10. Caste categories in Malleboinpally.

Kurva (20%) and Tenugu (15%), which represents the caste composition of the entire village. In Mentapally, SC comprised about 45% of the total households in the village followed by BC (34%) (Fig. 11). There were only 5 castes in the entire village. The major castes in the village were Madiga, Reddy and Musti. The Mentapally sample households were composed of Madiga (41.5%), Musti (30.8%) and Reddy (24.6%). Mentapally had a relatively homogeneous caste structure as compared to Malleboinpally, which was more heterogeneous.

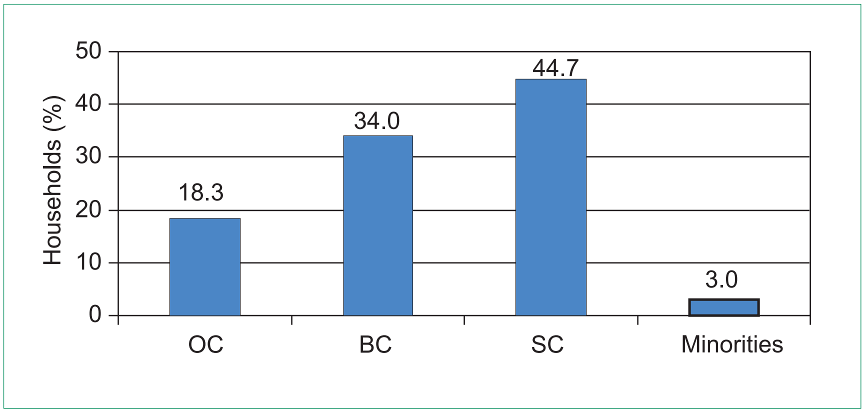

Figure 11. Caste categories in Mentapally.

Land ownership

This section discusses the land ownership details, caste-wise land distribution and land equity issues in the watershed villages. The average land ownership for Malleboinpally sample was 1.58 ha with a standard deviation of 1.55. Landholdings ranged between 0 and 10.12 ha (Table 7). The mean wetland was about 0.38 ha and dryland 1.21 ha. Even though the average irrigable land was 0.38 ha, the actual irrigated land cultivated in *kharif* was only 0.16 ha indicating water scarcity. The average actual cultivated dryland (0.83 ha) too was very much lower than the mean total owned dryland (1.21 ha). The mean land under permanent fallow was 0.16 ha. The average per capita landholding was 0.32 ha. Majority of sample households in Malleboinpally had 1–2 ha of land (41.67%). About 33% of sample households had no land or less than 1 ha (Fig. 12).

The average land owned in Mentapally was 2.39 ha with a standard deviation of 1.71 and a maximum land ownership of 9.31 ha (Table 8). As can be expected in a semi-arid region, the average dryland ownership (1.86 ha) was more than the average wetland owned (0.53 ha). The mean actual irrigated land cultivated was only 0.16 ha and the actual dryland cultivated in *kharif* season 2002 was 1.27

Table 7. Land ownership in Malleboinpally[1].

Variable	Mean	SD	Minimum	Maximum
Total own land (ha)	1.58	1.55	0	10.12
Irrigable land (ha)	0.38	0.70	0	4.05
Dryland (ha)	1.21	1.08	0	6.07
Irrigated own cultivated land (ha)	0.16	0.27	0	1.21
Dryland own cultivated land (ha)	0.83	0.68	0	3.24
Permanent fallow (ha)	0.16	0.48	0	2.83
Per capita land (ha)	0.32	0.37	0	2.53

1. Sample size (n) = 60; SD = Standard deviation.

Table 8. Land ownership in Mentapally[1].

Variable	Mean	SD	Minimum	Maximum
Total own land (ha)	2.39	1.71	0	9.31
Irrigable land (ha)	0.53	0.68	0	3.64
Dryland (ha)	1.86	1.34	0	6.28
Irrigated own cultivated land (ha)	0.16	0.31	0	1.62
Dryland own cultivated land (ha)	1.27	1.10	0	5.26
Permanent fallow (ha)	0.37	0.75	0	3.34
Per capita land (ha)	0.49	0.47	0	3.24

1. Sample size (n) = 65; SD = Standard deviation.

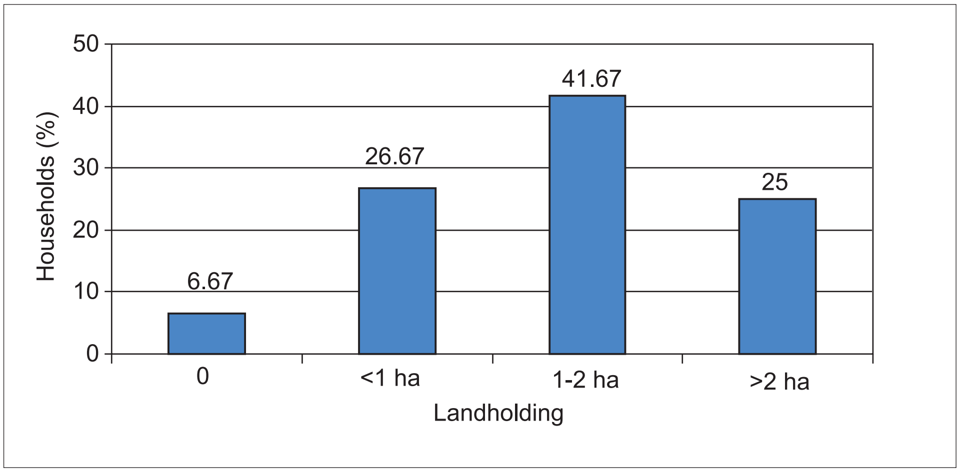

Figure 12. Landholding categories in Malleboinpally sample households.

ha. The average land under permanent fallow was 0.37 ha which was much higher than that found in Malleboinpally.

The mean per capita landholding was 0.49 ha, which was slightly higher than Malleboinpally. In Mentapally, more than 50% of the sample households had more than 2 ha of land whereas in Malleboinpally, only 25% of sample households owned more than 2 ha land. About 14% of the sample households had no land or less than 1 ha land (Fig. 13).

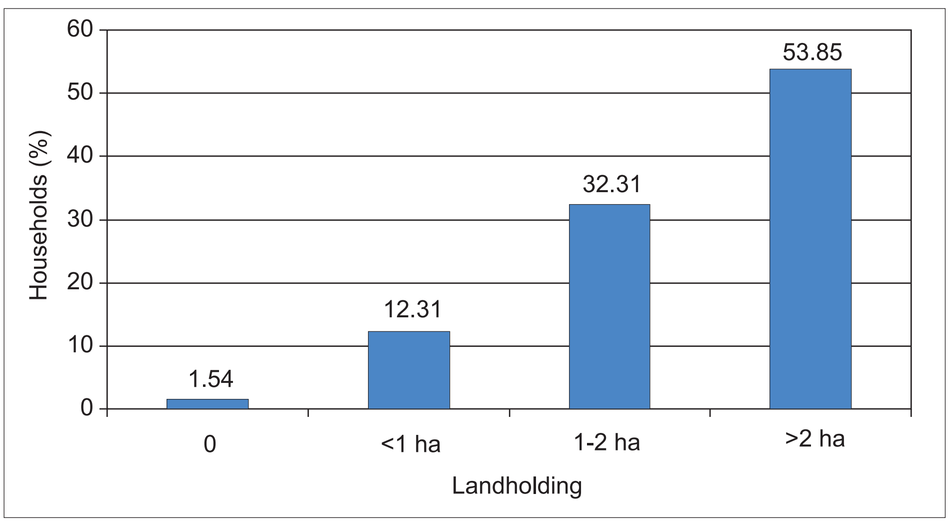

Figure 13. Landholding categories in Mentapally sample households.

Historically land ownership and political power were vested with the dominant communities like Reddys and Kammas. These communities have traditionally controlled the village political life (Srinivasulu 2002). In Malleboinpally, the average landholdings was highest for Reddys (3.02 ha), followed by Tenugu (1.83 ha) and Musti (1.72 ha) (Fig. 14). The average landholding of these castes was higher than the mean landholding of the village (1.58 ha). The average landholding of Madiga was 1.01 ha which was less than village average. Similarly, in Mentapally, the mean landholding (3.73 ha) and mean per capita land (0.81 ha) was highest for Reddys when compared with any other caste (Fig. 15). This distribution brings out the historical caste characteristics of villages in the region with Reddys having higher land ownership than Madigas. The per capita land is highest for Reddy caste (0.71 ha) with not much difference among rest of the castes.

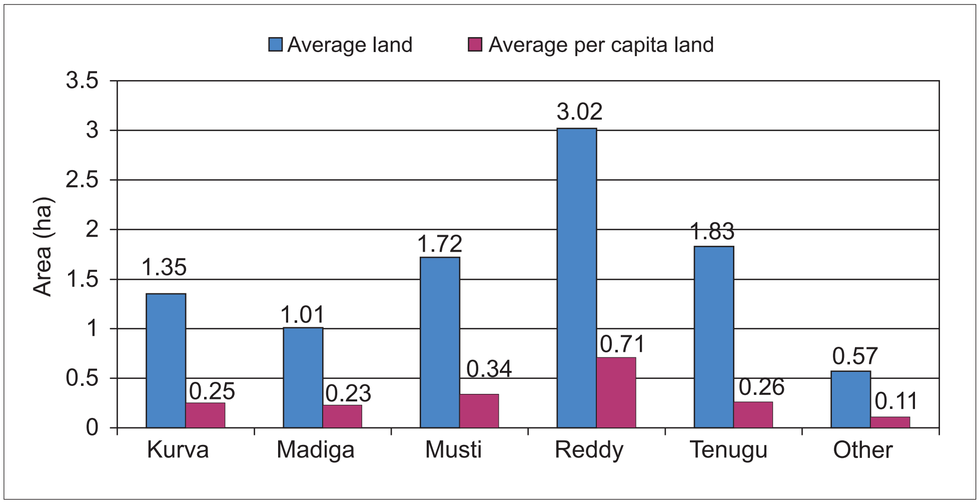

Figure 14. Caste-wise land ownership in Malleboinpally.

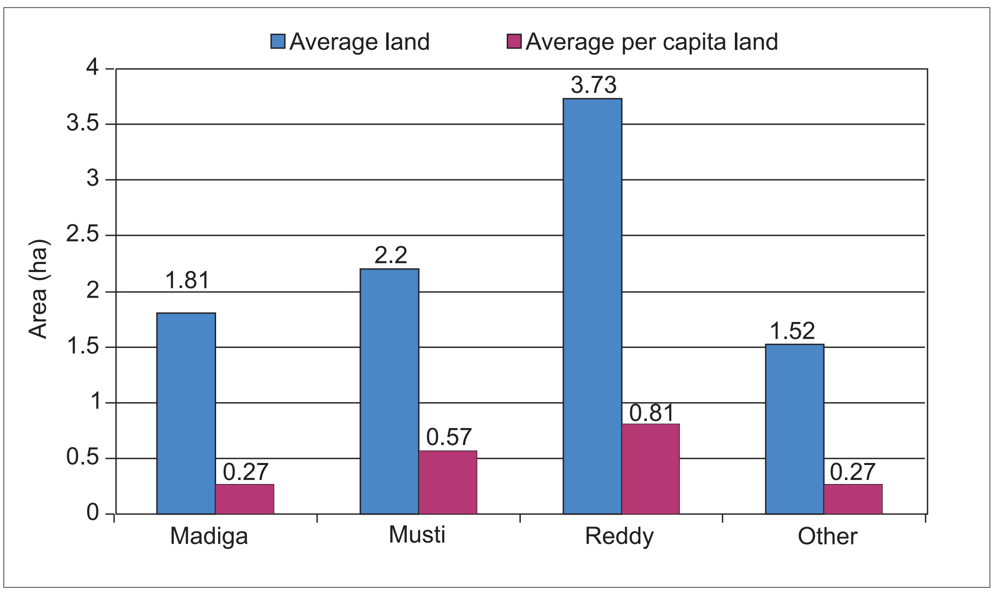

Figure 15. Caste-wise land ownership in Mentapally.

Figures 16 and 17 illustrate the land distribution pattern among the sample households in Malleboinpally and Mentapally, respectively. The cumulative frequency curves (Lorenz curves) depict the extent of inequalities in the land distribution. The equality distribution is represented by a diagonal line, and the greater the deviation of the Lorenz curve from this line, the greater the inequality. In Malleboinpally, 25% of the households owned only 5.75% of total land and 75% of households owned less than half the total land (45%). The remaining 25% of households owned 55% of the total land. The Gini coefficient[1] for Malleboinpally was 0.43 indicating significant inequalities in the land distribution.

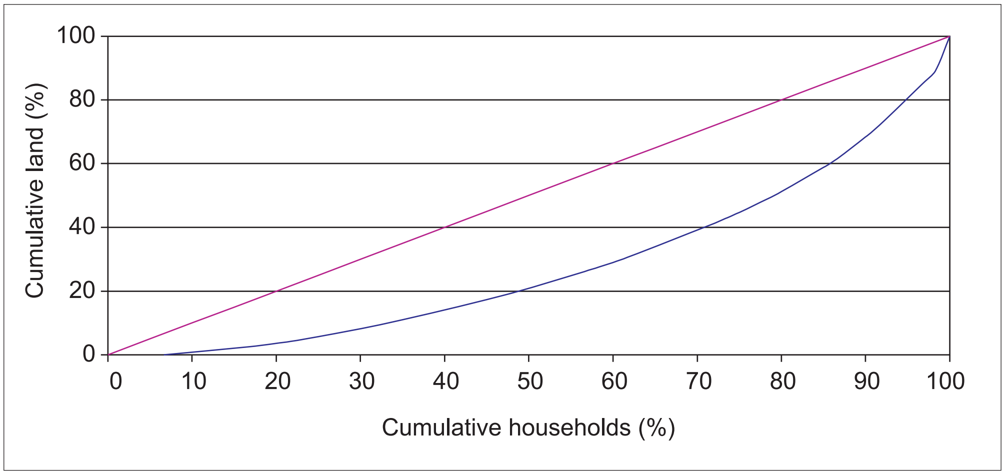

Figure 16. Land distribution in Malleboinpally.

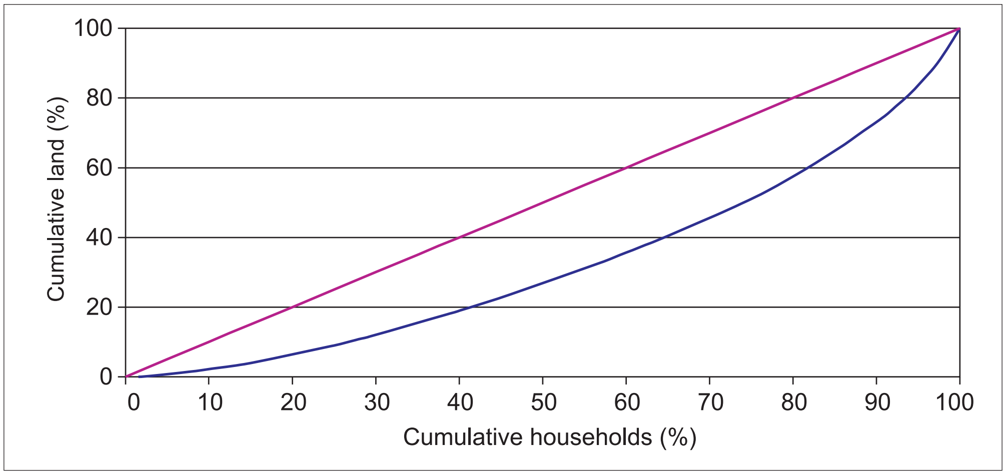

Figure 17. Land distribution in Mentapally.

In Mentapally, 25% of households owned 8.5% of land and 74% of households owned 50% land. The remaining 26% of households owned the other 50% of land. The Gini coefficient for Mentapally was 0.38. Even though the land distribution is relatively better off as compared to Malleboinpally, significant inequalities exist.

The caste system could be one of the important reasons for such unequal distribution. In general, as discussed above, households belonging to OCs (Reddys) had a higher percentage of land as compared to SCs (Madigas).

1. The Gini coefficient is a measure for inequality and a summary statistic of the Lorenz curve. The Gini coefficient can range from zero (perfect equality) to one (perfect inequality).

Crop production

Castor, sorghum, maize, finger millet, pigeonpea, paddy, cotton and chili accounted for 75% of the total cropped area in the district in *kharif* season of 2002. The major crops were dryland crops with castor being the dominant crop that accounted for about 31% of total cropped area in the district (Table 3). In Jadcherla mandal, the above crops accounted for 93.7% of total cropped area with castor and sorghum accounting for 39.3% and 21.6% of total cropped area, respectively. In Wanaparthy mandal, these crops accounted for 89.3% of total cropped area with castor being the main crop (39.3% of total cropped area) followed by maize (13.2%) and sorghum (10.8%) among dryland crops and paddy accounted for 15.5% of total cropped area.

The cropping patterns in Malleboinpally (Jadcherla mandal) and Mentapally (Wanaparthy mandal) were similar to that of the district and their respective mandals. In Malleboinpally, castor is mainly grown as sole crop with mean plot size of 0.19 ha (Table 9). The other important cropping system was sorghum intercropped with pigeonpea with mean plot area of 0.32 ha. Maize was equally grown as sole crop and as intercrop with pigeonpea with mean plot area of 0.10 ha.

Table 9. Mean area of major crops grown in Malleboinpally[1].

Crop	No. of plots	Mean area (ha)
Kharif		
Castor	21	0.19
Castor+Pigeonpea	2	0.02
Chili	2	0.01
Finger millet	10	0.06
Maize	12	0.10
Maize+Pigeonpea	11	0.10
Paddy	27	0.15
Sorghum	6	0.05
Sorghum+Pigeonpea	38	0.32
Rabi		
Groundnut	6	0.05
Paddy	9	0.03

1. Sample size (n) = 60.

Maize was a recent crop and has become a preferred crop by the farmers, which is in line with the overall trend in the district and mandal. Even with water scarcity, paddy was still the important irrigated crop with a mean plot area of 0.15 ha. There was only limited *rabi* cultivation with groundnut and paddy grown on a small area (<5 ha) depending on access to water.

In Mentapally, castor was mainly grown as an intercrop system with pigeonpea with a mean plot size of 0.49 ha (Table 10). This was followed by sorghum+pigeonpea intercropping system with a mean plot size of 0.23 ha. Maize+pigeonpea was also an important cropping system with a mean plot size of 0.12 ha. Paddy was grown to a considerable extent with mean plot size of 0.19 ha. Some other minor crops include cowpea, green gram, horsegram, groundnut and pearl millet.

Groundnut was the main *rabi* crop with mean plot size of 0.19 ha followed by paddy (mean plot size 0.06 ha). The advent of maize, castor and pigeonpea in the respective villages can be attributed in part if not whole to the efforts of the consortium. ICRISAT provided seeds of castor, maize and pigeonpea to some farmers during the 2002–03 cropping season as part of the IWM program.

Table 10. Mean area of major crops grown in Mentapally[1].		
Crop	No. of plots	Mean area (ha)
Kharif		
Castor	12	0.14
Castor+Pigeonpea+Cowpea	2	0.03
Castor+Pigeonpea	30	0.49
Cotton	3	0.04
Green gram	2	0.02
Horsegram	2	0.01
Maize	6	0.07
Maize+Pigeonpea	9	0.12
Paddy	25	0.19
Pearl millet	2	0.01
Sorghum	14	0.17
Sorghum+Pigeonpea	20	0.23
Pigeonpea	4	0.05
Rabi		
Groundnut	15	0.19
Horsegram	5	0.04
Paddy	8	0.06

1. Sample size (n) = 65.

In Malleboinpally, fertilizer usage was higher in irrigated crops (paddy and groundnut) and lower in rainfed crops. The commonly used fertilizers were diammonium phosphate (DAP) [46% phosphorus (P) and 18% nitrogen (N)] and urea (46% N). Fertilizer application was highest for paddy. In the *kharif* season, DAP was applied at an average rate of about 142 kg ha^{-1}, urea at 169 kg ha^{-1} and farmyard manure (FYM) at 1 t ha^{-1} (Table 11).

Table 11. Average fertilizer usage for major crops in Malleboinpally.					
Crop	No. of plots	% plots fertilized	DAP (kg ha^{-1})	Urea (kg ha^{-1})	FYM (t ha^{-1})
Castor	23	56.5	47.3	13.6	0.5
Finger millet	10	60.0	45.0	4.9	0.7
Maize	23	78.3	50.5	48.7	0.7
Pigeonpea[1]	51	66.7	10.8	2.8	0.1
Sorghum	44	61.4	42.2	9.5	0.5
Paddy (*Kharif*)	27	96.3	142.6	169.4	1.0
Paddy (*Rabi*)	9	100	153.7	208.6	0.2
Groundnut (*Rabi*)	6	100	110.5	24.7	0.1

1. Grown as intercrop.

Fertilizer usage was more in *rabi* as compared to *kharif*. Application of FYM was higher in *kharif* as compared to that in *rabi*. This may be because of the practice of applying FYM during land preparation activities in the month of May.

In Mentapally, the highest fertilizer usage in *kharif* was in paddy where approximately 184 kg ha^{-1} of DAP and 144.5 kg ha^{-1} of urea were applied. Fertilizer use was also high for paddy (*rabi*) and groundnut (*rabi*) which are irrigated crops. FYM application was higher in *kharif* season for paddy at 0.7 t ha^{-1} as compared to 0.4 t ha^{-1} in *rabi* (Table 12).

Table 12. **Average fertilizer usage for major crops in Mentapally.**

Crop	No. of plots	% plots fertilized	DAP (kg ha^{-1})	Urea (kg ha^{-1})	Triple 17 (kg ha^{-1})	FYM (t ha^{-1})
Castor	44	90.9	25.2	6.6	27.7	0.2
Sorghum	34	67.7	22.1	7.9	8.6	0.3
Maize	15	80	22.8	30.6	20.2	0.6
Pigeonpea[1]	67	82.1	7.1	5.1	4.9	0.1
Paddy (*Kharif*)	25	100	184.1	144.6	19.8	0.7
Paddy (*Rabi*)	8	100	138.9	154.4	0.0	0.4
Groundnut (*Rabi*)	15	100	120.8	67.2	0.0	0.5
Horsegram (*Rabi*)	5	20	0.0	0.0	3.0	0.7
Pearl millet	3	66.7	31.1	0.0	0.0	0.0
Cotton	3	100	192.1	82.3	0.0	0.6
Cowpea	3	66.7	0.0	0.0	7.2	0.0

1. Grown as intercrop.

In Malleboinpally, the average yield of castor was 504 kg ha^{-1} (Table 13) which is higher than the average district yield (470 kg ha^{-1}) for *kharif* season in 2002. Sorghum yield was 450 kg ha^{-1} which was much lower than the district average of 920 kg ha^{-1} and mandal average of 1765 kg ha^{-1}. Eighty-five percent of the sample plots with paddy were irrigated. In the remaining few cases, paddy was grown under dry conditions where paddy seeds were directly broadcasted without transplantation. The mean yields of paddy were 3076 kg ha^{-1} in *kharif* and 3048 kg ha^{-1} in *rabi*. The average yield of groundnut in Malleboinpally was 840 kg ha^{-1}. Average yield of maize was about 1124 kg ha^{-1}, which was lower than the average district yield (1175 kg ha^{-1}). Pigeonpea was always grown as an intercrop with different crops namely castor, maize and sorghum with a mean yield of about 110 kg ha^{-1}.

The coefficient of variation, computed as standard deviation as a percentage of mean, provides a measure for variability in the yields. Variability in yields was lower for irrigated crops such as paddy and groundnut.

In Mentapally, the mean yield of castor was 335 kg ha^{-1} which was lower than the district average (Table 14). The mean yield of maize (719 kg ha^{-1}) was also lower than the mean district yield (1175 kg ha^{-1}). The average sorghum yield was 431 kg ha^{-1}, which was lower than the district average (921 kg ha^{-1}) and also the mandal average (805 kg ha^{-1}). Pigeonpea was mainly grown as an intercrop with castor, maize and sorghum with a mean yield of 90 kg ha^{-1}.

Table 13. Mean yield and variability for the major crops in Malleboinpally.

Crop	No. of plots	% plots irrigated	Mean yield (kg ha^{-1})	CV	District yield (kg ha^{-1}) (2002–03)
Castor	23	0	504	63	470
Finger millet	10	0	913	72	1093
Maize	23	8.7	1124	73	1175
Paddy *(Kharif)*	27	85	3076	51	2025
Pigeonpea[1]	51	0	108	90	–
Sorghum	44	0	450	69	920
Groundnut *(Rabi)*	6	83.3	840	49	950
Paddy *(Rabi)*	9	100	3048	52	2002

1. Grown as intercrop.

Table 14. Mean yield and variability for the major crops in Mentapally.					
Crop	No. of plots	% plots irrigated	Mean yield (kg ha^{-1})	CV	District yield (kg ha^{-1}) (2002–03)
Castor	44	0	335	62	471
Maize	15	0	719	100	1175
Paddy *(Kharif)*	25	88	3271	41	2025
Sorghum	34	0	431	71	921
Pigeonpea[1]	67	0	90	97	–
Groundnut *(Rabi)*	15	87	1067	33	951
Horsegram *(Rabi)*	5	0	285	73	127
Paddy *(Rabi)*	8	100	3743	20	2002

1. Grown as intercrop.

The mean yields of paddy were 3271 kg ha^{-1} in *kharif* and 3743 kg ha^{-1} in *rabi* and were higher than the district average yields. The mean yield of groundnut was 1067 kg ha^{-1}. The variability is lower for both the irrigated crops (paddy and groundnut) when compared with rainfed crops.

Livestock production

Livestock has an important role in the livelihood strategies of rural households. The types of livestock include dairy animals (cows and buffaloes), draught animals (bullocks), other cattle for meat, small ruminants (sheep and goats) and chicken. The crop-livestock interactions are complementary in nature.

In Malleboinpally, 32% of the sample households did not own any livestock; 56.7% of the households had no milch animals and 73.3% of the households had no bullocks. The average ownership of different animals was 1.17 milching buffaloes, 0.38 other she-buffaloes, 0.18 milching cows, 0.28 bullocks, 2.23 sheep and 2.08 goats (Table 15).

Table 15. Livestock ownership (number household^{-1}) in Malleboinpally.			
Livestock[1]	Mean	Minimum	Maximum
Milching cows	0.18 (0.54)[2]	0	2
Milching buffaloes	1.17 (1.89)	0	6
Other cows	0.03 (0.18)	0	1
Bullocks	0.28 (0.67)	0	2
Heifers (cows)	0.02 (0.13)	0	1
Bulls	0.12 (0.56)	0	3
Calves	0.20 (0.51)	0	2
Other she-buffaloes	0.38 (1.14)	0	5
Heifers (buffaloes)	0.10 (0.40)	0	2
Calves	0.72 (1.49)	0	6
Sheep	2.23 (12.08)	0	80
Goats	2.08 (5.55)	0	21
Chicken	1.67 (3.51)	0	17
TLU	2.68 (3.53)	0	15

1. Sample size (n) = 60; TLU = Tropical livestock unit.
2. Figures in parentheses are standard deviation values.

The animal populations were aggregated by taking the number of each kind and multiplied by a factor to convert into a standard tropical livestock unit (TLU). A TLU is an animal unit used to aggregate different classes of livestock. One TLU equals an animal of 250 kg live weight. Sheep, goats and cattle were assigned 0.1, 0.1 and 0.7 TLU per head, respectively and buffalo was counted as 1 TLU (Nordblom et al. 1997). The average TLU for Malleboinpally was 2.68 with maximum TLU of 15.

In Mentapally, 38.46% of the sample households did not have any livestock; 76.92% of the households were without any milch animals and 55.38% had no bullocks. The average ownership of animals was 0.97 for bullocks, 0.34 for milching buffaloes, 0.08 for sheep and 0.03 for goats (Table 16). The average TLU was 1.47 with a maximum of 8.95. In general, Mentapally had relatively lower livestock holdings when compared with Malleboinpally.

Table 16. Livestock ownership (number household^{-1}) in Mentapally.

Livestock[1]	Mean	Minimum	Maximum
Milching cows	0.08 (0.37)[2]	0	2
Milching buffaloes	0.34 (0.91)	0	6
Other cows	0.11 (0.40)	0	2
Bullocks	0.97 (1.16)	0	4
Heifers (cows)	0.09 (0.34)	0	2
Bulls	0.11 (0.36)	0	2
Calves	0.12 (0.33)	0	1
Other she-buffaloes	0.06 (0.30)	0	2
Heifers (buffaloes)	0.06 (0.24)	0	1
Calves	0.09 (0.29)	0	1
Sheep	0.08 (0.51)	0	4
Goats	0.03 (0.25)	0	2
Chicken	1.51 (3.38)	0	14
TLU	1.47 (1.79)	0	8.95

1. Sample size (n) = 65; TLU = Tropical livestock unit.
2. Figures in parentheses are standard deviation values.

Figures 18 and 19 provide insights into the distribution of value of livestock assets among the sample households in the respective villages. Inequalities seem to exist regarding livestock assets among the sample households. In Malleboinpally, 85% of total sample households possess only 42% of the total value of livestock assets. In Mentapally, 81% of total sample households own 43% of total value of livestock assets.

Livestock assets owned by Madigas were low and relatively high among certain castes. Kurvas traditionally have livestock-based occupations and have the highest average livestock asset ownership valued at Rs 31271 per household. Reddy caste also has substantial livestock assets with an average value of Rs 25734 per household.

The important livestock products include milk, meat, FYM, draught power and transportation. The average milk production and sales per annum for a household were much higher in Malleboinpally as compared to Mentapally (Table 17). In Malleboinpally, the sample average of milk produced per annum was 554 L and milk sold was 489 L whereas in Mentapally, the sample average of milk produced per annum was only 148 L and milk sold was about 100 L.

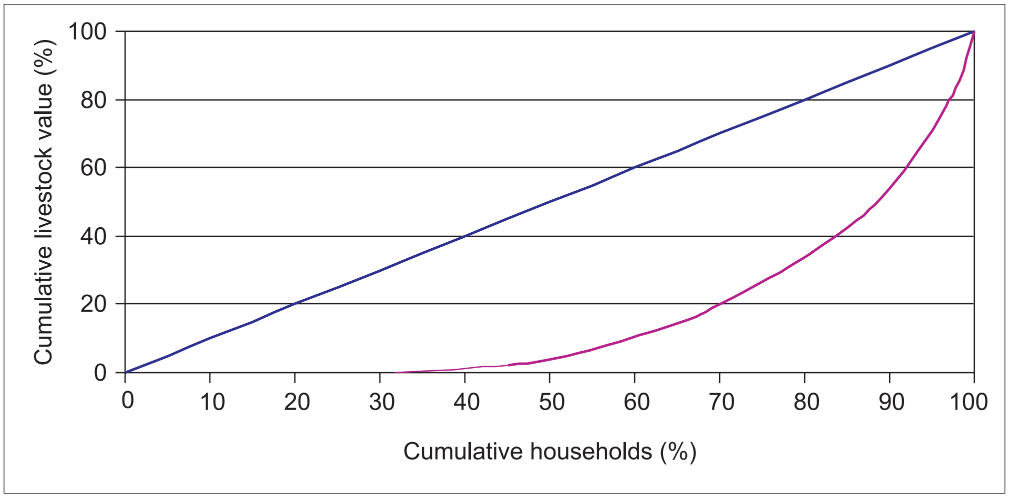

Figure 18. Distribution of livestock assets in Malleboinpally.

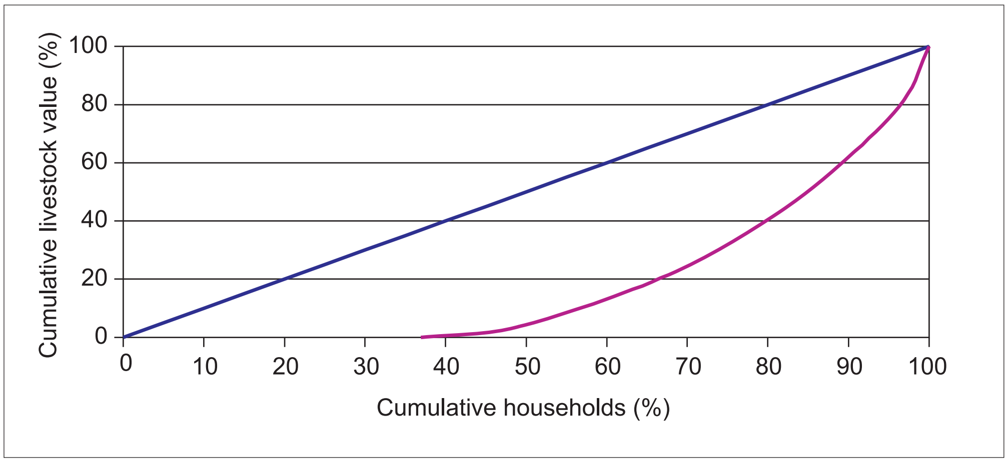

Figure 19. Distribution of livestock assets in Mentapally.

Table 17. Average household milk production and sales per annum.

Watershed village	Sample households	Milk production (L)	Milk sold (L)	Milk sales (Rs)
Malleboinpally	60	554	489	4612
Mentapally	65	148	100	937

Other household assets

Assets have been divided into farm assets and other assets. Farm assets include items such as tractor, electric motors, sprayers, bullock carts, and other major and minor farm implements (*kurpi*, plows, etc). Other assets include houses, residential plots, electronic gadgets (television, radio, tape recorder, etc), vehicles, jewelry and other such accessories.

Table 18. Average household assets (Rs household^{-1}) in Malleboinpally.

Assets[1]	Mean	Minimum	Maximum
Farm assets	6840 (16537)[2]	0	120500
Other assets	73820 (53234)	10500	262000
Total assets	80660 (57504)	10500	282000
Per capita assets	16820 (15052)	2362	70500

1. Sample size (n) = 60.
2. Figures in parentheses are standard deviation values.

In Malleboinpally, the average value of farm assets was Rs 6840 and value of non-farm assets was Rs 73,820 (Table 18). The average total value of assets was Rs 80,660 with minimum of Rs 10,500 to a maximum of Rs 282,000. The mean per capita assets was Rs 16,820 with a minimum of Rs 2362 and a maximum of Rs 70,500. Almost 65% of households had less than the mean per capita assets and only 15% of households had per capita assets greater than Rs 30,000. The average per capita assets was highest for Reddys (Rs 29,160) followed by Tenugu (Rs 18,060) and Kurva (Rs 15,205). The Madigas had the lowest per capita assets (Rs 9580).

In Mentapally, the mean value of farm assets was Rs 9835 and other assets was Rs 58,800 (Table 19). The average per capita assets was Rs 12,745 with a minimum of Rs 3300 and a maximum of Rs 69,720. Approximately 71% of households had per capita assets equal to or less than Rs 15,000. Only about 5% of households had per capita assets greater than Rs 30,000 which is much lower than that of Malleboinpally. The average per capita assets was highest for Reddys (Rs 19,660) followed by Musti (Rs 12,715). The Madigas had the lowest per capita assets (Rs 8490).

Table 19. Average household assets (Rs household^{-1}) in Mentapally.

Assets[1]	Mean	Minimum	Maximum
Farm assets	9835 (15856)[2]	0	105500
Other assets	58800 (66412)	17000	522000
Total assets	68636 (78102)	17300	627500
Per capita assets	12745 (10096)	3300	69720

1. Sample size (n) = 65.
2. Figures in parentheses are standard deviation values.

Income from other sources

Most often on-farm income sources were complemented with one or more income generating activities to meet household needs and also to overcome the drought conditions. Major income sources other than crop cultivation in Malleboinpally were casual village labor and other regular employment. Regular employment in the present context included teaching jobs, *hamalis* (load runners), drivers, government jobs, contractors and mechanics. Proximity of the village to both Mahabubnagar (district headquarters) and Jadcherla (mandal headquarters) enables most of the employees to commute from the village to their work place rather than migrate from the village. The average annual household income from such regular employment was Rs 19580 (Table 20). The average annual household income from casual village labor was Rs 6120. The wage rates for hired labor ranged from Rs 50 to 60 per day for men and Rs 20 to 25 per day for women.

Table 20. Other major sources of household income.

Village	Source of income	No. of households	Mean annual income (Rs)
Malleboinpally (n=60)	Casual village labor	35	6120
	Other regular employment	31	19580
	Business net income	7	1240
Mentapally (n=65)	Casual village labor	52	6130
	Migration income	19	5850
	Rented out bullocks	14	745
	Business net income	10	4730
	Other regular employment	8	2040

The types of varied sources of income were many in Mentapally as compared to Malleboinpally. The majority of households were involved in casual village labor with mean income of Rs 6130. The wage rates were Rs 50 for men and Rs 20 to 25 per day for women. Migration was the other important source of income with a mean income of Rs 5850. Migration was widely prevalent in Mentapally due to drought. Also a labor contract system exists in the village, wherein a village contractor hires the laborers to work on construction projects (roads, etc) within the state and sometimes outside the state. Other sources of income include rented out bullocks (Rs 745) and business income (Rs 4730) (Table 20).

Household income

Total income of a household is a combination of various income generating activities such as crop cultivation, livestock and other sources of income. The net returns from crop production were calculated by deducting the total crop expenditure from the total production value. Crop expenditure included hired labor expenses, expenditure on seed (own + bought), irrigation costs (own + bought), fertilizers, pesticides, sheep penning and FYM (own + bought). Other capital costs included expenditure on hired bullocks, tractor hiring cost, and expenditure on sprayers and threshing machine. Total production value is the total output from the crop multiplied by its harvest price. The harvest prices used were the average prices for the respective variety, crop and village.

Livestock income includes income from milk sales, value of own bullocks used for traction, value of FYM used from own livestock, income from sale of goats and sheep, income from sale of buffaloes, bullocks and cows (annualized using their life expectancies), and value of new born cattle. Maintenance expenditure of livestock includes value of green fodder and dry fodder (own + bought) and other costs such as medicines and labor. Net returns were computed by deducting the maintenance costs from total income from livestock. Income from other sources includes income from casual village labor, caste occupation, regular employment, migration income, business net income, sale from CPR and any other sources. Finally, the total income of a household is an aggregation of crop income, livestock income and income from all other sources.

The average net return from crop cultivation was Rs 3970 in Malleboinpally, which is much lower than that of Mentapally (Rs 7775). The average livestock income was higher in Malleboinpally (Rs 7650) as compared to Mentapally (Rs 2105) since livestock holdings were relatively high in Malleboinpally (Table 21).

Table 21. Average net returns from various sources.		
Source of income	Malleboinpally (n=60)	Mentapally (n=65)
Crop income (Rs)	3970	7775
Livestock income (Rs)	7650	2105
Other income (Rs)	29820	20750
Total income (Rs)	41440	30630

Income from other sources was also higher in Malleboinpally, which can be expected because of its nearness to the mandal and district headquarters and since regular employment and remittances from migration were important sources of income as observed earlier. The average total income was also higher in Malleboinpally (Rs 41440) as compared to Mentapally (Rs 30630).

The contribution of different livelihood sources to the total household income is shown in Figure 20. Other sources of income were important in both the villages but more so in Malleboinpally (72% of total income). Crop income was more predominant in Mentapally (25% of total income) when compared with Malleboinpally.

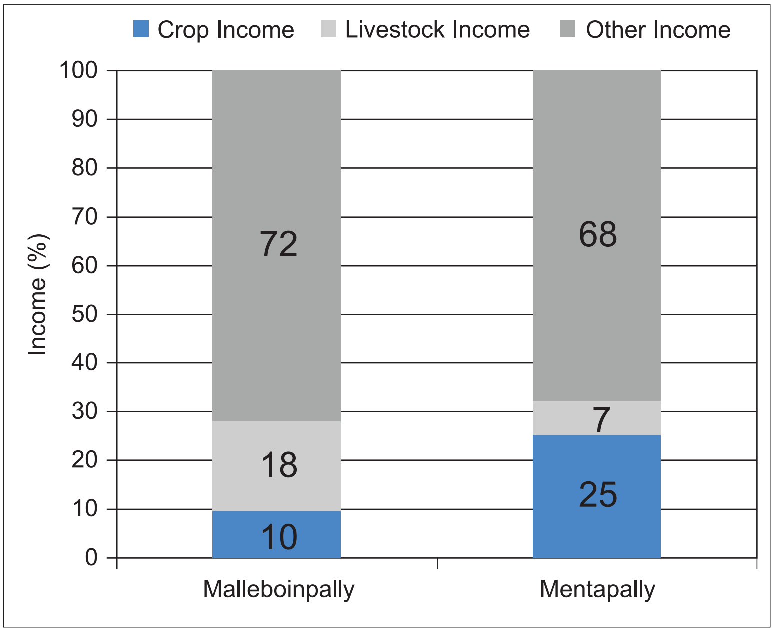

Figure 20. Sources of household income.

Mentapally was poor in livestock resources and hence livestock income was low. The contribution of livestock to the average household income was about 7% in Mentapally when compared to 18.5% in Malleboinpally. In general, Mentapally has more of an agricultural based economy whereas Malleboinpally economy was based on external sources of income.

Groundwater resources

Groundwater levels have been depleting over the period. Nearly 77% of open wells have dried up in Malleboinpally and about 98% dried up in Mentapally (Table 22). Even though tube wells were

Table 22. Number of wells in the watershed villages.

Wells	Dried	Functional	Total
Malleboinpally			
Open wells	27 (77)[1]	8 (23)	35
Tube wells	35 (56)	27 (44)	62
Mentapally			
Open wells	108 (98)	2 (2)	110
Tube wells	14 (19)	60 (81)	74

1. Figures in parentheses are percentage values.
Source: Focus group meetings.

the main source of irrigation in both the villages (with 44% functional in Malleboinpally and 81% functional in Mentapally), the farmers noticed depleting groundwater reserves and had to go to greater depths to get sufficient water. Most of the farmers felt that there should be some sort of restriction on the number of tube wells drilled. But the modalities of such regulations need to be studied in more detail, so that those already owning tube wells do not have an advantage over those not owning a tube well.

Common property resources

Common property resources are considered as a form of natural and social capital (Turton 2000). These act as a source of fuel and fodder for the rural poor in many cases. They also provide the raw material for different livelihood activities such as leaf-plate making, basket making and livestock grazing. Malleboinpally has about 91 ha under CPR whereas Mentapally has only 4.05 ha. The area under CPR was not significant in Mentapally village.

At present access to CPR is not restricted in the concerned watershed villages. The landless and poor people depend on CPR for firewood, raw material for making leaf-plates and grazing of their livestock. For any decision on future restrictions on CPR, the opinion of those who will be directly affected by such decisions (landless and poor) should be considered.

Role of project implementing agencies in watershed management

The PIAs have much to contribute to institutional sustainability beyond the four-year implementation period and can assist with conflict resolution and forge long-term development links (Turton and Farrington 1998). Some of the important criteria for selection of PIAs to support village organizations include the extent to which they have achieved recognition with organizations of the people and of government; and the length of time for which they have been active in the area (Farrington and Lobo 1997).

The guidelines for watershed development (1994–95) and the revised guidelines in 2001 in the past did not envisage a pivotal role for the Panchayat Raj institutions in the implementation of watershed projects and the concept of Watershed Association and Watershed Committee at the village level was prevalent. The Ministry of Rural Development modified the existing provisions and brought out the new revised "Guidelines for Hariyali" in 2003 (GoI 2003). Under these guidelines, more power is vested in the Panchayat Raj institutions. According to these guidelines, at the field level, the gram panchayats would implement the projects under the overall supervision and guidance of PIAs. Panchayat may be the PIA for all the projects sanctioned to a particular Block or Taluka. Under the circumstances where panchayats are not adequately empowered, Zilla Parishad/District Rural Development Agency (DRDA) may use its discretion to appoint an NGO as PIA if it meets the eligibility criteria. Eligibility criteria require that the NGO has been active in the field of watershed development or any similar area in rural areas for some years. But Hariyali guidelines were not operational immediately on their release.

Some of the arguments for involving Panchayat Raj institutions in watershed management were that they could be the natural apex body for linking watershed development with other objectives and that the management of commons and wasteland is under the control of gram panchayat (Baumann 2000). They also have the powers to raise revenue and collect taxes.

In Andhra Pradesh, the watershed activities were initiated prior to the Hariyali guidelines and the district line departments and the DRDAs managed most of the rural development activities through watershed associations. Springate-Baginski et al. (2002) suggested that active involvement of panchayat bodies or legalizing the existence of these watershed institutions through legislation might be important from the point of watershed program sustainability, which was also reflected in the current revised guidelines.

In Malleboinpally, the PIA was Bharatiya Agro Industries Foundation (BAIF) which was a non-local NGO with headquarters at Pune. The watershed activities such as construction of check-dams and other soil and water conservation structures were delayed since the NGO was not able to discharge its duties due to conflict of interest with the local political leaders. In Mentapally, the PIA entrusted with the watershed development activities was Society for Development of Drought Prone Area (SDDPA) with headquarters at Wanaparthy (mandal headquarters). But the awareness among the villagers about SDDPA was limited.

Selection of an NGO-PIA is an important issue and should be based on its suitability to a specific location. Sometimes, even though the overall capacity and track record of implementing watershed projects of an NGO in the district may be good it is possible that political and other cultural environment may not be conducive.

Summary and conclusions

The baseline analysis of the watershed villages, Malleboinpally and Mentapally, provides information on the major income generating activities in the villages, land ownership and distribution aspects, cropping patterns, agricultural practices, livestock holdings, water availability for irrigation and other constraints or problems in the villages. This serves as a baseline in the process of monitoring and evaluation of socioeconomic and environmental impacts of the watershed interventions.

A thorough understanding of the village social structure ensures the realization of watershed development goals especially the equity and sustainability objectives. The caste structure in the village is closely associated with landholdings, livestock holdings, assets and livelihood strategies. Malleboinpally had a more heterogeneous caste structure with about 15 castes as compared to only 5 castes in Mentapally. The major castes in Malleboinpally were Madiga, Reddy, Kurva and Tenugu. The minor castes were Kammari, Gowda and Erukula. In Mentapally, the major castes were Madiga, Reddy and Musti and other minor castes were Vysya and Gowda.

In Malleboinpally, about 91% of the cultivated area was dryland and remaining 9% was irrigated and in Mentapally, dryland cultivation accounted for about 85% of the total cultivated area and the remaining

15% consisted of irrigated land. The average land ownership in Malleboinpally was 1.58 ha and in Mentapally it was 2.39 ha. There was an unequal distribution of land in both the villages and the Gini coefficients computed indicate that the land inequality was relatively higher in Malleboinpally.

The major crops cultivated in the villages were dryland crops such as castor, sorghum, maize and pigeonpea. Pigeonpea was mainly grown as an intercrop with castor, sorghum or maize. In spite of water scarcity, paddy was still the popular crop. The cropping pattern was broadly similar in both the villages. There has been a shift towards castor and maize in both the villages in the 2002 cropping season. Cotton was low on the farmer's priority because of pest incidence and the costs associated with their control. Crop yields, in general, have been low in both the villages when compared to the district averages. In Malleboinpally, the average yields of castor (504 kg ha^{-1}), sorghum (449.5 kg ha^{-1}), maize (1124 kg ha^{-1}) and groundnut (840 kg ha^{-1}) were lower than their respective district averages. Similarly in Mentapally also, the average yields of castor (334.5 kg ha^{-1}), sorghum (431 kg ha^{-1}) and maize (719 kg ha^{-1}) were lower than the district averages. Yields were low due to poor rainfall in these areas. In the irrigated crops such as paddy, the yields were higher than the district averages in both Malleboinpally and Mentapally villages.

Even though agriculture was an important occupation, the majority of farmers were supplementing their livelihoods through other activities such as hired labor and off-farm activities. A larger percentage of household members combined on-farm activities with one or more income generating activities to sustain the household needs and to overcome the drought conditions in the previous cropping season. In Malleboinpally, regular employment in neighboring towns was one of the major livelihood strategies. In Mentapally, migration was an important livelihood avenue. Therefore, there may always be a possibility that short-term strategies to cope with drought such as migration might as well become an adaptive strategy in the long run that could undermine the role of agriculture as a sustainable livelihood strategy. In such a scenario watershed development that enhances land and water productivity as well as sustainability will have a greater significance.

On the gender issue, women play an important role in supporting their households. Women performed multiple tasks that include working on own farm, and working in local labor markets apart from the usual household activities. In Malleboinpally, about 54% of total sample women performed household chores and 46% of them were involved in on-farm activities. Thirty-five percent of the sample women worked as hired labor. Similarly in Mentapally, 45.5% of sample women performed household chores, about 44% were involved in on-farm activities on their own land and 40.5% worked as hired labor.

Households in rural areas derive their livelihoods from various sources that include crop cultivation, livestock rearing and other non-farm activities. The average total annual household income was higher in Malleboinpally (Rs 41438) as compared to Mentapally (Rs 30631). Other non-farm sources of income were important in both the villages but more so in Malleboinpally (72% of total income). In Malleboinpally, because of its proximity to both mandal and district headquarters, opportunities for non-farm activities like regular government or private employment were more and therefore contribution of these activities to the total household income was significant. Crop income was more predominant in Mentapally (about 25% of total income) when compared with Malleboinpally (about 10% of total income). Mentapally was poor in livestock resources and hence income from livestock was very small.

Groundwater reserves have been depleting over the period as was seen from the number of dried up open wells. Nearly 77% of open wells have dried up in Malleboinpally and about 98% dried up in Mentapally. Dependence on tube wells for irrigation has increased. Even though most of the tube wells appeared to be functional, farmers opine that the groundwater levels were declining and that they had to go to greater depths for adequate water supply.

Since watershed activities were initiated only recently in the villages, watershed related constructions such as check-dams, percolation tanks, etc have not been undertaken at the time of the survey. ICRISAT, as part of the consortium, provided castor, maize, sorghum and pigeonpea seed to some farmers for participatory evaluation and best-bet options. Apart from seed, the farmers also benefited from the technical support provided by ICRISAT-led consortium partners, in the form of IPM, INM, training for tropicultor use and other such activities. A dhal mill was initially put up at Mentapally (but recently moved to a nearby village, Kadukuntla, so that it could be easily accessible to the surrounding satellite villages including Mentapally). The dhal mill seems to have evoked a good response from the villagers and has the potential to be a viable income generating option.

The need for more participatory approach in watershed development involving all classes of people to promote collective action is required at this stage. The contribution of NGOs in the form of capacity building in their respective villages is a prerequisite for successful watershed development interventions and sustainability of the community assets created and their benefits. Therefore, selection of appropriate PIA in consultation with local population would be more effective. Since these were the nucleus watershed villages, the emphasis on promoting collective action is all the more important for scaling up and replicating the innovative farmer participatory consortium model to other neighboring and satellite villages.

3. Socioeconomic Profiles and Resource Use Patterns in Watersheds of Nalgonda District

This section characterizes and assesses the baseline biophysical and socioeconomic conditions in the selected watersheds of Tirumalapuram in Chintapally mandal and Kacharam in Yadagirigutta mandal of Nalgonda district.

District profile

Nalgonda is located at 17º03' N and 79º02' E in the state of Andhra Pradesh and spread over an area of 14,240 km^2 with a population of about 3,238,440 (based on 2001 census). About 87% of the population was concentrated in the rural areas. Mining was the major activity in the district. Even though agriculture may not be comparable with mining activity, it is a major income generating and subsistence activity at the household level.

Major crops during 2002–03 cropping season in Nalgonda district were paddy, cotton, castor and green gram accounting for about 28%, 16%, 13% and 9% of gross cropped area, respectively (Fig. 21).

There was a decline in the total rainfall in Andhra Pradesh during 2002–03 by about 35% as compared to normal years. Consequently, the crop area also declined by 11.19%. The standing crops were badly affected in all the districts of the state due to prolonged dry spells in July and September 2002. Figure 22 compares the actual monthly rainfall during the monsoon period in 2002 in Nalgonda with the rainfall during normal years. In Nalgonda district, the total rainfall during June 2002 to May 2003 was only 447 mm as compared to 751 mm in normal years (decreased by about 40%).

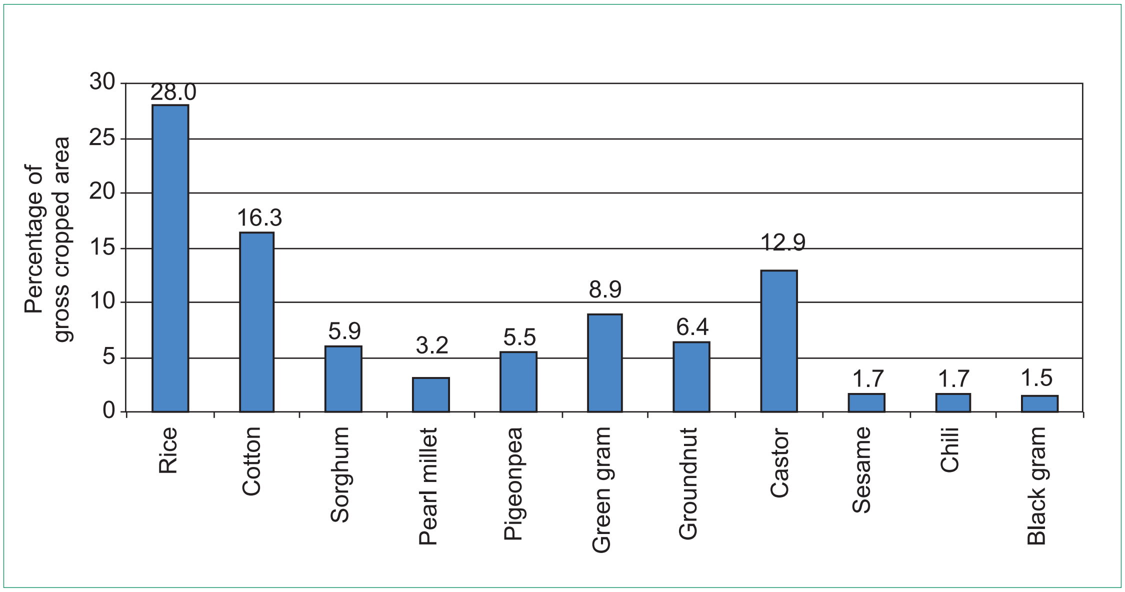

Figure 21. Area under major crops in 2002–03 in Nalgonda district.

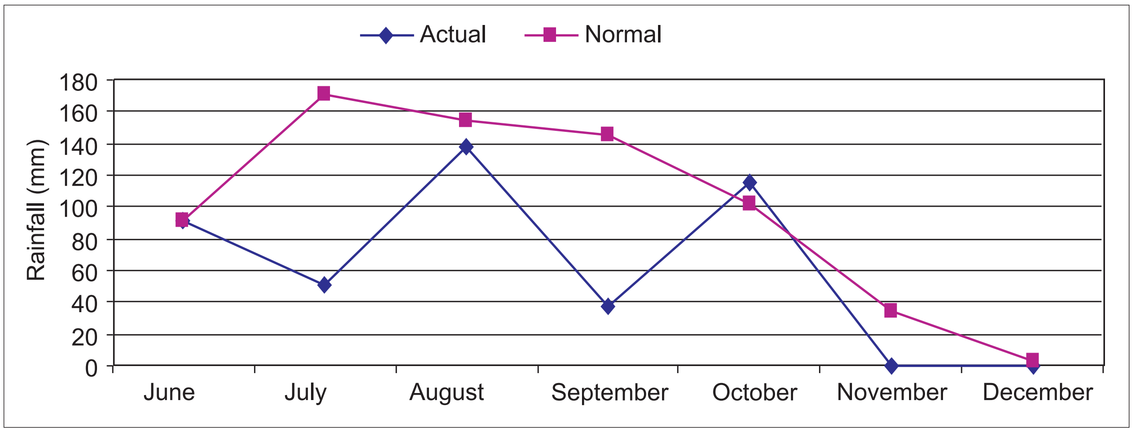

Figure 22. Monsoon rainfall in 2002 in Nalgonda district.

One of the major problems and constraint that affects the labor productivity in Nalgonda district is excess flourine in the drinking water that causes flourosis. Flourosis is a physically debilitating disease that leaves the affected person totally disabled. Nearly 500 villages in the district were affected by the problem. The normal flourine content in the drinking water was about 1 ppm whereas in the affected villages flourine content was about 10 ppm. In the watershed villages of Tirumalapuram and Kacharam, dental flourosis was more widely prevalent and villagers complained about their inability to do physical work in their farms due to joint pains.

Village characteristics

Tirumalapuram is located in Chintapally mandal at 78°87′ longitude and 16°81′ latitude. The distance to the mandal headquarters is about 5 km. Kacharam is located in Yadagirigutta mandal at 78°99′ longitude and 17°65′ latitude (Fig. 23). The distance to mandal headquarters is about 11 km and the nearest market town is Aleru (about 7 km). There were about 5 castes in Tirumalapuram with major

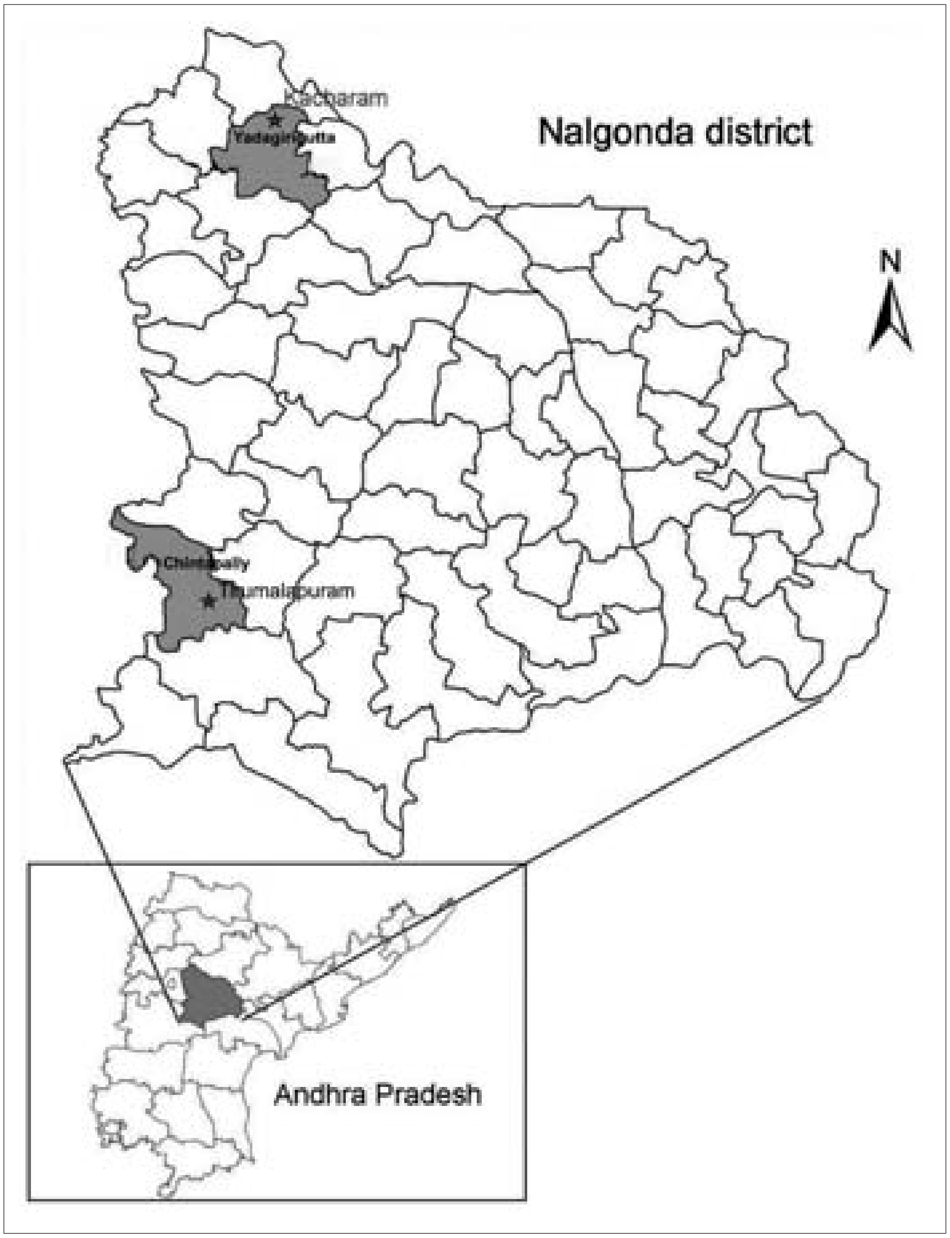

Figure 23. Watershed locations in Nalgonda district.

castes being Madiga and Velama. In Kacharam, there were about 18 castes with Reddy, Madiga and Kurma being the major castes.

The total village area of Tirumalapuram was 518 ha of which 81% consisted of cultivated area and 16% was under permanent fallow (Table 23). About 86% of cultivated area was under dryland agriculture and 14% under irrigated cultivation.

The area of Kacharam village was about 662 ha. Cultivated area accounted for 78% of total area and 15.6% was under permanent fallow; 71% of the cultivated area was under dryland agriculture and 29% was irrigated. The CPR were more in Kacharam (about 35 ha) as compared to Tirumalapuram (12 ha). In Kacharam, the CPR consisted of *Acacia* trees (*sarkar thumma)* on about 29.5 ha that were protected by the village panchayat.

Table 23. General characteristics of the selected villages in Nalgonda district.		
Characteristics	Tirumalapuram	Kacharam
Total cultivated area (ha)	421.9 (81.4)[1]	518.6 (78.3)
- Irrigated cultivated (ha)	60.7	149.8
- Dryland cultivated (ha)	364.4	368.8
Permanent fallow (private) (ha)	84.2 (16.3)	103.2 (15.6)
CPR and forest area (ha)	12.1 (2.3)	35.2 (5.3)
Other land (settlements, etc) (ha)	4.0 (0.8)	5.3 (0.8)
Total village area (ha)	518.2 (100)	662.3 (100)

1. Figures in parentheses are percentage values.
Source: Focus group meetings.

The major soil types in both the villages were red soils, deep black soils (*nalla regadi*) and sodic soils (*choudu*). The major crops in Tirumalapuram were paddy, sorghum, castor and pigeonpea (grown as an intercrop). The main crops in Kacharam were paddy, maize, cotton, sesame, green gram, castor and sorghum.

Demographic characteristics

The average age of household head in Tirumalapuram was 48 years with mean education level of 3 years (Table 24); 80.5% of household heads had education of less than 5 years. The average family size was 4.79. Sixty-five percent of sample households had a family size of more than 4. The work force was computed as a weighted sum of individuals in the age groups of 11–15 years, 16–55 years and 56–65 years with weights of 0.25, 1.00 and 0.25, respectively (Shiferaw et al. 2002). The average weighted work force for Tirumalapuram was 2.94 persons per household. Household members below 10 years of age and those above 65 years were considered as dependents. The dependency ratio was computed as the ratio of non-working members to working family members (Shiferaw et al. 2002). The average dependency ratio of 0.28 indicates that every working family member supported 0.28 persons.

Table 24. Demographic details of Tirumalapuram[1].				
Characteristics	Mean	SD	Minimum	Maximum
Age of household head (yr)	48.18	13.75	25	75
Education of household head (yr)	2.9	4.31	0	19
Education of family (yr)	2.89	2.79	0	10.25
Persons below 5 years	0.56	0.87	0	3
Persons 6–10 years	0.58	0.78	0	3
Persons 11–15 years	0.39	0.64	0	3
Persons 16–55 years	2.74	1.52	0	8
Persons 56–65 years	0.43	0.53	0	2
Persons above 65 years	0.29	0.52	0	2
Family size	4.79	1.99	1	10
Total work force	2.94	1.50	0	8.25
Dependents	0.76	0.80	0	3
Dependency ratio	0.28	0.33	0	1

1. Sample size (n) = 72; SD = Standard deviation.

The average age and education of household head in Kacharam was 47 years and 4 years of education (Table 25). About 70% of the household heads had less than 5 years of education. The average family size (4.83) was almost same as in Tirumalapuram. The dependency ratio was 0.19.

Table 25. Demographic details of Kacharam[1].

Characteristics	Mean	SD	Minimum	Maximum
Age of household head (yr)	46.94	11.76	23	76
Education of household head (yr)	4.03	4.08	0	15
Education of family (yr)	5.19	2.67	0	12.5
Persons below 5 years	0.20	0.52	0	2
Persons 6–10 years	0.51	0.71	0	3
Persons 11–15 years	0.59	0.70	0	2
Persons 16–55 years	3.00	1.25	0	7
Persons 56–65 years	0.40	0.63	0	2
Persons above 65 years	0.17	0.43	0	2
Family size	4.83	1.71	2	12
Total work force	3.25	1.23	0.5	7.5
Dependents	0.58	0.72	0	3
Dependency ratio	0.19	0.28	0	1.5

1. Sample size (n) = 90; SD = Standard deviation.

Household activities

In Tirumalapuram, 52% of the women were involved in household chores, 41% worked as hired labor and 37% of them were involved in their own farm work (Fig. 24). Often, women from the SC category usually work as hired labor. Men were mainly involved in on-farm activities (41%). In Kacharam, 61% of women were involved in household chores and 45% in on-farm work. Men were mainly involved in on-farm activities (46%) and other income-generating activities (28%) (Fig. 25).

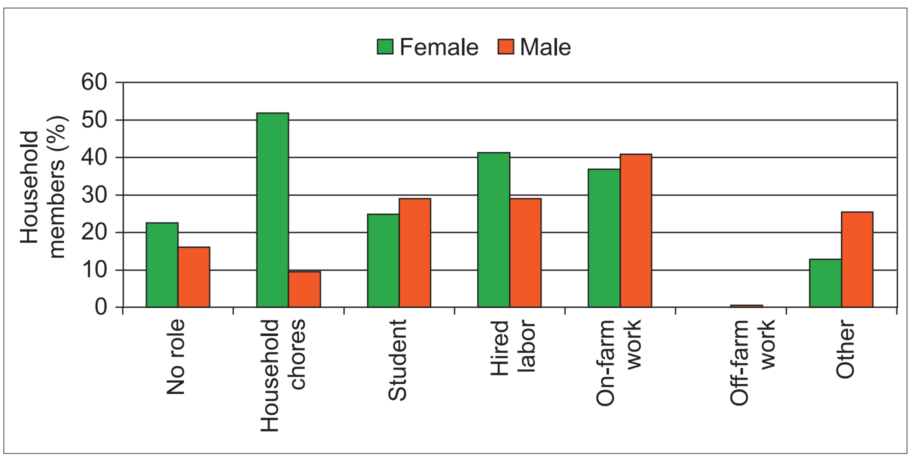

Figure 24. Household activities in Tirumalapuram.

Caste composition

Caste system still forms the basis of the social structure in the Indian villages. Even though rigid social demarcation does not exist anymore, families and individuals are still identified on the basis of their respective castes. In Tirumalapuram, SC constituted the major caste category (about 61% of total

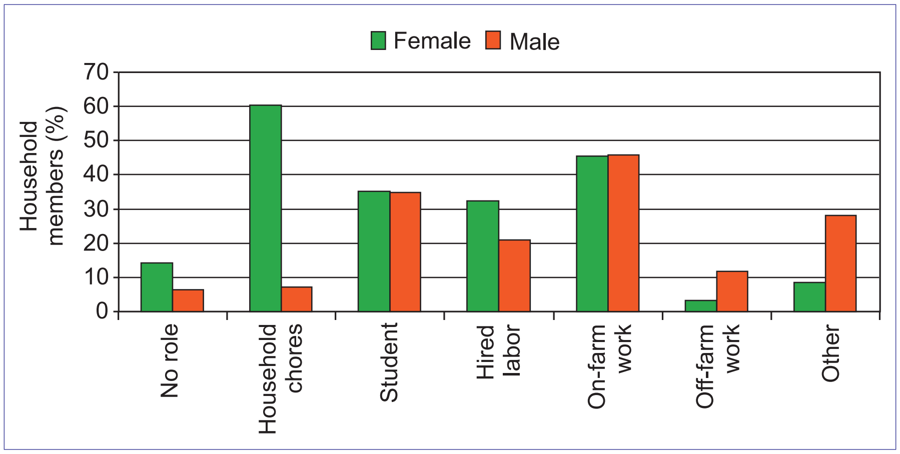

Figure 25. Household activities in Kacharam.

households) followed by OC category (35%). The two major castes in the village were Vellamas (OC) and Madigas (SC) (Fig. 26).

In Kacharam, BC constituted the major caste category (about 52% of total households) with almost equal representation of OC and SC (22% and 21%, respectively) (Fig. 27). The major castes in the village were Reddys (OC), Kurma (BC) and Madigas (SC). The caste structure in Kacharam was more heterogenous than in Tirumalapuram.

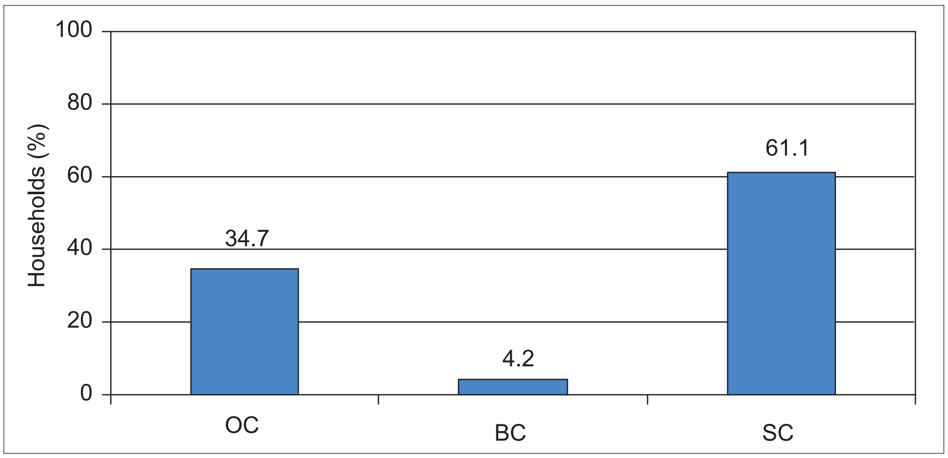

Figure 26. Caste categories in Tirumalapuram.

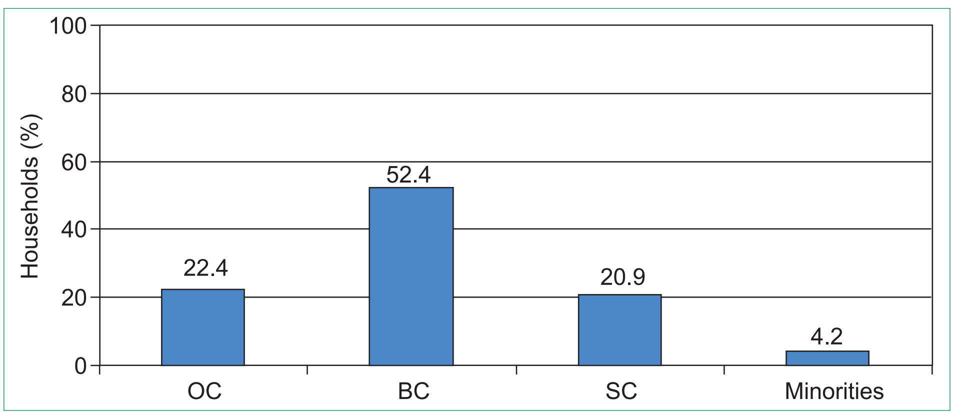

Figure 27. Caste categories in Kacharam.

Land ownership

The average land ownership was 3.67 ha in Tirumalapuram with a standard deviation of 5.61 and 2.76 ha in Kacharam with a standard deviation of 2.59 (Tables 26 and 27). The average per capita land in Tirumalapuram was almost double that of Kacharam. The average irrigated cultivated land was relatively higher in Tirumalapuram (0.70 ha) as compared to Kacharam (0.15 ha). This may be due to the existence of several tanks in the village that become the major source of irrigation with the advent of adequate rains. In both the villages the average dryland cultivated land was higher than the irrigated cultivated land.

Table 26. Land ownership in Tirumalapuram[1].

Variable	Mean	SD	Minimum	Maximum
Total own land (ha)	3.67	5.61	0	30.36
Irrigable land (ha)	0.80	1.66	0	10.93
Dryland (ha)	2.87	4.66	0	27.94
Irrigated own cultivated land (ha)	0.70	1.64	0	10.93
Dryland own cultivated land (ha)	1.21	1.47	0	7.09
Permanent fallow (ha)	0.80	1.86	0	11.34
Per capita land (ha)	1.08	2.22	0	15.18

1. Sample size (n) = 72; SD= Standard deviation.

Table 27. Land ownership in Kacharam[1].

Variable	Mean	SD	Minimum	Maximum
Total own land (ha)	2.76	2.59	0	11.74
Irrigable land (ha)	0.61	0.69	0	3.64
Dryland (ha)	2.15	2.13	0	9.72
Irrigated own cultivated land (ha)	0.15	0.29	0	1.42
Dryland own cultivated land (ha)	1.36	1.31	0	7.29
Permanent fallow (ha)	0.78	1.44	0	8.06
Per capita land (ha)	0.56	0.41	0	2.22

1. Sample size (n) = 90; SD= Standard deviation.

Even though the average landholdings appear to be higher in Tirumalapuram, analysis of the land distribution provides better insights into the landholding patterns in the villages. The OC category had larger landholdings in both villages. In Tirumalapuram, on average, OC, BC and SC hold about 8.22 ha, 2.85 ha and 1.14 ha of land, respectively (Fig. 28). The average landholdings and per capita landholdings of OC were very much higher than other categories indicating considerable inequalities in land distribution. The average landholding of OC was almost 3 times that of BC and 7 times that of SC. In Kacharam, the average land ownership was 4.37 ha for OC, 2.49 ha for BC and 1.91 ha for SC and 0.43 ha for muslims (Fig. 29). The OC category had a higher average land ownership. But the difference in land ownership between OC and other categories was not as prominent as in the case of Tirumalapuram. The per capita landholdings also show similar pattern.

The land distribution patterns can be illustrated through Lorenz curves. The 45 degrees angle straight line shows the land distribution under perfect equality conditions. The curved line shows the actual distribution of land. Greater the distance from the straight line, greater the inequalities in the land distribution. Figures 30 and 31 show that land inequalities were higher in Tirumalapuram as compared to Kacharam. In Tirumalapuram, about 75% of land was owned by 25% of households. Velamas who form the dominant caste own higher per capita land as compared to other categories in the

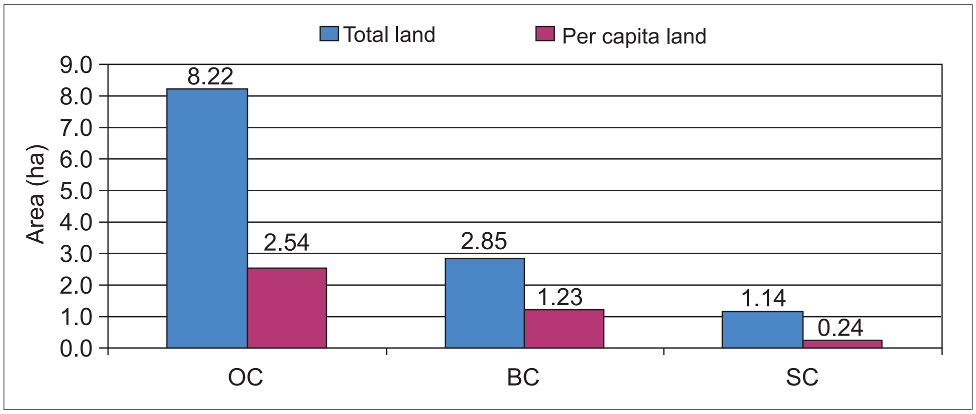

Figure 28. Caste-wise landholdings in Tirumalapuram.

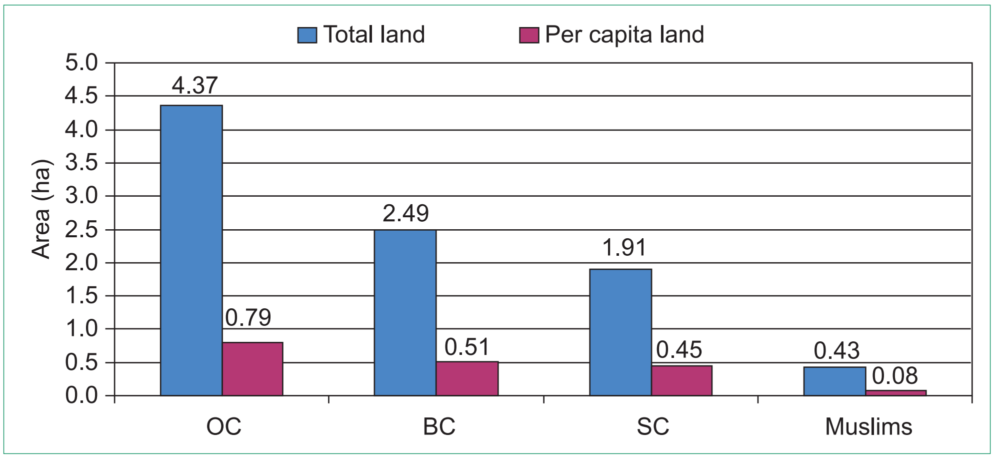

Figure 29. Caste-wise landholdings in Kacharam.

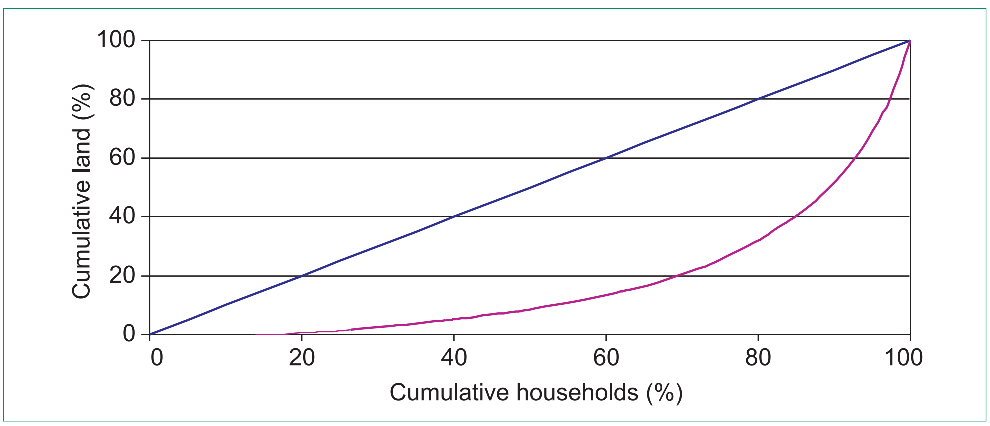

Figure 30. Land distribution in Tirumalapuram.

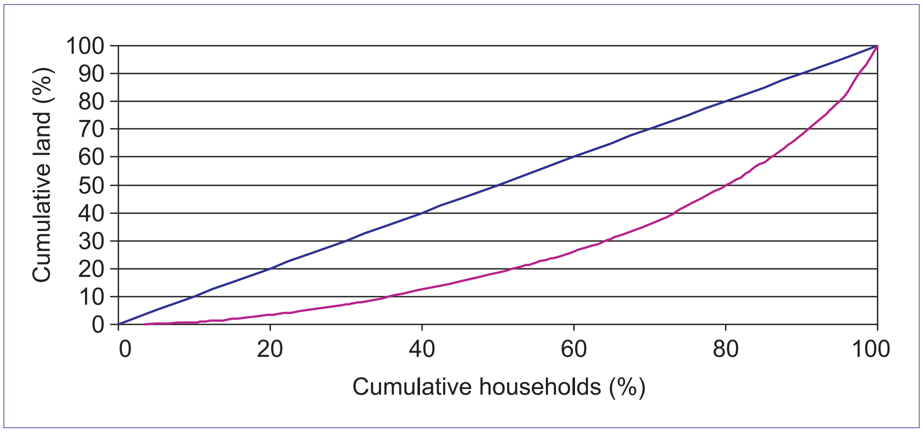

Figure 31. Land distribution in Kacharam.

village. In Kacharam, 20% of households own about 50% of land. The Gini coefficient was 0.65 in Tirumalapuram and 0.47 in Kacharam indicating higher land inequalities in Tirumalapuram.

Crop production

The major dryland crops in Tirumalapuram were castor, sorghum and pearl millet, which are grown with pigeonpea as intercrop. Paddy was also grown to a considerable extent depending on the availability of water. In *kharif*, castor and pigeonpea intercrop system was relatively more common with a mean plot size of 0.56 ha followed by paddy with mean plot size of 0.30 ha (Table 28).

Table 28. Mean area of major crops grown in Tirumalapuram[1].

Crop	No. of plots	Mean area (ha)
Kharif		
Castor+Pigeonpea	41	0.56
Green gram	5	0.07
Green gram+Pigeonpea	1	0.04
Paddy	28	0.30
Pearl millet	10	0.07
Pearl millet+Pigeonpea	11	0.06
Pigeonpea (sole)	2	0.08
Sorghum	2	0.01
Sorghum+Pigeonpea	11	0.08
Rabi		
Paddy	9	0.05
Perennial		
Sweet lemon	8	0.19

1. Sample size (n) = 72.

In Kacharam, the major crops were maize, sesame, sorghum, cotton and green gram. Maize, sesame and sorghum were mainly grown with pigeonpea as intercrop (Table 29). Paddy was also an important irrigated crop in *kharif* and *rabi* seasons. Maize was a recent crop (since last two years) and currently popular among the farmers. Tobacco was popular in the past but now it was grown by only a few farmers. In general, more crops were grown in Kacharam as compared to Tirumalapuram.

Table 29. Mean area of major crops grown in Kacharam[1].

Crop	No. of plots	Mean area (ha)
Kharif		
Castor	4	0.02
Castor+Pigeonpea	6	0.06
Cotton	19	0.16
Cotton+Pigeonpea	1	0.02
Green gram	13	0.02
Maize	10	0.08
Maize+Pigeonpea	49	0.45
Paddy	39	0.13
Pigeonpea (sole)	5	0.03
Sesame	9	0.04
Sesame+Pigeonpea	38	0.27
Sorghum	13	0.08
Sorghum+Pigeonpea	18	0.10
Sorghum fodder	9	0.03
Tobacco	10	0.07
Rabi		
Paddy	13	0.03
Sorghum fodder	8	0.04

1. Sample size (n) = 90.

Fertilizer usage and FYM application were more for irrigated crops such as paddy. In Tirumalapuram, about 141 kg ha^{-1} of DAP and 222 kg ha^{-1} of urea were applied in *kharif* (Table 30). In *rabi* also fertilizer application was almost similar. Fertilizer and FYM usage was relatively higher in Kacharam as compared to Tirumalapuram. In Kacharam, about 171 kg ha^{-1} of DAP and 224 kg ha^{-1} of urea were applied for paddy in *kharif* and 210 kg ha^{-1} of DAP and 230.5 kg ha^{-1} of urea in *rabi* season (Table 31). About 88.5 kg ha^{-1} of DAP was applied for castor in Kacharam as compared to only 18.4 kg ha^{-1} in Tirumalapuram. Even though the average quantity of commonly used fertilizers such as DAP and urea were lower in Tirumalapuram, other fertilizers such as triple 17, superphosphate and micronutrients were more frequently used as compared to Kacharam.

The average yields of almost all the major crops in Tirumalapuram were higher than the district average of the 2002–03 cropping season (Table 32). The average yield of castor was 390 kg ha^{-1} as compared to the district mean of 206 kg ha^{-1}. The yields of paddy and sorghum were almost double that of the district mean yields. This may be due to good quality soils coupled with adequate groundwater

Table 30. Fertilizer usage for major crops in Tirumalapuram.

Crop	No. of plots	% plots fertilized (kg ha^{-1})	DAP (kg ha^{-1})	Urea (kg ha^{-1})	Triple 17 (kg ha^{-1})	Micro-nutrients (kg ha^{-1})	Zinc (kg ha^{-1})	Super phosphate (kg ha^{-1})	Potash (kg ha^{-1})	FYM (t ha^{-1})
Castor	42	92.86	18.4	1.1	14.4				0.3	0.7
Green gram	6	100	25.5		14.7					
Paddy (*Kharif*)	28	92.86	140.7	222.3	39.0	0.9	1.6	9.7	2.9	3.4
Paddy (*Rabi*)	9	100	144.1	248.4	77.8	0.0	8.2	13.7		
Pearl millet	21	90.48	38.7	2.4	2.2					
Sorghum	13	76.92	20.0		8.5					
Sweet lemon	8	87.5	0.0	0.0	32.4	6.2	61.0	228.5	37.1	2.3

Table 31. Fertilizer usage for major crops in Kacharam.

Crop	No. of plots	% plots fertilized (kg ha^{-1})	DAP (kg ha^{-1})	Urea (kg ha^{-1})	Triple 17 (kg ha^{-1})	Micro-nutrients (kg ha^{-1})	Zinc (kg ha^{-1})	Potash (kg ha^{-1})	FYM (t ha^{-1})
Castor	11	100	88.5	3.6					2.7
Chili	3	100	301.9	54.9				43.9	6.6
Cotton	20	100	148.6	111.6	18.5				3.0
Green gram	13	53.85	58.9	5.7					2.4
Maize	59	100	76.9	49.5		0.3		0.5	1.1
Paddy *(Kharif)*	39	100	171.3	223.8			0.6	3.0	9.1
Paddy *(Rabi)*	13	100	210.3	230.5		0.4			1.5
Sesame	47	97.87	73.6	10.4					1.7
Sorghum	31	87.1	49.4	15.7					1.1
Sorghum fodder *(Kharif)*	9	88.89	43.9	140.0					9.5
Sorghum fodder *(Rabi)*	8	100	70.0	144.1					1.2
Tobacco	10	100	166.7	113.2	12.4				6.0

Table 32. Crop yields in Tirumalapuram during 2002–03.

Crop	No. of plots	% plots irrigated	Mean yield (kg ha^{-1})	Minimum yield (kg ha^{-1})	Maximum yield (kg ha^{-1})	CV	District yield (kg ha^{-1})
Castor	42	0	390.2	0.0	906.1	46.2	206
Green gram	6	0	289.2	197.7	494.2	41.2	347
Paddy (*Kharif*)	28	88	4793.1	0.0	6054.1	28.4	2244
Paddy (*Rabi*)	9	100	5039.1	3459.5	5765.8	13.8	2301
Pearl millet	21	0	570.5	173.0	2471.1	92.5	413
Pigeonpea[1]	62	0	118.3	0.0	370.7	79.8	–
Sorghum	13	0	498.1	0.0	1235.5	73.4	246

1. Intercrop.

resources. Most of the farmers opined that majority of the tube wells yielded adequate water. The only constraint was the availability of continuous power supply.

In Kacharam also, the average yields of castor, paddy, sesame and sorghum were almost twice higher than the district mean yields (Table 33). But maize, which appeared to be popular in recent years among the farmers had lower average yield (850.6 kg ha^{-1}) as compared to the district mean (2311 kg ha^{-1}).

Livestock production

Livestock has an important role in the livelihood strategies of rural households. It includes dairy animals (cows and buffaloes), draught animals (bullocks), other cattle for meat, small ruminants (sheep and goats) and chicken. The crop-livestock interactions are complementary in nature.

In Tirumalapuram, 30.5% of the sample households did not own any livestock; 62.5% of the households had no milch animals and 68% of the households had no bullocks. The average ownership of different animals was 0.75 milching buffaloes, 0.15 other she-buffaloes, 0.21 milching cows, 0.81 bullocks, 0.35 other cows and 1.24 goats (Table 34).

Table 33. Crop yields in Kacharam during 2002–03.

Crop	No. of plots	% plots irrigated	Mean yield (kg ha^{-1})	Minimum yield (kg ha^{-1})	Maximum yield (kg ha^{-1})	CV	District yield (kg ha^{-1})
Castor	11	0	489.0	123.6	1482.6	76.0	206
Cotton	20	0	859.7	370.7	1976.8	43.4	–
Green gram	13	0	252.0	0.0	988.4	111.6	347
Maize	59	0	850.6	0.0	3088.8	72.8	2311
Paddy (*Kharif*)	39	95	4880.2	0.0	7495.5	32.0	2244
Paddy (*Rabi*)	13	100	5367.9	2965.3	9044.0	32.3	2301
Pigeonpea[1]	110	0	147.7	0.0	794.3	88.3	–
Sesame	47	0	238.2	0.0	593.1	67.8	62
Sorghum	31	0	416.6	0.0	1647.4	101.2	246
Tobacco	10	10	1021.8	148.3	1729.7	48.0	2525

1. Intercrop.

Table 34. Average livestock ownership (number household^{-1}) in Tirumalapuram.

Variable[1]	Mean	Minimum	Maximum
Milching cows	0.21 (0.56)[2]	0	3
Milching buffaloes	0.75 (1.93)	0	13
Other cows	0.35 (0.65)	0	2
Bullocks	0.81 (1.56)	0	8
Heifers (cows)	0.21 (0.60)	0	3
Bulls	0.19 (0.49)	0	2
Calves	0.31 (0.66)	0	3
Other she-buffaloes	0.15 (0.76)	0	6
Heifers (buffaloes)	0.40 (1.32)	0	6
Calves	0.35 (0.95)	0	6
Sheep	0.00 (0.00)	0	0
Goats	1.24 (3.00)	0	14
Chicken	1.61 (2.53)	0	10

1. Sample size (n) = 72.
2. Figures in parentheses are standard deviation values.

In Kacharam, 27.8% of the sample households did not have any livestock. About 43% of the households were without any milch animals and 69% had no bullocks. The average ownership of animals was 0.71 for bullocks, 1.07 for milching buffaloes, 0.54 for milching cows, 2.39 for sheep, 0.41 for goats and 6.1 for chicken (Table 35).

Figures 32 and 33 depict the distribution of value of livestock assets among the sample households in the respective villages. Inequalities seem to exist regarding livestock assets among the sample households. In Tirumalapuram, 75% of total sample households possess only 24% of the total value of livestock assets. In Kacharam, 75% of total sample households own 31% of total value of livestock assets. A caste-wise distribution of livestock assets provides some insights into such inequalities. Livestock assets owned by the SC category was less and relatively high among OC category in both the watershed villages.

The important livestock products include milk, meat, FYM, draught power and transportation. The average milk production and sales per annum for a household were much higher in Kacharam as compared to Tirumalapuram (Table 36). In Kacharam, the sample average of milk produced per

Table 35. Average livestock ownership (number household^{-1}) in Kacharam.

Variable[1]	Mean	Minimum	Maximum
Milching cows	0.54 (1.18)[2]	0	7
Milching buffaloes	1.07 (1.32)	0	6
Other cows	0.01 (0.11)	0	1
Bullocks	0.71 (1.13)	0	4
Heifers (cows)	0.14 (0.55)	0	4
Bulls	0.02 (0.21)	0	2
Calves	0.60 (1.16)	0	5
Other she-buffaloes	0.11 (0.46)	0	3
Heifers (buffaloes)	0.26 (0.63)	0	3
Calves	0.49 (1.07)	0	6
Sheep	2.39 (9.72)	0	60
Goats	0.41 (3.20)	0	30
Chicken	6.10 (52.66)	0	500

1. Sample size (n) = 90.
2. Figures in parentheses are standard deviation values.

Table 36. Average household milk production and sales per annum.

Village	Sample households	Milk production (L)	Milk sold (L)	Milk sales (Rs)
Tirumalapuram	72	318	228	2148
Kacharam	90	1259	1124	10023

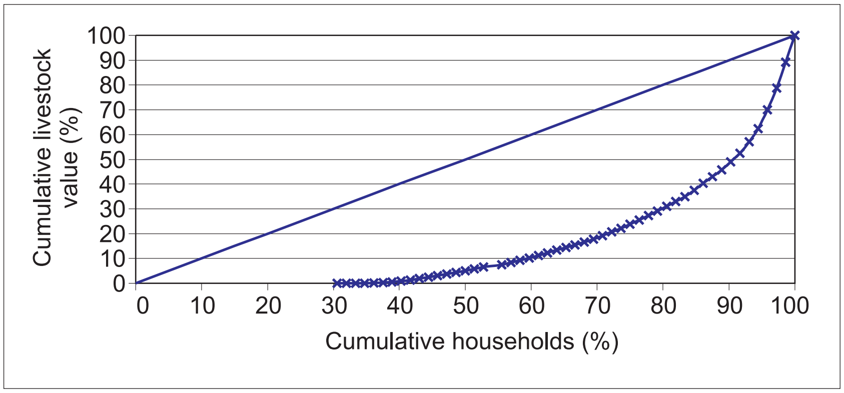

Figure 32. Distribution of livestock assets in Tirumalapuram.

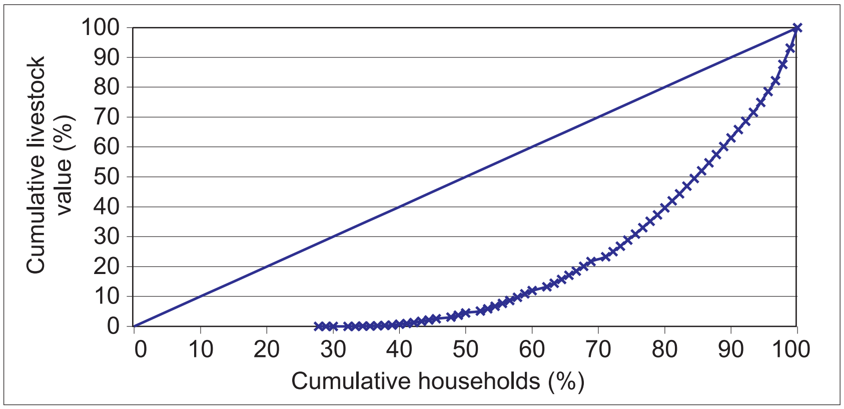

Figure 33. Distribution of livestock assets in Kacharam.

annum was 1259 L and milk sold was 1124 L, whereas in Tirumalapuram, the sample average of milk produced per annum was only 318 L and milk sold was 228 L. Even though one of the farmers' group voluntarily performs milk testing and acts as a collecting point in the village, it was not as well organized as in Kacharam. In Kacharam, there was a dairy association that was politically strong and well organized. Many households also own Jersey cows, which yield higher milk than the conventional cows. The fodder for livestock was catered by the paragrass supply from Uppal, which is about 40 km from the village.

Other household assets

The average household assets in Tirumalapuram was Rs 127,653 (Table 37) with average per capita assets of Rs 35048. Ninety percent of the sample households had per capita assets less than the mean. This relatively large value of per capita assets may be due to the large assets of a few households.

Table 37. Average household assets (Rs household^{-1}) in Tirumalapuram.

Variable[1]	Mean	Minimum	Maximum
Farm assets	27932 (92346)[2]	0	495000
Other assets	99721 (322806)	1500	2466500
Total assets	127653 (352567)	5800	2491400
Per capita assets	35048 (101450)	1545	577750

1. Sample size (n) = 72.
2. Figures in parentheses are standard deviation values.

The mean value of household assets in Kacharam was Rs 69179 and the average per capita value of assets was Rs 14424 (Table 38). About 62% of the sample households had assets less than the mean per capita assets. Even though the average value of total assets appeared to be much higher in Tirumalapuram, it was mainly due to a few economically well-off OC (Velama) community households that had large landholdings along with high household incomes from regular employment in government service.

Table 38. Average household assets (Rs household^{-1}) in Kacharam.

Variable[1]	Mean	Minimum	Maximum
Farm assets	12992 (35746)[2]	0	331800
Other assets	56188 (48835)	2825	281000
Total assets	69179 (65236)	2975	405400
Per capita assets	14424 (11270)	595	63300

1. Sample size (n) = 90.
2. Figures in parentheses are standard deviation values.

Income from other sources

The major income sources other than the crop and livestock incomes in Tirumalapuram were casual village labor, regular employment and migration income. The mean annual income from casual village labor was Rs 5912 (Table 39). Households belonging to the SC category are mainly dependent on this income source. Income from shared land was also relatively common in the village mainly due to large landholdings of absentee landlords and aged landowners who reside in the village and are unable to cultivate land by themselves.

Table 39. Other non-farm household income sources.

Village	Activity	No. of households	Mean annual income (Rs)
Tirumalapuram (n=72)	Shared land	12	1147
	Other regular employment	20	4763
	Wage employment in watershed project	13	320
	Casual village labor	48	5912
	Migration income	17	3326
	Remittances	7	8037
	Business income	11	1569
Kacharam (n=90)	Rented-out bullock	6	216
	Other regular employment	28	4406
	Wage employment in watershed project	7	56
	Casual village labor	56	4855
	Migration income	13	1665
	Caste occupation	12	1324
	Sales from CPR	7	294
	Business income	12	1690

In Kacharam also, casual village labor was an important source of income (with a mean annual income of Rs 4855). Income from regular employment was higher in Kacharam as compared to Tirumalapuram as opportunities were higher due to its proximity to all the major market towns like Yadagirigutta (11 km), Bhongir (20 km) and Aler (7 km). Other important sources of income include migration income, business income and caste occupation (such as toddy tapping).

Household income

The average per capita net returns from crop cultivation was Rs 3544 in Tirumalapuram, which was much higher than that of Kacharam (Rs 1742). But the average per capita livestock income was higher in Kacharam (Rs 2296) as compared to Tirumalapuram (Rs 1138) (Table 40).

Table 40. Average per capita net returns from various sources.

Source of income	Tirumalapuram (n=72)	Kacharam (n=90)
Crop income (Rs)	3544	1742
Livestock income (Rs)	1138	2296
Non-farm income (Rs)	5670	3406
Total income (Rs)	10352	7444

The per capita average income from non-farm sources was also higher in Tirumalapuram and this may be because of a few households with persons holding high ranking government jobs. The average per capita total income was also higher in Tirumalapuram (Rs 10352) as compared to Kacharam (Rs 7444).

The contribution of different livelihood sources to the total household income is shown in Figure 34. Non-farm income sources were important sources of income in both Tirumalapuram and Kacharam villages (55% and 46% of total income, respectively). Crop income contribution to total household income was relatively high in Tirumalapuram (34%) as compared to Kacharam (23%). Livestock was

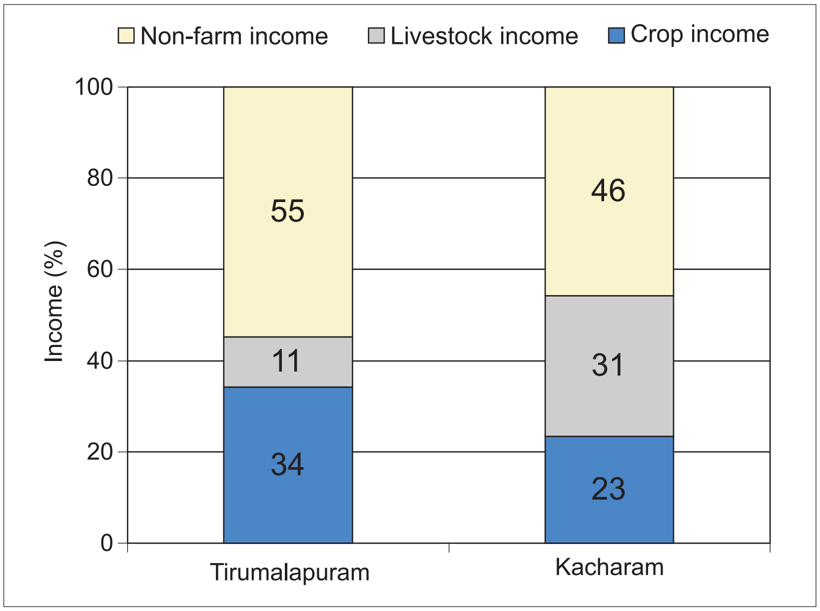

Figure 34. Sources of household income.

an important source of income in Kacharam and contributes more than the crop cultivation (about 31%) whereas in Tirumalapuram its contribution was limited.

Groundwater resources

In general, groundwater levels were relatively better in Tirumalapuram when compared with Kacharam as can be seen from the number of functional open wells (34% in Tirumalapuram and 0% in Kacharam) (Table 41). The number of tube wells was also higher in Tirumalapuram (70) as compared to Kacharam (54) and almost 76% of them were functional. In Kacharam, about 67% of the tube wells were functional. One reason for better groundwater availability in Tirumalapuram could be the large number of tanks in the village that get filled during rains and facilitate groundwater recharge.

Table 41. Number of wells in the watershed villages.

Wells	Functional	Dried	Total
Tirumalapuram			
Open wells	12 (34.3)[1]	23 (65.7)	35
Tube wells	53 (75.7)	17 (24.3)	70
Kacharam			
Open wells	0 (0.0)	85 (100.0)	85
Tube wells	36 (66.7)	18 (33.3)	54

1. Figures in parentheses are percentage values.

Institutional aspects

Tirumalapuram had a more homogeneous community with clear demarcations. Groups were associated through familial relations. The Velama caste constituted the single dominant community that was affluent and politically well connected. The Madiga was the other concentrated group. The watershed committee was formed with proper representations but there was a sentiment among certain sections that involvement in decision-making process was limited to certain members only. The PIA in the village was an NGO called Deena Daya Abhyudaya Seva Samithi. So far four percolation tanks have been dug and other construction activities have yet to be completed.

Social networks and political lineage was more pronounced in Kacharam as compared to Tirumalapuram. Almost all the villagers were strongly associated with one political party or the other in Kacharam. Any elections including that of the dairy cooperative, etc were keenly contested. The watershed in Kacharam was named as Jalsagar watershed. There were 8 watershed user groups that were formed based on the clusters of landholdings. A watershed committee was constituted with appropriate representations in accordance with the specified guidelines. The chairperson of the watershed committee was a woman as it was reserved for women. But there was unhappiness among certain big farmers regarding a woman leading the committee as they felt that women lacked farm experience and questioned their ability to make any decisions regarding watershed activities. The PIA was an NGO called Action for Development of Rural Education and Service Society (ADDRESS). It carries a fair amount of recognition among the villagers and watershed activities were currently underway.

Summary and conclusions

The purpose of this study was to characterize and assess the baseline biophysical and socioeconomic conditions in the selected watershed villages of Tirumalapuram and Kacharam in Nalgonda district of Andhra Pradesh. Knowledge of such conditions helps us in understanding and identifying the factors that contribute to the success of the watershed development approach.

The two villages had similar characteristics in terms of age, education and household activities even though Kacharam was a much bigger village in terms of population (330 households as compared to 72 households in Tirumalapuram). The caste structure in Kacharam was more heterogeneous than in Tirumalapuram. The average per capita land in Tirumalapuram was almost double that of Kacharam. The Gini coefficient was 0.65 in Tirumalapuram and 0.47 in Kacharam indicating higher land inequalities in Tirumalapuram.

More number of crops were grown in Kacharam as compared to Tirumalapuram. The major crops in Tirumalapuram were paddy, castor, sorghum and pearl millet whereas in Kacharam the major crops were paddy, maize, sesame, sorghum, cotton and green gram. Pigeonpea was grown as an intercrop in both the villages. Maize was the popular crop since past two years in Kacharam. In general, the average yields for almost all the major crops were higher than the district averages of the 2002–03 cropping season in both the villages. The yields of castor, sorghum, pearl millet and paddy (*kharif*) in Tirumalapuram were 390, 498, 570 and 4793 kg ha^{-1}, respectively. In Kacharam, the average yields of maize, sesame, sorghum, cotton, green gram and paddy (*kharif*) were 851, 238, 417, 860, 252 and 4880 kg ha^{-1}, respectively.

The average milk production and sales per annum for a household were much higher in Kacharam as compared to Tirumalapuram. Milk cooperatives were better organized in Kacharam. Casual village labor was an important livelihood strategy, especially in the case of SC category in both watershed villages. Other important sources of income include regular employment, migration income and business income.

The average per capita total income was also higher in Tirumalapuram (Rs 10352) as compared to Kacharam (Rs 7444). Non-farm income and crop income constituted the important components of the total per capita household income in Tirumalapuram (55% and 34% of total per capita income, respectively). In Kacharam, non-farm income and livestock income were the important components (46% and 31%, respectively).

In general, groundwater levels were relatively better in Tirumalapuram when compared with Kacharam. The number of tanks that get filled during rains and facilitate recharge was more in Tirumalapuram and could be the reason for better groundwater levels.

On the whole there were distinct differences among the two villages that could have an impact on the implementation process of watershed activities. Tirumalapuram was a relatively smaller village with a more homogenous social structure as compared to Kacharam. Tirumalapuram was also better endowed with groundwater resources. There was less diversification in the type of crops grown and number of non-farm activities in Tirumalapuram as compared to Kacharam. Any technological intervention is expected to have a better chance to succeed in Tirumalapuram for crop productivity enhancement through increased water use efficiency. But a single caste (Velama) dominates the political and economic aspects of the village and involvement of this community in any program process becomes imperative for its success. Therefore, a proper balance by including the community without alienating other weaker communities in the decision-making process is a must to achieve the equity objectives. Kacharam presents a different picture with a bigger size in terms of population, heterogeneous community and strong political affiliations within the community. This entails greater knowledge and persuasion about the different political groups and their sensitivities for better cooperation in adoption of technological interventions.

4. Socioeconomic Profiles and Resource Use Patterns in Watersheds of Kurnool District

This section characterizes and assesses the baseline biophysical and socioeconomic conditions in the selected micro-watersheds of Nandavaram in Banaganapally mandal and Kanugulavanka (Gadderalla-II) in Devanakonda mandal of Kurnool district.

District profile

Kurnool is located at latitude of 15°50' N and longitude of 78°05' E in the state of Andhra Pradesh and spread over an area of 17658 km^2 with a population of about 3,512,260 (based on 2001 census). About 77% of the population is concentrated in the rural areas; 75% of the population is dependent on agriculture and allied activities in the district.

Major crops during 2002–03 cropping season in Kurnool district were sunflower, groundnut, chickpea, sorghum, paddy and cotton accounting for about 21%, 20%, 16%, 11%, 6.5% and 6% of gross cropped area, respectively (Fig. 35). Kurnool accounts for about 55% of total sunflower seed production and 41% of chickpea production in Andhra Pradesh. Even though onion accounts for only 1% of the gross cropped area in Kurnool, it accounts for 31.5% of total production in Andhra Pradesh.

The standing crops were badly affected in all the districts of the state due to prolonged dry spells in July and September 2002. In Kurnool district, the total rainfall in 2002–03 was only 506 mm as compared to 670 mm in normal years (decreased by about 24%). Figure 36 compares the actual monthly rainfall during 2002 with the rainfall during normal years (calculated as average of last 5 years). The rainfall was erratic, especially during the critical months of July to September and was very much less than the normal.

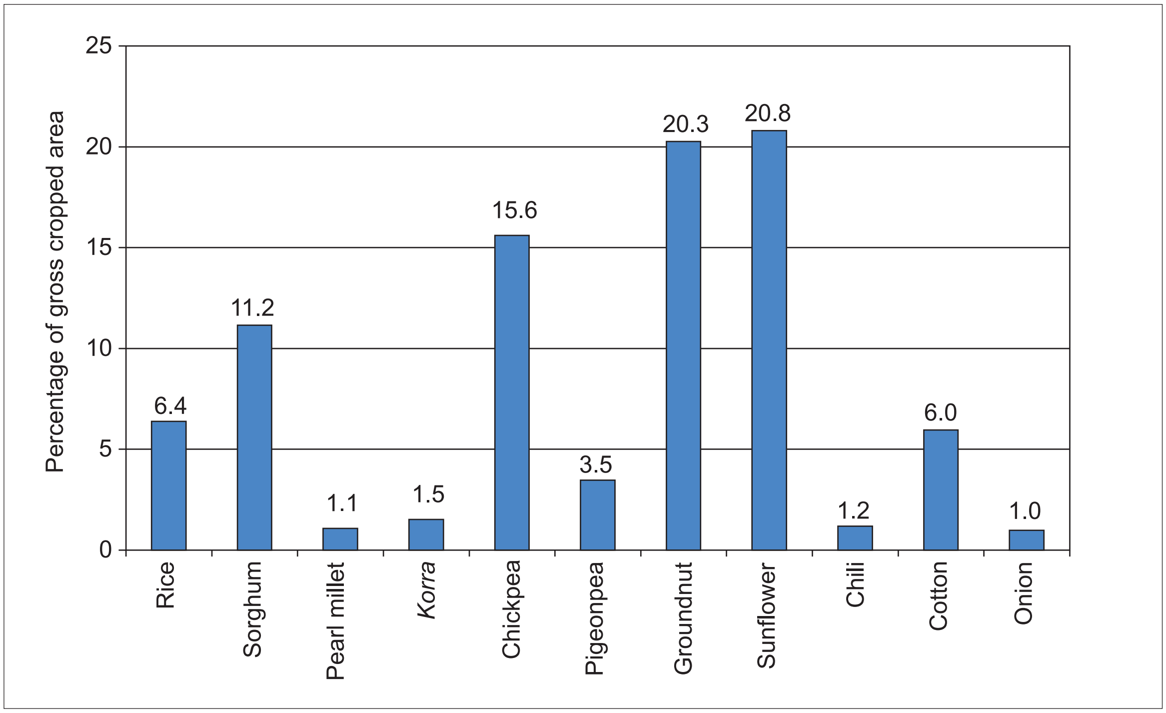

Figure 35. Area under major crops in Kurnool district (Source: Directorate of Economics and Statistics, Government of Andhra Pradesh).

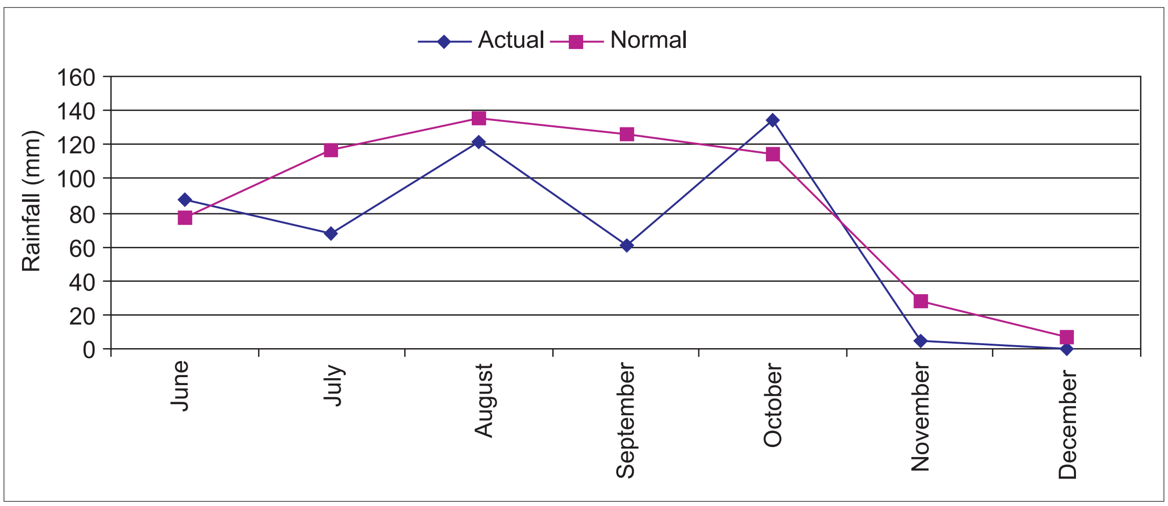

Figure 36. Monsoon rainfall in 2002 in Kurnool district (Source: Directorate of Economics and Statistics, Government of Andhra Pradesh).

Village characteristics

Nandavaram is located in Banganapally mandal at 78°28' longitude and 15°37' latitude (Fig. 37). The distance to the mandal headquarters is about 10 km. There were about 21 castes in Nandavaram with major communities being Reddys, Vaddera, Madiga, Mala and Muslims. The total village area of Nandavaram was 3177 ha of which 83% consisted of cultivated area and 4.7% was under permanent fallow (Table 42). The CPR accounted for about 180 ha. Since last 4 years, about 94% of the cultivated area has been under rainfed agriculture. Since Nandavaram is a fairly large village it was divided into micro-watersheds of about 500 ha each. ICRISAT was associated with one micro-watershed that lies in the western part of the village and is called Nandavaram (West).

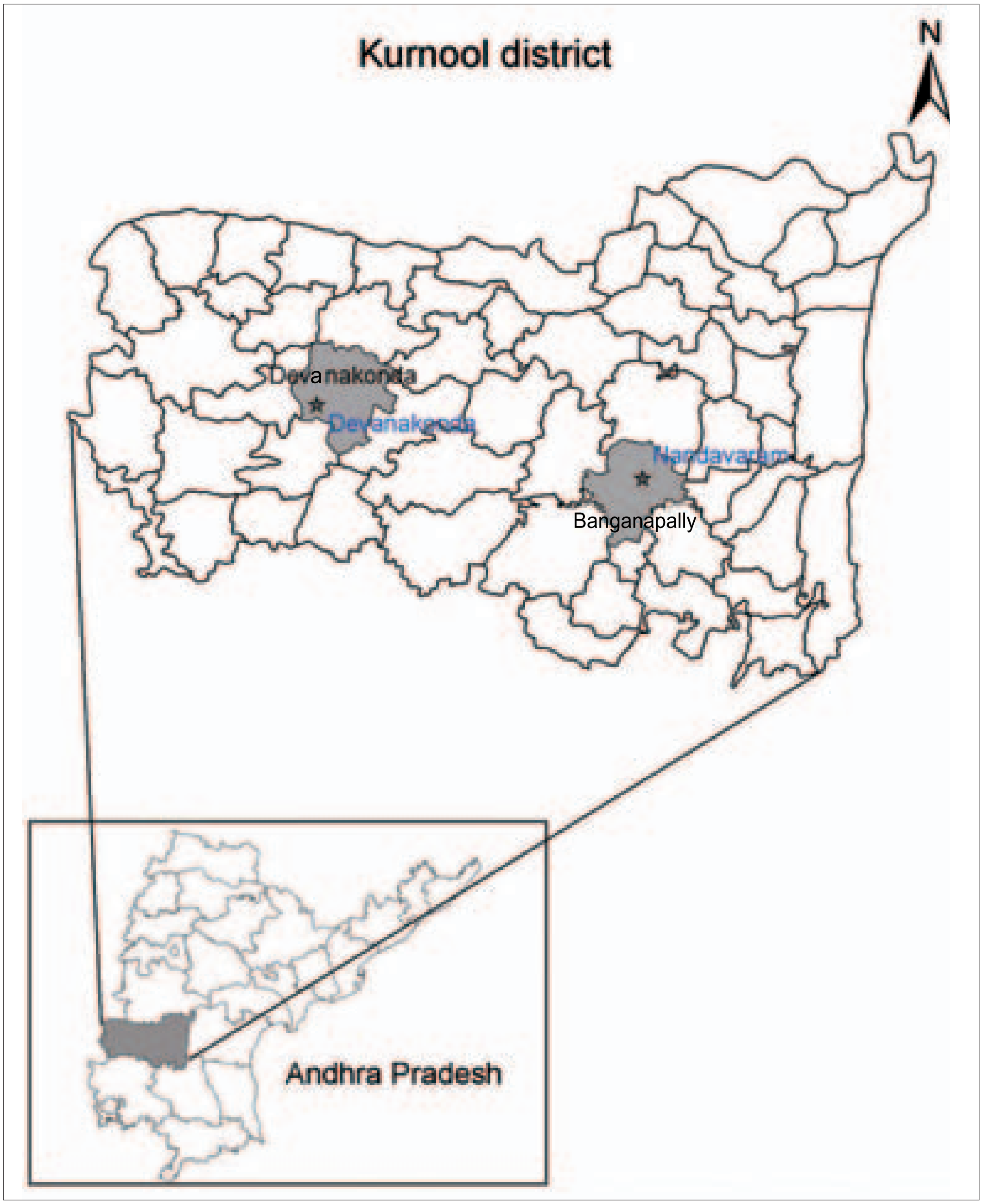

Figure 37. Watershed locations in Kurnool district.

Table 42. General characteristics of the selected villages in Kurnool district.

Characteristics	Nandavaram	Kanugulavanka
Total cultivated area (ha)	2631.6 (82.83)[1]	1372.1 (77.68)
- Irrigated cultivated (ha)	144.7	95.1
- Dryland cultivated (ha)	2486.8	1276.9
Permanent fallow (private) (ha)	150.6 (4.74)	152.2 (8.62)
CPR and forest area (ha)	179.8 (5.66)	52.6 (2.98)
Other land (settlements, etc) (ha)	215.0 (6.77)	189.5 (10.73)
Total village area (ha)	3176.9 (100)	1766.4 (100)

1. Figures in parentheses are percentage values.
Source: Focus group meetings.

Devanakonda is located at 77°55’ longitude and 15°54’ latitude. Devanakonda itself is the mandal headquarters and also the market town. In Devanakonda mandal, the villages earmarked for watershed program were divided into 12 micro-watersheds and ICRISAT was associated with Kanugulavanka (Gadderalla-II). Kanugulavanka village area was about 1766 ha. About 78% of total area was under cultivation and 8.6% under permanent fallow. About 93% of the cultivated area consisted of dryland agriculture and 7% was under irrigation. The CPR accounted for 53 ha. In Kanugulavanka, there were about 32 castes with Dudekula, Muslims, Katika and Padmashalis being the major castes.

The Kanugulavanka watershed was part of the integrated watershed program during the period 1995–99. This is a completed watershed and the soil and water conservation structures were in place at the time of data collection. The water harvesting structures included four masonry check-dams and one farm pond. Soil and moisture conservation measures included contour bunds (covering about 365 ha), strengthening of border beds with agave suckers, gabion structures (17 units) and wrist weirs (25 units). Other activities included forestry, horticulture, animal husbandry and income generating activities such as beekeeping, vermicompost, etc.

The major soil types in Nandavaram were *garugu nelalu*, deep black soils (*nalla regadi*) and sodic soils (*choudu*). Red soils dominated the Kanugulavanka watershed. The major crops were cotton intercropped with pigeonpea and sole crop of pigeonpea in the *kharif* season and coriandar, chickpea and sorghum in the *rabi* season. The main *kharif* crops in Kanugulavanka were groundnut, tomato, sunflower, pearl millet and *korra*. The major *rabi* crops included groundnut and sunflower.

Demographic characteristics

The average age of household head in Nandavaram watershed was 48 years with mean education level of 5 years (Table 43). About 62% of household heads had education of less than or equal to 5 years. The average family size was 5.52. Sixty-two percent of sample households had a family size of more than 4. The average weighted work force for Nandavaram was 3.67 persons per household. About 15.7% of the sample population can be considered as dependents based on age criteria (less than 10 years and those above 65 years). The dependency ratio was computed as the ratio of non-working members to working family members (Shiferaw et al. 2002). The average dependency ratio of 0.23 indicates that every working family member supported 0.23 persons.

The average age and education of household head in Kanugulavanka was 46 years and 5 years of education (Table 44). About 53% of the household heads had less than or equal to 5 years of education. The average family size of 6.54 was higher than that of Nandavaram watershed. About

Table 43. Demographic details of Nandavaram (West)[1].

Characteristics	Mean	SD	Minimum	Maximum
Age of household head (yr)	48.32	10.84	25	73
Education of household head (yr)	5.4	5.4	0	18
Education of family (yr)	4.99	5.25	0	20
Persons below 5 years	0.14	0.35	0	1
Persons 6–10 years	0.59	0.89	0	3
Persons 11–15 years	0.43	0.73	0	3
Persons 16–55 years	3.51	1.63	1	10
Persons 56–65 years	0.24	0.56	0	2
Persons above 65 years	0.05	0.28	0	2
Family size	5.52	2.51	2	15
Total work force	3.67	1.58	1.25	10
Dependents	0.78	1.20	0	4
Dependency ratio	0.23	0.40	0	2

1. Sample size (n) = 63; SD = Standard deviation.

Table 44. Demographic details of Kanugulavanka watershed[1].

Characteristics	Mean	SD	Minimum	Maximum
Age of household head (yr)	45.89	12.17	26	70
Education of household head (yr)	5.3	4.7	0	15
Education of family (yr)	3.80	4.47	0	17
Persons below 5 years	0.11	0.36	0	2
Persons 6–10 years	0.60	0.97	0	4
Persons 11–15 years	0.66	0.81	0	3
Persons 16–55 years	3.89	1.88	1	9
Persons 56–65 years	0.27	0.48	0	2
Persons above 65 years	0.04	0.20	0	1
Family size	6.54	2.30	2	15
Total work force	4.12	1.89	1.25	9.75
Dependents	0.76	1.04	0	4
Dependency ratio	0.23	0.37	0	1.5

1. Sample size (n) = 70; SD = Standard deviation.

86% of the households had a family size of greater than 4. About 13.6% of the sample households can be considered as dependents. The dependency ratio was 0.23 which is same as in Nandavaram watershed.

Household activities

In Nandavaram, 59% of the women were involved in household chores and 55% of them were involved in their own farm work (Fig. 38). Men were mainly involved in on-farm activities (52%). Agriculture is the predominant activity in which both women and men were almost equally involved. Casual labor and other activities were limited as most of the households in this watershed belong to OC and were relatively land owners. In Kanugulavanka, 47% of women were involved in household chores, 48% in on-farm work and 25% worked as hired labor. Men were mainly involved in on-farm activities (49%) and other income generating activities (27%) (Fig. 39). Agriculture was once again a major livelihood activity. Since Kanugulavanka watershed is part of Devanakonda, which is the mandal headquarters,

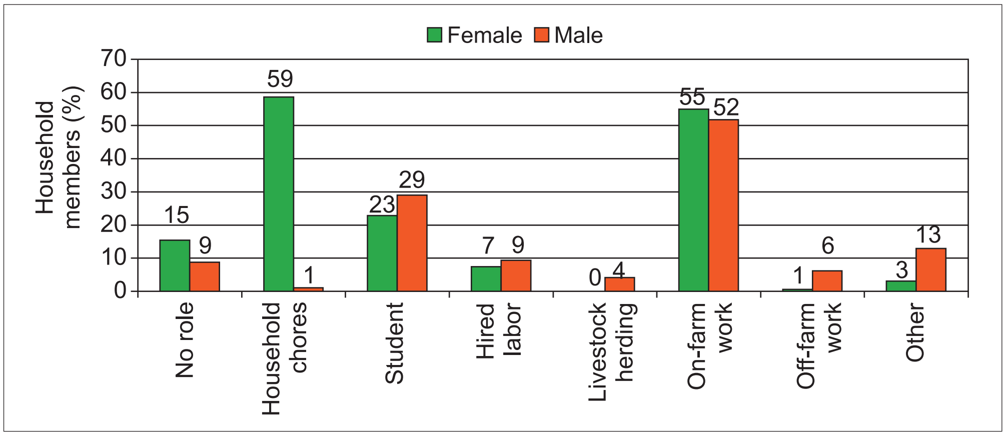

Figure 38. Household activities in Nandavaram watershed.

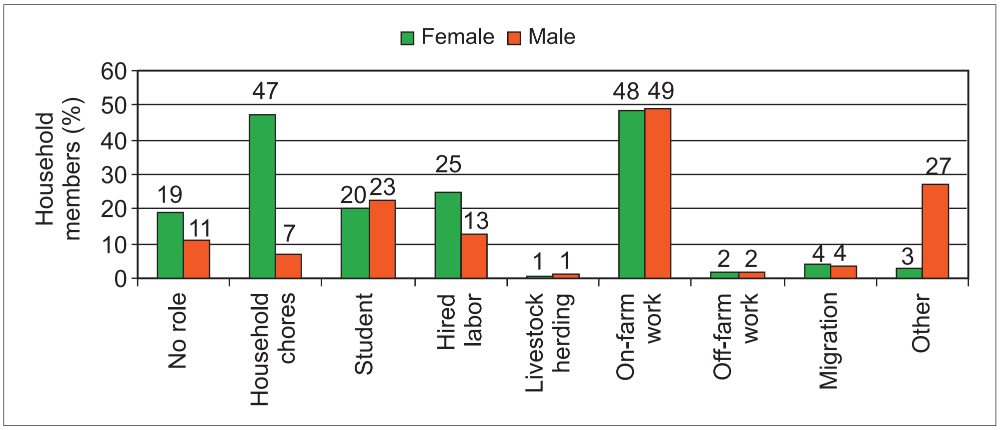

Figure 39. Household activities in Kanugulavanka watershed.

opportunities existed for the households to involve in various other income generating activities such as regular employment and small businesses.

Caste composition

The major caste categories in Nandavaram micro-watershed were OC and BC constituting about 51% and 43% of the sample households, respectively (Fig. 40). Among the OCs, Reddy was the dominant caste and among the BCs, Golla was the prominent caste. In Kanugulavanka micro-watershed, BC was the dominant category accounting for 79% of the sample households (Fig. 41). Among the BCs, Dudekula was the important caste.

Land ownership

The average landholding of the sample households in Nandavaram watershed was about 5.94 ha, which was about twice that of Kanugulavanka watershed (mean landholding of 2.86 ha) (Tables 45 and 46). Dryland constituted the major cultivated land tracts in both the micro-watersheds with average household ownership of 5.5 ha in Nandavaram and 2.44 ha in Kanugulavanka. Per capita landholdings were also much higher in Nandavaram watershed at 1.21 ha as compared to 0.46 ha in Kanugulavanka watershed.

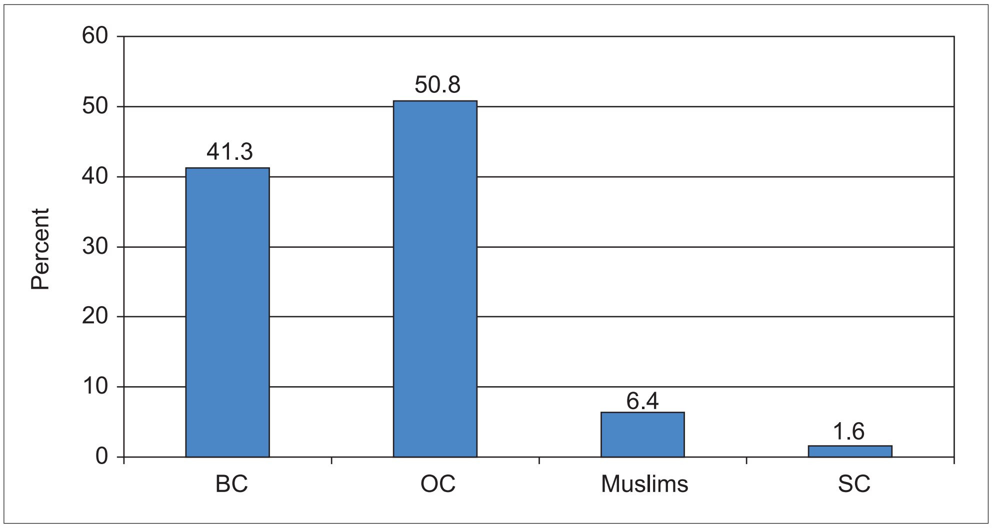

Figure 40. Caste categories in Nandavaram.

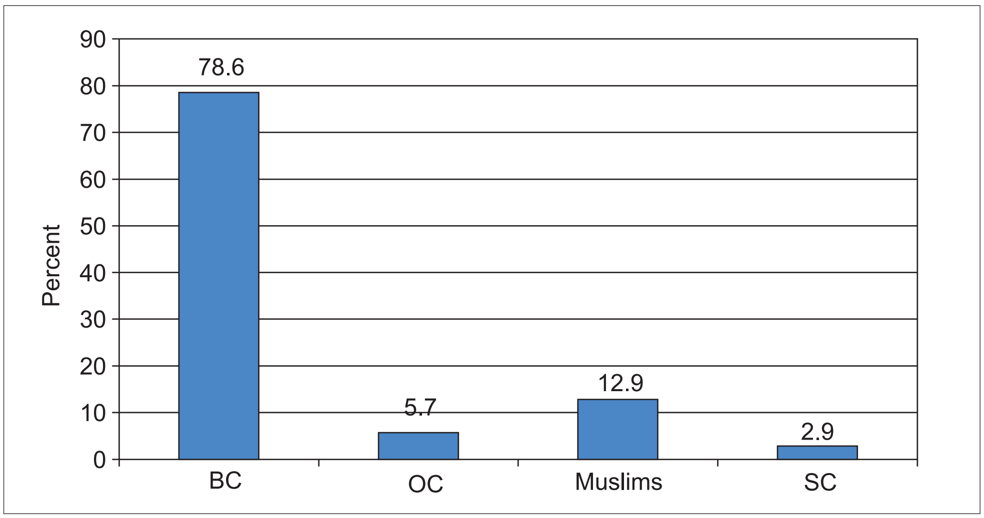

Figure 41. Caste categories in Kanugulavanka.

Table 45. Land ownership in Nandavaram[1].

Variable	Mean	SD	Minimum	Maximum
Total own land (ha)	5.94	4.73	0	24.29
Irrigable land (ha)	0.23	0.60	0	2.83
Dryland (ha)	5.70	4.47	0	21.46
Irrigated own cultivated land (ha)	0.21	0.60	0	2.83
Dryland own cultivated land (ha)	5.38	4.22	0	16.19
Leased in land (ha)	0.36	1.35	0	9.72
Leased out land (ha)	0.13	0.66	0	4.05
Permanent fallow (ha)	0.20	0.81	0	6.07
Per capita land (ha)	1.21	0.95	0	3.69

1. Sample size (n) = 63; SD = Standard deviation.

Table 46. Land ownership in Kanugulavanka[1].

Variable	Mean	SD	Minimum	Maximum
Total own land (ha)	2.86	3.16	0	20.81
Irrigable land (ha)	0.42	0.76	0	3.85
Dryland (ha)	2.44	3.14	0	20.81
Irrigated own cultivated land (ha)	0.38	0.73	0	3.85
Dryland own cultivated land (ha)	2.38	3.77	0	27.28
Leased in land (ha)	0.34	1.56	0	11.34
Leased out land (ha)	0.29	1.08	0	4.86
Permanent fallow (ha)	0.04	0.19	0	1.21
Per capita land (ha)	0.46	0.42	0	2.31

1. Sample size (n) = 70; SD = Standard deviation.

In Nandavaram, the average land ownership of households belonging to OC category was much higher than the rest of the communities at 7.6 ha with mean per capita landholding of 1.66 ha (Fig. 42). In Devanakonda, the average landholding of households belonging to BCs and Muslims (3 ha and 2.9 ha respectively) was higher than that of the households belonging to OC category (2.2 ha) (Fig. 43). The per capita landholdings were more or less similar across the communities.

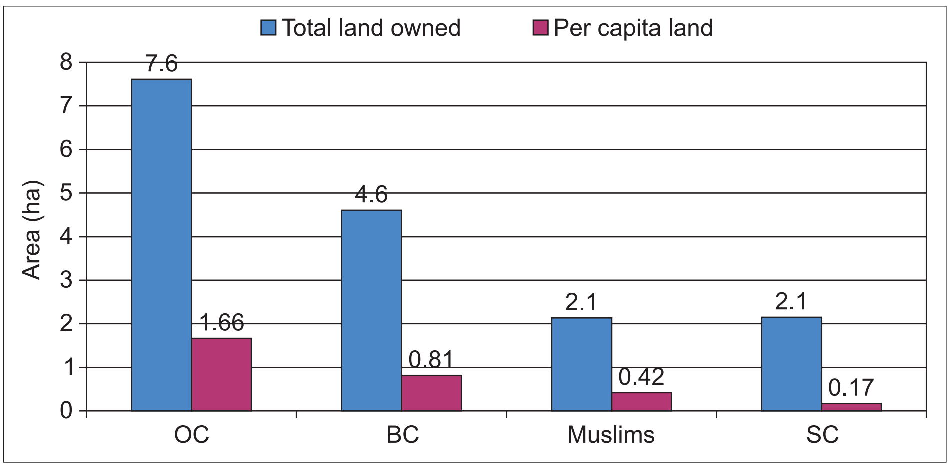

Figure 42. Caste-wise landholdings in Nandavaram.

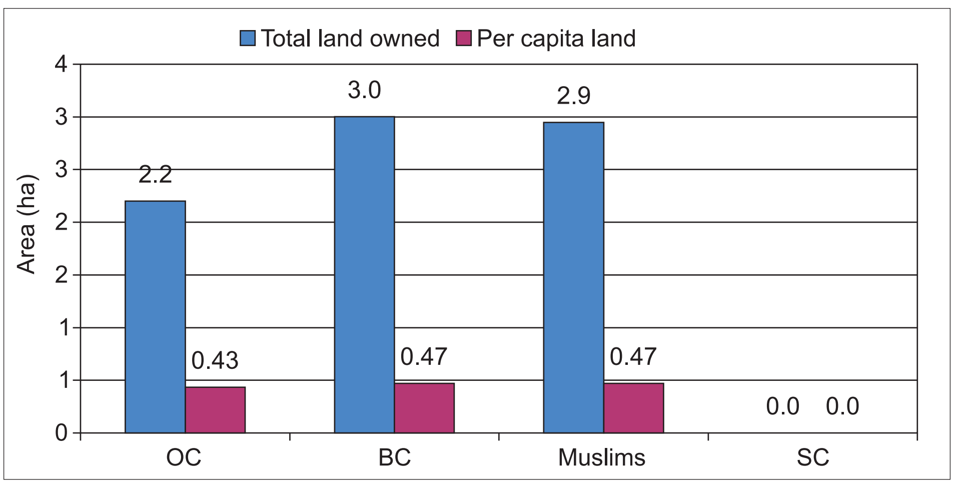

Figure 43. Caste-wise landholdings in Kanugulavanka.

Land distribution among the sample households has the inherent land inequalities in both micro-watersheds that are common in the rural areas in India. Lorenz curves show that land distribution is more or less similar in both the micro-watersheds (Figs. 44 and 45). For example, in Nandavaram, about 80% of the sample households own about 56% of the land and in Devanakonda, 80% of the households own about 51% of the land.

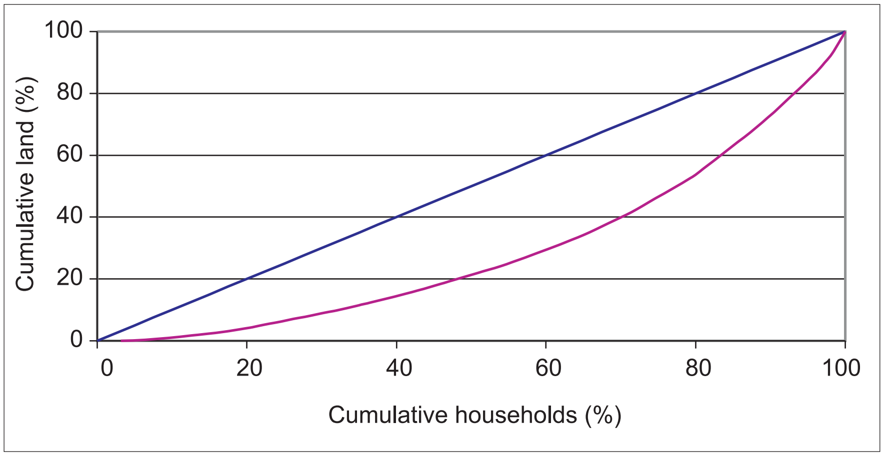

Figure 44. Land distribution in Nandavaram.

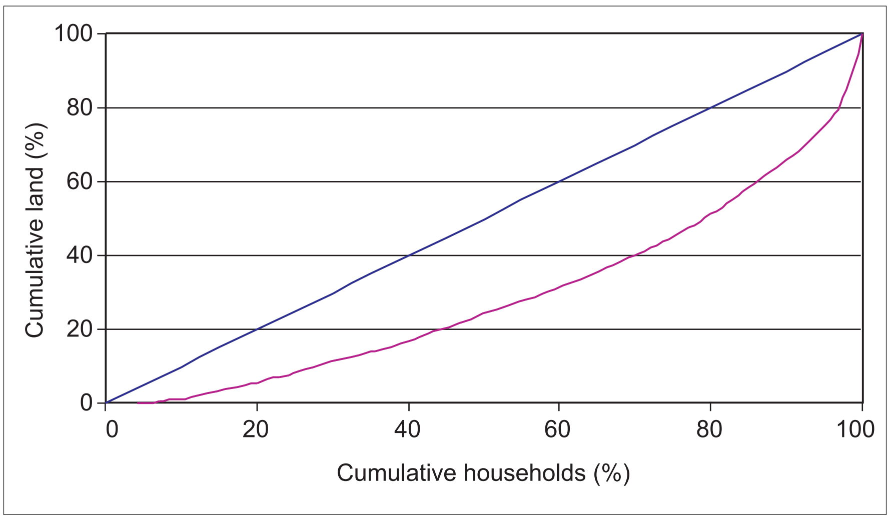

Figure 45. Land distribution in Kanugulavanka.

Crop production

The major crops grown in Nandavaram watershed in *kharif* season were cotton intercropped with pigeonpea (with an average plot size of 1.06 ha) and pigeonpea as sole crop (mean plot size of 0.37 ha) (Table 47). Major *rabi* crops were chickpea, coriander and sorghum (with average plot size of 1.27 ha, 1.9 ha and 0.77 ha, respectively).

The major *kharif* crops in Kanugulavanka watershed were groundnut and tomato (with average plot size of 0.8 ha and 0.46 ha, respectively) (Table 48). The other important crops were onion, paddy, pearl millet (grown as both sole and intercropped with pigeonpea) and sunflower. The major *rabi* crop was sunflower with an average plot size of 0.17 ha. Since Devanakonda is itself the mandal headquarters and market center, vegetable crops such as tomato, okra, onion, etc were commonly

Table 47. Mean area of major crops grown in Nandavaram[1].		
Crop	No. of plots	Mean area (ha)
Kharif		
Cotton+Pigeonpea	57	1.06
Cotton	15	0.21
Castor	12	0.13
Paddy	12	0.15
Pigeonpea (sole)	27	0.37
Rabi		
Chickpea	66	1.27
Coriander	91	1.90
Paddy	7	0.09
Sorghum	39	0.77

1. Sample size (n) = 63.

Table 48. Mean area of major crops grown in Kanugulavanka[1].		
Crop	No. of plots	Mean area (ha)
Kharif		
Cotton	8	0.09
Cotton+Pigeonpea	4	0.07
Groundnut	39	0.80
Groundnut+Pigeonpea	12	0.38
Korra	10	0.11
Okra	7	0.05
Onion	10	0.06
Paddy	12	0.05
Pearl millet	11	0.12
Pearl millet+Pigeonpea	10	0.22
Sunflower	15	0.37
Tomato	48	0.46
Rabi		
Sunflower	11	0.17

1. Sample size (n) = 70.

grown in this watershed. Crops grown in the watershed were much diversified as compared to Nandavaram watershed.

The most commonly used fertilizer was DAP in all the crops in both the watersheds. In general, fertilizer usage (specifically DAP and urea), was more for crops such as paddy and high value vegetable crops (Tables 49 and 50). For example, in Nandavaram watershed, average fertilizer usage in paddy was about 118 kg ha^{-1} of DAP, 158 kg ha^{-1} of urea in *rabi* and 113 kg ha^{-1} DAP and 105 kg ha^{-1} urea in *kharif* season. In Kanugulavanka, 142 kg ha^{-1} of DAP and 147 kg ha^{-1} of urea were used in *kharif* paddy. Potash was commonly applied in paddy in both the watersheds. Along with DAP and urea, other fertilizers such as Triple 17 and f28 were used in the vegetable crops such as coriander, onion and okra. In general, more fertilizer usage was observed in irrigated and commercial crops as compared to other crops.

The average yields in both the watersheds for all the major crops are given in Tables 51 and 52. In Nandavaram watershed, the average yield of chickpea (1262 kg ha^{-1}) was higher as compared to the

Table 49. Fertilizer usage for major crops in Nandavaram.

Crop	No. of plots	% of plots fertilized	DAP (kg ha^{-1})	Urea (kg ha^{-1})	Triple 17 (kg ha^{-1})	f28 (kg ha^{-1})	Potash (kg ha^{-1})	f20 (kg ha^{-1})	FYM (t ha^{-1})
Castor	12	100	77.1	0.0	0.0	20.8	0.0	11.9	0.2
Chickpea (*Rabi*)	66	100	118.1	3.0	1.3	9.4	0.0	0.0	1.2
Coriander (*Rabi*)	91	98.9	78.9	9.1	2.5	33.6	0.0	0.8	0.7
Cotton	72	100	57.6	3.2	41.9	3.0	0.6	0.0	0.5
Paddy (*Rabi*)	7	100	118.2	157.6	0.0	0.0	26.3	17.5	0.2
Paddy (*Kharif*)	12	100	112.8	104.7	0.0	32.2	15.0	0.0	1.9
Pigeonpea	83	98.8	31.8	2.5	4.2	1.0	0.0	0.0	0.2
Sorghum (*Rabi*)	39	97.4	74.3	4.1	0.0	22.5	0.0	0.0	0.5

Table 50. Fertilizer usage for major crops in Kanugulavanka.

Crop	No. of plots	% of plots fertilized	DAP (kg ha^{-1})	Urea (kg ha^{-1})	Triple 17 (kg ha^{-1})	f28 (kg ha^{-1})	Potash (kg ha^{-1})	FYM (t ha^{-1})
Cotton	12	83.3	93.2	18.3	11.4	0.0	31.7	1.6
Groundnut	51	96.1	70.8	5.2	16.6	0.0	5.4	1.7
Korra	11	54.5	30.3	0.6	0.0	0.0	0.0	1.2
Okra	7	100	110.9	91.9	63.4	0.0	0.0	1.5
Onion	10	100	145.4	100.6	28.0	22.4	11.2	2.6
Paddy (*Kharif*)	12	83.3	141.8	147.4	0.0	14.0	21.1	3.2
Pearl millet	21	90.5	31.4	6.0	1.3	0.0	0.0	0.5
Pigeonpea	25	84.0	7.2	1.3	0.9	0.0	0.3	0.1
Sunflower (*Rabi*)	11	100	70.4	21.5	4.3	0.0	0.0	0.4
Sunflower (*Kharif*)	16	93.8	56.9	27.3	1.7	0.0	1.9	0.4
Tomato	49	95.9	85.5	9.7	20.8	5.9	0.1	2.0

Table 51. Crop yields in Nandavaram during 2002–03.

Crop	No. of plots	% plots irrigated	Mean yield (kg ha^{-1})	Minimum yield (kg ha^{-1})	Maximum yield (kg ha^{-1})	CV	District yield (kg ha^{-1})
Castor	12	0	723	371	1647	45.4	203
Chickpea (*Rabi*)	66	0	1262	494	1977	26.1	1091
Coriander (*Rabi*)	91	0	567	237	1236	29.4	
Cotton	72	2.8	723	247	1730	38.4	153
Paddy (*Kharif*)	12	91.7	3964	0	6487	58.2	2096
Paddy (*Rabi*)	7	100	4312	1426	6487	45.8	2265
Pigeonpea	83	0	401	0	1853	91.5	420
Sorghum (*Rabi*)	39	0	1215	0	2471	40.4	1341

district mean of 1091 kg ha^{-1} for the 2002–03 cropping season (Table 51). The yields of paddy and castor were also much higher than the district yields.

In the Kanugulavanka watershed, yields of majority of the crops were higher as compared to the district yields. The average yields of groundnut (822 kg ha^{-1}), *korra* (891 kg ha^{-1}), onion (15765 kg ha^{-1}) and paddy (2912 kg ha^{-1}) were all higher than the average district yields (Table 52). The yields of sunflower crop during *kharif* and *rabi* (845 kg ha^{-1} and 1253 kg ha^{-1}, respectively) were also higher than the district yields. This could be due to the improved water availability since Kanugulavanka

Table 52. Crop yields in Kanugulavanka during 2002–03.							
Crop	No. of plots	% plots irrigated	Mean yield (kg ha^{-1})	Minimum yield (kg ha^{-1})	Maximum yield (kg ha^{-1})	CV	District yield (kg ha^{-1})
Cotton	12	41.7	859	185	1730	48.0	153
Groundnut	51	11.8	822	267	2681	56.7	575
Korra	11	0.0	891	412	1483	44.1	623
Okra	7	85.7	6328	3212	9637	38.4	
Onion	10	90.0	15765	0	24711	48.4	12548
Paddy	12	91.7	2912	0	5535	59.1	2096
Pearl millet	21	0.0	664	82	1483	66.5	663
Pigeonpea	25	0.0	202	0	741	95.7	420
Sunflower (*Kharif*)	16	12.5	845	0	1606	43.0	695
Sunflower (*Rabi*)	11	54.5	1253	494	2281	49.1	855
Tomato	49	10.2	7258	1977	12541	37.1	

watershed is a completed watershed with all the water conservation structures in place. This can be seen from the number of plots irrigated for the major commercial crops.

Livestock production

The livestock holdings were relatively higher in Nandavaram watershed as compared to Kanugulavanka watershed. In Nandavaram, 25.4% of the sample households did not own any livestock; 47.6% of the households had no milch animals and 46% of the households had no bullocks. The average ownership of different animals was 1.02 milching buffaloes, 0.1 milching cows, 1.13 bullocks, 0.02 other cows, 3.37 sheep and 0.37 goats (Table 53).

Table 53. Average livestock ownership (number household^{-1}) in Nandavaram.			
Variable[1]	Mean	Minimum	Maximum
Milching cows	0.10 (0.47)[2]	0	3
Milching buffaloes	1.02 (1.30)	0	4
Other cows	0.02 (0.13)	0	1
Bullocks	1.13 (1.08)	0	4
Heifers (cows)	0.08 (0.33)	0	2
Bulls	0.06 (0.40)	0	3
Calves (cows)	0.19 (0.53)	0	3
He-buffaloes	0.02 (0.13)	0	1
Heifers (buffaloes)	0.13 (0.46)	0	3
Calves (buffaloes)	0.30 (0.61)	0	3
Sheep	3.37 (21.92)	0	170
Goats	0.37 (2.77)	0	22
Chicken	0.35 (1.89)	0	14

1. Sample size (n) = 63.
2. Figures in parentheses are standard deviation values.

In Kanugulavanka watershed, about 53% of the sample households did not have any livestock. About 65.7% of the households were without any milch animals and 77% had no bullocks. The average ownership of animals was 0.54 for bullocks, 0.4 for milching buffaloes, 0.17 for milching cows, 0.01 for sheep and 0.16 for goats (Table 54).

Table 54. Average livestock ownership (number household-1) in Kanugulavanka.			
Variable[1]	Mean	Minimum	Maximum
Milching cows	0.17 (0.61)[2]	0	4
Milching buffaloes	0.40 (0.79)	0	4
Other cows	0.01 (0.12)	0	1
Bullocks	0.54 (1.07)	0	4
Bulls	0.10 (0.59)	0	4
Calves (cows)	0.39 (0.84)	0	4
Other she-buffaloes	0.09 (0.37)	0	2
Calves (buffaloes)	0.16 (0.47)	0	2
Sheep	0.01 (0.12)	0	1
Goats	0.16 (1.02)	0	8
Chicken	0.07 (0.60)	0	5

1. Sample size (n) = 70.
2. Figures in parentheses are standard deviation values.

The distribution of value of livestock assets among the sample households in the respective villages reveals inequalities in livestock assets (Figs. 46 and 47). In Nandavaram, about 75% of the households own about 40% of total value of livestock assets. Similarly, in Kanugulavanka watershed, 75% of the sample households own only about 24% of total value of livestock assets. This shows that livestock inequalities were much higher in Kanugulavanka watershed as compared to Nandavaram watershed.

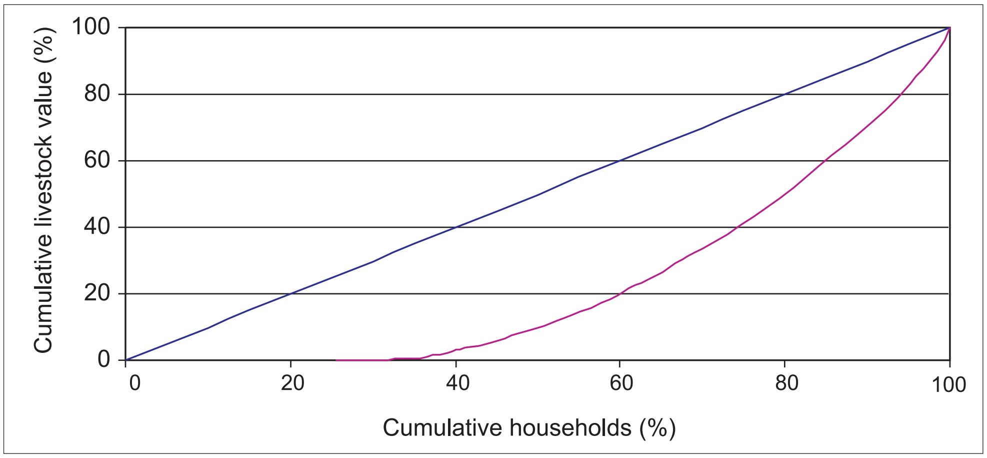

Figure 46. Distribution of livestock assets in Nandavaram.

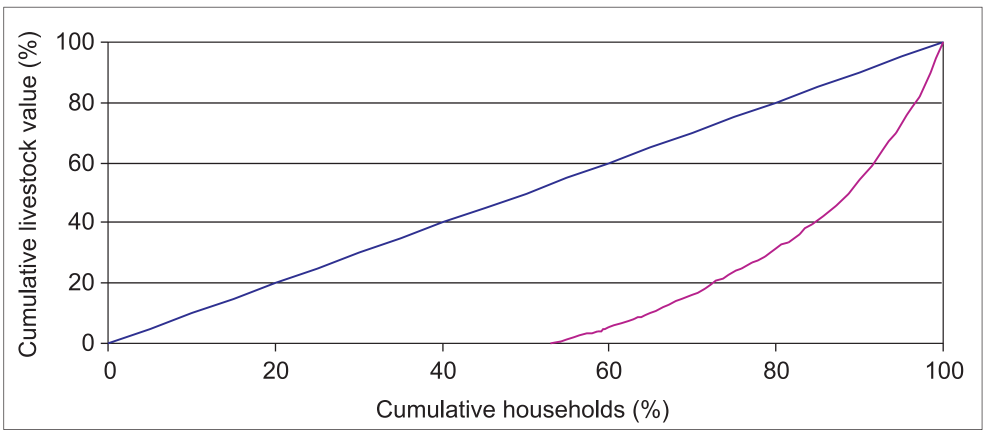

Figure 47. Distribution of livestock assets in Kanugulavanka.

One of the important livestock products has always been milk used for own consumption as well as for commercial sales. In Nandavaram, the sample average of milk produced per annum was 343 L and milk sold was about 233 L, whereas in Kanugulavanka, the sample average of milk produced per annum was 324 L and milk sold was 263 L (Table 55).

Table 55. Average household milk production and sales per annum.

Village	Sample households	Milk production	Milk sold	Milk sales (Rs)
Nandavaram	63	343	233	1889
Kanugulavanka	70	324	263	2535

Other household assets

The average household assets in Nandavaram watershed was Rs 127,462 (Table 56) with average per capita assets of Rs 25,101. About 67% of the sample households had per capita assets less than the mean. The mean value of household assets in Kanugulavanka watershed was Rs 70,556 and the average per capita value of assets was Rs 11178 (Table 57). About 70% of the sample households had assets less than the mean per capita assets.

Table 56. Average household assets (Rs household^{-1}) in Nandavaram.

Variable[1]	Mean	Minimum	Maximum
Farm assets	15102 (27748.2)[2]	0	212800
Other assets	112360 (90937.4)	18000	479200
Total assets	127462 (106912.1)	24500	618300
Per capita assets	25101 (19441.4)	4600	102840

1. Sample size (n) = 63.
2. Figures in parentheses are standard deviation values.

Table 57. Average household assets (Rs household^{-1}) in Kanugulavanka.

Variable[1]	Mean	Minimum	Maximum
Farm assets	12792 (35136.3)[2]	0	276000
Other assets	57764 (54742.5)	5750	341000
Total assets	70556 (82520.3)	6150	574000
Per capita assets	11178 (11196.9)	1025	63778

1. Sample size (n) = 70.
2. Figures in parentheses are standard deviation values.

Income from other sources

The major income sources other than the crop and livestock incomes in Nandavaram were casual village labor, regular employment, rented out bullocks and small businesses. The average annual income was Rs 11985 from regular employment and Rs 4616 from casual village labor (Table 58). Income from rented out bullocks was also common indicating the dominance of agriculture as livelihood in the watershed.

In Kanugulavanka also, casual village labor, small businesses and regular employment were important sources of income with a mean annual income of Rs 5208, Rs 4857 and 6104, respectively. Other important sources of income include rented out bullocks and leased out land.

Table 58. Other non-farm income sources.

Village	Activity	No. of households	Mean annual income (Rs)
Nandavaram (n = 63)	Rented out bullocks	9	649
	Other regular employment	16	11985
	Casual village labor	14	4616
	Business net income	7	1860
Kanugulavanka (n = 70)	Wage employment from watershed project	7	434
	Other regular employment	20	6104
	Casual village labor	40	5208
	Business net income	23	4857
	Leased out land	6	323
	Rented out bullock	6	350
	Migration income	5	880

Household income

The average per capita net returns from crop cultivation was Rs 16,411 in Nandavaram, which was much higher than that of Kanugulavanka (Rs 3906). Even the average per capita livestock income and non-farm income were higher in Nandavaram as compared to Kanugulavanka (Table 59). On the whole, the average per capita total income was higher by almost three times in Nandavaram as compared to Kanugulavanka. This may be due to the larger landholdings in the Nandavaram micro-watershed and also cultivation of commercial crops such as coriander (as spice) on large tracts by majority of farmers.

Table 59. Average per capita net returns from various sources.

Source of income	Nandavaram (n=63)	Devanakonda (n=70)
Crop income (Rs)	16411	3906
Livestock income (Rs)	964	540
Non-farm income (Rs)	3907	2996
Total income (Rs)	21282	7442

The contribution of different livelihood sources to the total household income is shown in Figure 48. Crop income was the important source of income in both Nandavaram and Kanugulavanka watersheds (77% and 52% of total per capita income, respectively). Contribution of non-farm income sources to total household income was relatively high in Kanugulavanka (40%) as compared to Nandavaram (18%). Livestock was not a significant contributor in both the watersheds.

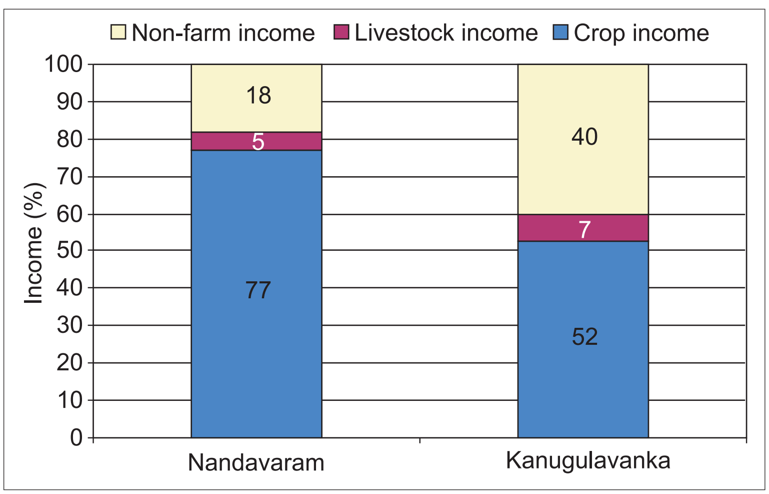

Figure 48. Sources of household income.

Groundwater resources

Most of the cultivation was rainfed. In general, groundwater availability and utilization was not much in both the watershed areas. There were only about 7 tube wells in Nandavaram micro-watershed, of which only 3 were functional and all the open wells had dried up (Table 60). In Kanugulavanka, there were about 20 tube wells of which about 70% were functional.

Table 60. Groundwater utilization and management in the micro-watersheds.

Wells	Total (No.)	Functional (%)	Dried (%)
Nandavaram			
Open wells	10	0	100
Tube wells	7	43	57
Kanugulavanka			
Open wells	6	20	80
Tube wells	20	70	30

Summary and conclusions

This section documents the socioeconomic conditions and resource endowment patterns of the micro-watershed farmers of Nandavaram and Kanugulavanka, and net income for different household groups from cropping, livestock and other off-farm sources. Among the two micro-watersheds, the watershed activities in Kanugulavanka have been completed and the water harvesting structures and soil and moisture conservation structures were in place at the time of the survey.

Demographic details such as age, education of household head, mean work force and dependency ratio were similar in both the micro-watersheds. Average family size was slightly higher in Kanugulavanka watershed (6.54) as compared to Nandavaram (5.52). The major castes in Nandavaram micro-watershed were Reddy (OC) and Golla (BC) and in Kanugulavanka micro-watershed, Dudekula (BC) was the dominant category. Agriculture was the predominant activity in both the micro-watersheds with equal involvement of both women and men. Average landholdings were much higher in Nandavaram micro-watershed as compared to Kanugulavanka with per capita landholdings of 1.21 ha in Nandavaram watershed and 0.46 ha in Kanugulavanka.

The major *kharif* crops grown in Nandavaram watershed were cotton (intercropped with pigeonpea) and pigeonpea (sole crop). Major *rabi* crops were chickpea, coriander and sorghum. The major *kharif* crops in Kanugulavanka watershed were groundnut and tomato. The other important crops were onion, paddy, pearl millet (grown as both sole and intercropped with pigeonpea) and sunflower. Kanugulavanka had a higher percentage of irrigated plots especially for most of the commercial crops which may be attributed to the watershed activities implemented in the catchment. The average yields of the major crops in both the micro-watersheds were higher than the district average.

The livestock holdings were relatively higher in Nandavaram watershed as compared to Kanugulavanka watershed. The average per capita asset endownments of sample households in Nandavaram (Rs 25,101) were much higher than those of Kanugulavanka (Rs 11,178). The major non-farm income sources other than the crop and livestock incomes in Nandavaram and Kanugulavanka were casual village labor, regular employment, rented out bullocks and small businesses.

The average per capita total income was higher by almost three times in Nandavaram (Rs 21,282) as compared to Kanugulavanka (Rs 7442). Income from crops was the most important source of income in both Nandavaram and Kanugulavanka watersheds contributing to 77% and 52% of total per capita income, respectively. The income from crops was much higher in Nandavaram watershed due to the large per capita landholdings, good soils and large-scale cultivation of commercial crops such as coriander, cotton and chickpea. Non-farm sources formed an important component in the total household income in Kangulavanka (40% of total per capita income) due to its proximity to the mandal headquarters and enhanced employment opportunities.

5. Income Inequality and its Decomposition by Source in the Watersheds

Introduction

Sustainable livelihoods are achieved through access to a range of livelihood resources (natural, economic, human and social capitals) which are combined in the pursuit of different livelihood strategies (agricultural intensification, livelihood diversification and migration) (Scoones 1998). But access to these resources is constrained by various forms of inequalities prevalent in the society.

Inequality exists in various forms in the society. It could be unequal distribution of land, income and assets, gender inequality or social inequality due to caste system or any other such delineation. Inequality measures have indicated an increase in inequality in rural areas. For example, the rural Gini coefficient (a measure of inequality) in the state of Andhra Pradesh in India increased from 28.42 in 1996 (NSS 52nd round) to 29.61 in 1997 (NSS 53rd round) (Jha 2000).

Watershed development programs while exhibiting significant impacts in terms of increased crop production and productivity due to improved groundwater availability and its use by large farm holders have accentuated the inter-household inequalities, by ignoring or sometimes negatively affecting small and marginal landholders (Wani et al. 2003). Therefore, benefits of the watershed program can be further enhanced through a better understanding of the inequalities prevalent in the watersheds and the major sources of these inequalities by using decomposition techniques.

In general, decomposition of aggregate inequality value into component contributions generally fall into two broad categories (Shorrocks 1982). The first category constitutes influence of population subgroups (eg, age, sex or race) and the second category includes examination of different components of total income. In the later category, income inequality is analyzed to measure the contribution of different sources of income (agricultural income, non-agricultural income, etc) to overall income inequality and to determine whether any particular source contributes to increase or decrease in income inequality (Sadoulet and de Janvry 1995). For example, Adams (1996) used income decomposition techniques to demonstrate the importance of livestock income in improving rural income distribution. The total income was decomposed among five sources: agricultural, non-farm, livestock, rental and transfers. Livestock income continued to decrease in inequality and that made the smallest contribution to overall inequality.

The objective of this section is to analyze the effect of different income sources on household income inequalities in all the selected watershed villages. Income inequality decomposition techniques are used to assess the contribution of different sources of household income towards the total income inequality. This helps in understanding the structure of inequality by income source. Such decomposition of the overall inequality illustrates the relative importance of various sources in respect to overall inequality and draws attention to potential areas of research (Fields 1979). Gini decomposition method is the commonly used procedure for such analysis (Fields 1979, Adams 1996) and helps in constructing factor inequality weights that can be broken down into factor shares, factor Gini and correlational components.

In the first part of the section, a village-wise analysis was undertaken for three major categories of income sources, namely, crop income, livestock income and non-farm income sources in the six watersheds of Malleboinpally, Mentapally, Tirumalapuram, Kacharam, Nandavaram and Kanugulavanka. In the later part, the decomposition techniques were applied to the entire dataset comprising of all sample households from all the watersheds, for a more detailed classification of income sources.

Methodology

In the first part, a watershed-wise analysis was undertaken for a broader classification of income sources (crop, livestock and non-farm income). In the later part, income sources were classified based on the commonality of income sources across the different watersheds. The crop income source categories included income from dryland cereals, pulses, paddy and commercial crops (cotton, oilseed crops such as castor and groundnut, vegetables and other high-value crops). The other categories included income from milk sales, other livestock income (traction, FYM, etc) employment (labor and regular), business income (caste occupations and small businesses) and other non-farm sources (remittances, migration, etc).

Total income of a household was a combination of various income-generating activities such as crop cultivation and livestock and other non-farm sources of income. Computation of income from the different sources is described in section 2.

Inequality measures

Some of the inequality measures include coefficient of variation, Theil index, income shares, Atkinson index and the Gini coefficient and Lorenz curves. Coefficient of variation is simply the ratio of the standard deviation of income $\sigma(y)$ to mean income $\bar{y}$ (Sadoulet and de Janvry, 1995). Theil index is used to decompose the overall increase in inequality occurring due to changes between and within different social groups. Income shares involves arranging the income of households from the lowest to the highest, then dividing the distribution into equal parts (fifths or quantiles). Then, the percentage of total income received by each quantile or fifth was calculated. Atkinson index was developed to overcome the problem when Lorenz curves intersect. The basic notion was one of "inequality aversion". It is the price that society is willing to pay in order to decrease income inequality (Osberg 1984). Thus, if one specifies a high value of "inequality aversion", it implies that one is most concerned with changes occurring in the lower end of the income distribution, whereas a relatively low value reflects one's sensitivity to changes in the upper end of the distribution.

Gini is defined as the summary statistic of the Lorenz curve of the income distribution (Dorfman 1979) or as being equal to one minus twice the relative area under the Lorenz curve, as defined by Corrado in 1914 (Kakwani 1980). The Gini coefficient can range from zero (perfect equality) to one (perfect inequality). If y_i is the total income of the i^{th} family, the Gini coefficient for family income is given by (Pyatt et al. 1980):

$$G(y) = (2/n\bar{y})\mathrm{cov}(y,r(y))$$

where r(y) is the rank of i^{th} family when families are ranked according to y_i. The convention for ranking was that $r(y_i) = 1$ for the family with smallest y_i and $r(y_i) = n$ for the family with largest y_i. If two or more families have the same value for y_i, they are each given the average of the ranks that they would get if there were an infinitesimal difference between them.

Inequality decomposition

Some of the decomposition methodologies in current use include Gini decompositions, Theil decompositions, analysis of variance and decomposition of Atkinson index (Fields 1979). For decomposition of inequality by source, inequality measures of coefficient of variation and Gini coefficient were considered as appropriate (Adams 1996).

Following Sadoulet and de Janvry (1995), the decomposition of coefficient of variation was given by the following expression:

$$cv(y) = \sum_s \frac{\bar{y}^s}{\bar{y}} \rho(y^s, y) cv(y^s)$$

where $\rho(y^s, y)$ is the coefficient of correlation between y^s and y.

An income source s was defined as income inequality increasing (decreasing) if enlarging its share in total income increases (decreases) total inequality. Based on the decomposition of the coefficient of variation, the s^{th} income source was inequality increasing if $\rho(y^s, y)\ cv(y^s) / cv(y)$ was larger than unity.

The Gini coefficient decomposition was given by the expression:

$$G = \sum_s \frac{\bar{y}^s}{\bar{y}} R_s G_s$$

where G_s is the Gini coefficient of the i^{th} income source and R_s is the correlation ratio expressed as:

$$R_s = \frac{cov(y^s, r)}{cov(y^s, r^s)}$$

The components of the decomposition corresponding to each type of factor income were the product of: (i) the share of the factor in total income; (ii) a rank correlation ratio (R_s); and (iii) the Gini coefficient for the distribution of income of the given factor type (Pyatt et al. 1980).

Alternatively, the decomposition of the Gini coefficient can be written as (Sadoulet and de Janvry 1995)

$\Sigma w_s g_s = 1$, where $w_s = \bar{y}^s / \bar{y}$ and $g_s = R_s G_s / G$

Contribution of the s^{th} source of income to total inequality was hence measured by the factor inequality weight, $w_s g_s$. From the Gini coefficient decomposition, the s^{th} source of income is inequality increasing (decreasing) if its concentration coefficient gs was greater (less) than unity.

To understand how changes in particular income sources affect overall inequality, Lerman and Yitzhaki (1985) considered a change in each person's income from sources equal to eYs, where e is close to 1 and derived the expressions:

$$\partial G/\partial e_s = S_s(R_s G_s - G)$$

$$\frac{\partial G/\partial e_s}{G} = \frac{S_s G_s R_s}{G} - S_s$$

The above equation shows that the income source's marginal effect relative to overall Gini can be written as the source's inequality contribution as a percentage of the overall Gini minus the source's share of total income.

Watershed-wise analysis of income distribution

A watershed-wise analysis was undertaken to examine the effect of major income sources on the total income inequalities. The income sources were broadly classified into three categories, namely, crop income, livestock income and non-farm income.

Major income sources and their role in income inequalities

Income from crops was the most important source of income in Nandavaram and Kanugulavanka of Kurnool district accounting for 77 and 52.5% of total per capita household income, respectively. Livestock was important in Kacharam and Malleboinpally (accounting for 31 and 22.5% of total per capita household income, respectively). Non-farm sources of income were important in all the villages except in Nandavaram. In Nandavaram, majority of the farmers were mainly dependent on agriculture for their livelihood rather than any other non-farm sources.

Crop income was significantly correlated (at 0.01 level) with the total household income in all the villages except in Malleboinpally (Table 61). The correlation coefficients between crop income and total income were relatively higher in Tirumalapuram and Nandavaram as compared to other villages. Livestock was significantly correlated with total income in all villages with highest correlation in Kacharam (0.69). Non-farm income was also significantly correlated with total income in all villages except in Kacharam.

Table 61. Correlation of different sources of income with total household income.

	Sources of income[1]		
Village	Crop income	Livestock income	Non-farm income
Malleboinpally	0.14	0.50**	0.82**
Mentapally	0.57**	0.40**	0.70**
Tirumalapuram	0.80**	0.41**	0.69**
Kacharam	0.72**	0.69**	0.06
Nandavaram	0.94**	0.50**	0.32*
Kanugulavanka	0.76**	0.24*	0.42**

1. * = Significant at 0.05 level; ** = Significant at 0.01 level.

Land was considered as one of the most important forms of capital in the rural economy. Rural households depend on land for most of their income needs. Therefore, total income and income from crops were significantly positively correlated with land ownership as expected (Table 62).

Table 62. Correlation of income sources with land ownership[1].				
Village	Crop income	Livestock income	Non-farm income	Total income
Malleboinpally	0.3792**	0.1333	0.5680**	0.6334**
Mentapally	0.7114**	0.1477	0.1164	0.5511**
Tirumalapuram	0.3859**	0.5909**	0.6426**	0.7095**
Kacharam	0.5202**	0.5635**	-0.3322**	0.5364**
Nandavaram	0.7864**	0.4457**	0.0321	0.7592**
Kanugulavanka	0.6062**	0.25	-0.018	0.5796**

1. ** = Significant at 0.01 level.

Non-farm income can be expected to have a negative association with land ownership since large landholders tend to depend more on agricultural activities and less on non-farm income. But, in Tirumalapuram and Malleboinpally non-farm income was significantly positively correlated with land ownership. One reason could be the presence of several large landowners who complement their incomes through well paid government jobs in these villages. For such households, even though agriculture was one of the important sources of income, contribution from non-farm income was much higher towards the total household income. In Kacharam, non-farm income was significantly negatively correlated with land ownership indicating that households with small landholdings and landless households were supplementing their household incomes with non-farm activities such as casual village labor. Livestock income was positively significantly correlated with land ownership in Tirumalapuram, Kacharam and Nandavaram indicating a close crop-livestock association.

Income inequalities and inequality decomposition

Inequalities were relatively higher in Tirumalapuram (Gini coefficient of 0.5) of Nalgonda district and Nandavaram (0.45) of Kurnool district as compared to the other villages (Table 63). The average per capita incomes in these two watersheds were also higher when compared with the other watersheds. In general, inequalities varied between villages of same district. Income inequality was lowest in Kacharam (0.29) of Nalgonda district.

Table 63. Gini coefficients of total household incomes.	
Village	Gini coefficient
Malleboinpally	0.40
Mentapally	0.36
Tirumalapuram	0.50
Kacharam	0.29
Nandavaram	0.45
Kanugulavanka	0.32

The concentration coefficients based on coefficient of variation and Gini indicate that crop income had an inequality increasing effect on overall income inequality in all villages except in Malleboinpally (Tables 64 and 65). Even though crop income has an inequality decreasing effect on overall income, its contribution to overall inequality was only 2–6 percent whereas the contribution was highest in Nandavaram watershed (85%) (Table 66). The inequality increasing effect of crop income may be because of the inherent inequalities in the land distribution in the villages. Therefore, if the beneficiaries of the improved variety seed, new technologies or any other interventions are not

Table 64. Concentration coefficients of source incomes in total inequality.

	Crop income		Livestock income		Non-farm income	
Village	c_i	g_i	c_i	g_i	c_i	g_i
Malleboinpally	0.26	0.68	1.16	1.62	1.05	0.95
Mentapally	1.71	1.34	1.18	1.62	0.67	0.80
Tirumalapuram	1.58	1.41	0.39	0.84	0.76	0.76
Kacharam	1.98	1.82	1.61	1.75	0.09	0.08
Nandavaram	1.11	1.10	0.89	0.91	0.57	0.59
Kanugulavanka	1.27	1.27	0.76	0.94	0.69	0.66

Table 65. Effect of different sources of income to overall income inequality[1].

Village	Crop income	Livestock income	Non-farm income
Malleboinpally	-	+	+
Mentapally	+	+	-
Tirumalapuram	+	-	-
Kacharam	+	+	-
Nandavaram	+	-	-
Kanugulavanka	+	-	-

1. + indicates inequality increasing; - indicates inequality decreasing.

Table 66. Factor inequality weights of source incomes in total income inequality.

	Crop income		Livestock income		Non-farm income	
Village	c_iw_i	g_iw_i	c_iw_i	g_iw_i	c_iw_i	g_iw_i
Malleboinpally	0.02	0.06	0.26	0.36	0.72	0.65
Mentapally	0.47	0.37	0.09	0.13	0.43	0.52
Tirumalapuram	0.54	0.48	0.04	0.09	0.42	0.41
Kacharam	0.46	0.43	0.50	0.54	0.04	0.04
Nandavaram	0.85	0.85	0.04	0.04	0.10	0.11
Kanugulavanka	0.67	0.67	0.05	0.07	0.28	0.27

properly identified, inequalities in the watersheds could increase even if the average income of the watersheds increases.

Livestock was an income inequality increasing source in Malleboinpally, Mentapally and Kacharam villages. It implies that any additional increment of livestock will increase inequalities. But this observation is too generic and a further analysis based on type of animal could provide better insights. The effect would be more pronounced in Kacharam where livestock income accounts for about 50–54% of overall inequality (Table 66). In Mentapally, livestock income accounts for only 9–13% of overall inequality. Even though livestock income had an inequality decreasing effect in Tirumalapuram, Nandavaram and Kanugulavanka watersheds, livestock accounts for only 4–9%, 4% and 5–7% of overall inequality, respectively.

Non-farm income was a representative of inequality decreasing source in all villages except Malleboinpally where there is some ambiguity. The concentration coefficient based on Gini (g_i) does indicate non-farm income as inequality decreasing source even for Malleboinpally (Table 64). In Malleboinpally, Mentapally and Tirumalapuram villages non-farm income accounts for a significant share (65–72%, 43–52% and 41–42%, respectively) in overall inequality and hence has a more pronounced effect (Table 66). It accounts for only 4% in Kacharam and 10–11% in Nandavaram and 27–28% in Kanugulavanka.

A more disaggregated analysis of the income sources

Even though classification of household income into crop, livestock and non-farm income provides a general idea about the importance of each category of income source in each watershed, it does not elaborate on the type of specific crop or livestock or non-farm activity that contributes towards inequality. One limitation for such analysis for each watershed was the varied sources of income that were characteristic to a particular watershed. A specific source of income could be important in a particular watershed but may not contribute much to the household income in some other watershed. For example, vegetables and oilseeds (groundnut and sunflower) were more predominant in Kanugulavanka watershed whereas pulse crops (pigeonpea and chickpea), cotton and coriander were dominant in Nandavaram watershed of Kurnool district. Sorghum, paddy and pigeonpea were some of the commonly grown crops in all the watershed areas. In such a case, a blanket categorization of income sources across all the watersheds may not give an accurate insight. Too many zeros under a specific category due to absence of an activity in a watershed along with cases of negative returns causes an upward bias in source Gini, which in turn may distort the results.

Therefore, a more disaggregated analysis of the income sources was done for a combined dataset of all the watersheds. The income sources consisted of income from dryland cereals, pulses, paddy, commercial crops, milk sales, other livestock income, employment, business and other non-farm sources. Similar type of analysis with such detailed classification for each watershed separately is beyond the purview of this paper.

The average per capita total income for the combined dataset of 420 households across the six watershed villages was Rs 9269 (Fig. 49). Among the different categories of income sources, employment (which includes regular employment and casual village labor) had the highest per capita income of Rs 2731 and accounted for 29% of the total per capita household income (Fig. 50).

This was followed by commercial crops (that included cotton, castor, vegetables and other high-value crops) with a mean per capita income of Rs 1990 and accounted for 21% of the average per capita total income of the household. Dryland cereals (sorghum, pearl millet, etc) had the lowest per capita income among all the categories (Rs 248) accounting for only 3% of the total income of the household.

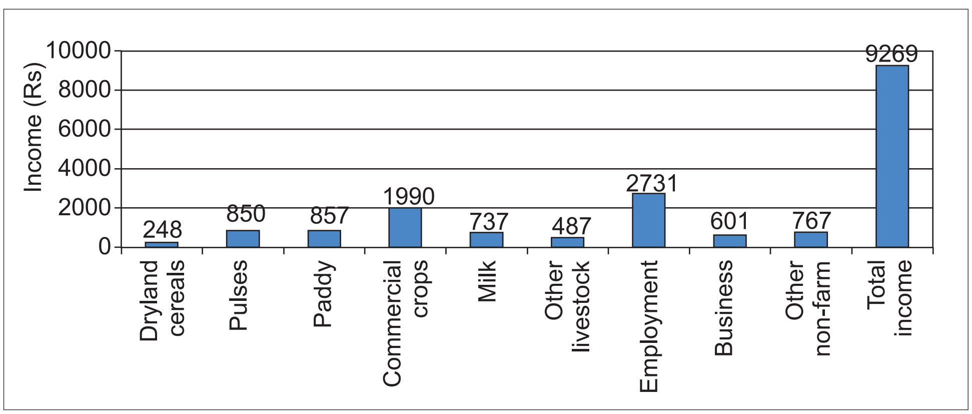

Figure 49. Average per capita income from different sources (n = 420).

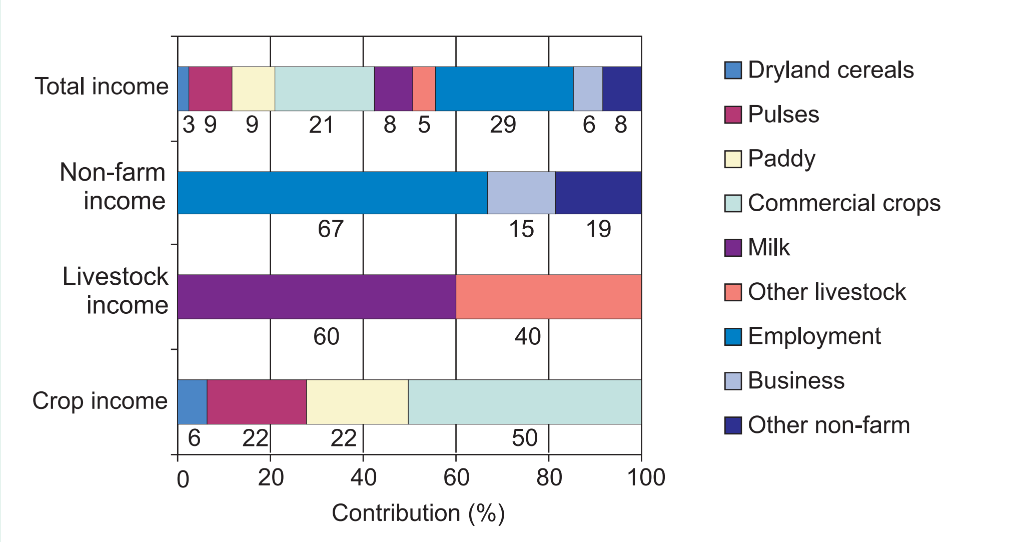

Figure 50. Contribution of different income sources to the total per capita income (n = 420).

The source Gini correlations (G_i) show that income from crops (dryland cereals, pulses and paddy) and livestock were more unequally distributed than most of the non-farm income sources. But the total household income is less unequal than any of the individual sources of income (Table 67). Income from employment category (regular employment and casual village labor) had a more equal distribution. Even though the source Gini coefficients were high for income from some sources, their contribution to overall inequality was not significant. For example, the contribution of dryland cereals to total income inequality was not much even though its source Gini was high whereas employment category had a relatively low source Gini but its contribution towards total inequality was high (Table 68).

The R_s value in Table 67 reflects correlation between each source of income and total income. A high positive value of R_s, ceteris paribus, implies that income source s contributes importantly to total income inequality (Boisvert and Ranney 1990). Crop incomes had higher correlations as compared to livestock related incomes and non-farm income sources.

Table 67. Gini decomposition of inequality for different sources.

Income source	S_i	R_i	G_i [2]	E_i
Dryland cereals	0.027	0.550	1.090	0.010
Pulses	0.092	0.800	0.908	0.062
Paddy	0.092	0.700	0.935	0.047
Commercial crops	0.215	0.707	0.798	0.065
Milk income	0.080	0.571	0.857	0.010
Other livestock	0.053	0.517	0.827	-0.001
Employment	0.295	0.396	0.638	-0.123
Business income	0.065	0.316	0.892	-0.023
Other non-farm	0.083	0.204	0.849	-0.050

1. S_i = Source's share of total income; R_i = Correlations between each source of income and total income; G_i = Source Ginis; E_i = Elasticity of total income inequality.
2. Source Ginis may be high when households with zero and negative incomes from different income sources were included and it may be possible to get source Gini values of greater than 1 (Findeis and Reddy 1987, Adams 1996).

The elasticity of total income inequality due to a small change in income from a given source (E_i) was computed for each source. These elasticities provide an initial indication of how changes in economic conditions and policies that effect income from a source are translated into the effects on income inequality. For example, 1% increase in profitability from pulse crops would also increase the disparity in the total household income by 0.062 of 1%. For employment category, the decrease in inequality would be 0.123 of 1%.

All the crop categories were inequality increasing sources based on the g_i (Table 68). The contribution of commercial crops category to total income inequality was 19–28%. Paddy accounted for about 14–27% of total income inequality. The results were ambiguous regarding income from milk and other livestock sources. Concentration coefficients based on Gini (g_i) showed these sources as inequality increasing whereas those based on coefficient of variation showed them as inequality decreasing sources. But in both cases, the contribution of these sources to the total inequality was not that significant (4–9% and 3–5%, respectively).

Table 68. Factor inequality weights of source incomes in total income inequality.

Income source	c_i	$c_i s_i$	g_i	$g_i s_i$
Dryland cereals	1.19	0.03	1.39	0.04
Pulses	1.61	0.15	1.68	0.15
Paddy	2.91	0.27	1.51	0.14
Commercial crops	0.87	0.19	1.30	0.28
Milk income	0.48	0.04	1.13	0.09
Other livestock	0.56	0.03	0.99	0.05
Employment	0.71	0.21	0.58	0.17
Business income	0.28	0.02	0.65	0.04
Other non-farm	0.84	0.07	0.40	0.03
Total		1.00		1.00

All the non-farm income sources were found to be inequality decreasing sources with employment category being the most important source of inequality (accounting for 17–21% of the total inequality). This may be due to inclusion of regular salaried employment in this category that contributes to relatively higher incomes in a household. The other two non-farm categories did not have significant contributions in the total inequality even though they had an inequality decreasing effect.

Conclusions

The watershed-level analysis showed that income from crop cultivation had an inequality increasing effect on overall income inequality in all the watershed areas. This could be because of the close association between crops and land ownership and a manifestation of unequal land distribution. This implies that there is a need for deliberate interventions that are targeted towards small and marginal landholders.

Livestock income was also an inequality increasing source in the watershed areas of Malleboinpally, Mentapally and Kacharam, with the effect being more pronounced in Kacharam. Livestock income was an inequality decreasing source in the watershed areas of Tirumalapuram, Nandavaram and Kanugulavanka but livestock does not account for any significant share in the overall inequality in these watersheds.

Non-farm income was an inequality decreasing source in all the watershed areas. The non-farm income accounts for a significant share of overall inequality in the watersheds of Malleboinpally, Mentapally and Tirumalapuram.

A more disaggregated analysis of income sources for the combined dataset of all watersheds provided better insights into the specific crop, livestock and non-farm category that caused inequality. All the crop categories had an inequality increasing effect with income from commercial crops being a major source of inequality. Commercialization helped to a certain extent in enhancing income. However, groundwater availability dictates adoption of commercial crops, which is a major constraint to small farmers. Appropriate interventions and support policies are therefore needed to enable small landholders to diversify and supplement their income with high-value crops. Paddy also accounted for a significant share of the total income inequality. But the elasticities of total income inequalities were low for income from crops. The contribution of livestock sources to total income inequality was also low.

All the non-farm income sources had an inequality decreasing effect with employment category accounting for the highest share in the total inequality. It implies that efforts in promoting microenterprises and non-farm income generating options would reduce overall inequalities in a watershed. These activities may negate the persistent inequalities due to the inherent unequal land distributions in the watershed areas, if beneficiaries of such activities were properly identified. Any effort to increase income from crops should also be accompanied by non-farm income generating activities (especially for landless and subsistence farmers whose main income sources were not crop based) to compensate the inequality increasing effects due to increased crop income.

Some of the important issues that still need to be addressed include whether the benefits from the current watershed activities were distributed equally and if there was scope for a more egalitarian growth in the watershed areas. Being participatory in approach, a degree of fairness exists and the watershed activities may probably reduce inequalities. The benefits from distribution of improved seed may increase income inequalities for a short period since the direct benefits go only to a few but in the long run these benefits could percolate to more number of farmers with increased adoption of the seed. Similar would be the trend for other soil and water conservation activities.

6. Summary and Conclusions

Watershed interventions

The APRLP-ICRISAT project was initiated with the objectives of developing a holistic participatory watershed-based model that leads to convergence of various technical and institutional innovations for integrated crop and livestock production and natural resource management systems to alleviate poverty and to provide technical know-how to farmers. The successful pilot watershed models at the selected nucleus watersheds were expected to serve as examples for satellite watersheds. The overall objective was to reduce poverty and protect the environment for sustainable agricultural development. A consortium model for IWM and development was adopted that included ICRISAT, NARS, government agencies and other development partners.

Apart from construction of soil and water conservation structures, IWM under the project included on-farm activities such as introduction of new improved crop varieties that suit the specific area, BBF system and contour planting to conserve in-situ soil and water, tropicultor usage for planting, balanced fertilizer application and interculture operations, and in-situ generation of organic matter through planting of fertilizer trees on field bunds. Activities such as seed banks, vermicomposting for producing biofertilizers, NPV for producing biopesticides, INM and IPM methods were also promoted in the watershed villages.

A detailed baseline socioeconomic household survey was conducted during the 2002–03 cropping season in selected nucleus watersheds in Mahabubnagar, Nalgonda and Kurnool districts. A random sampling procedure was used to select the households in the watershed villages such that the land distribution and caste distribution closely matched that of the land and caste distribution of the entire village. The sample size varied between 19 and 100% of the total households in the watershed communities across the watersheds. The overall objective of the survey was to provide a suitable benchmark for monitoring changes and to assess the impacts of watershed activities in the future. This report is a product of analysis of survey data and it provides a comprehensive snapshot of the socioeconomic conditions, social and political networks, cropping patterns, crop and livestock production, land characteristics, constraints and potential for increased productivity in the watershed areas. It offers careful insights into the existing production systems, resource use patterns, major livelihood strategies and the prevailing socioeconomic inequalities and distributional issues in the watershed communities. It also helps researchers and policy makers to understand the constraints, potential opportunities, farmer perceptions and priorities in the watersheds.

Demographic characteristics and social diversity

The average age of the household head and educational levels in the households were almost similar in all the watersheds and was 47–48 and about 5 years, respectively. The average family size was 5–6 persons and the mean work force was 3 to 4 workers. In general, women were mainly involved in tasks that included household chores and on-farm activities on their own land. Men were exclusively involved in income generating activities that included on-farm activities and other small businesses. Casual hired labor was one of the major income generating activities among the socially and economically disadvantaged groups of the community where both men and women were equally involved.

Social heterogeneity has implications for collective action in watershed management and development. The scope for collective action can be expected to be more in a watershed with relatively homogeneous community composition. Communities were more homogeneous in villages such as Mentapally and Tirumalapuram. They were relatively heterogeneous in Malleboinpally and Kacharam. Nandavaram and Kanugulavanka micro-watersheds were only a small part of large villages and collective action in such cases is complex as compared to other watershed areas where entire villages were considered as watershed.

Land ownership

The average land ownership was highest in Nandavaram in Kurnool district (5.94 ha) followed by Tirumalapuram in Nalgonda district (3.67 ha) (Fig. 51). The per capita land was also highest in these two villages compared to other villages (1.21 ha and 1.08 ha, respectively).

Dryland agriculture was the main cropping practice in all the villages which is a common characteristic of a semi-arid region. But a look into the irrigated cultivated area gives an idea about the agricultural potential in the watersheds. For example, the average irrigable land was highest in Tirumalapuram (0.80 ha) and the mean cultivated area under irrigation was also highest (0.79 ha) accounting for about

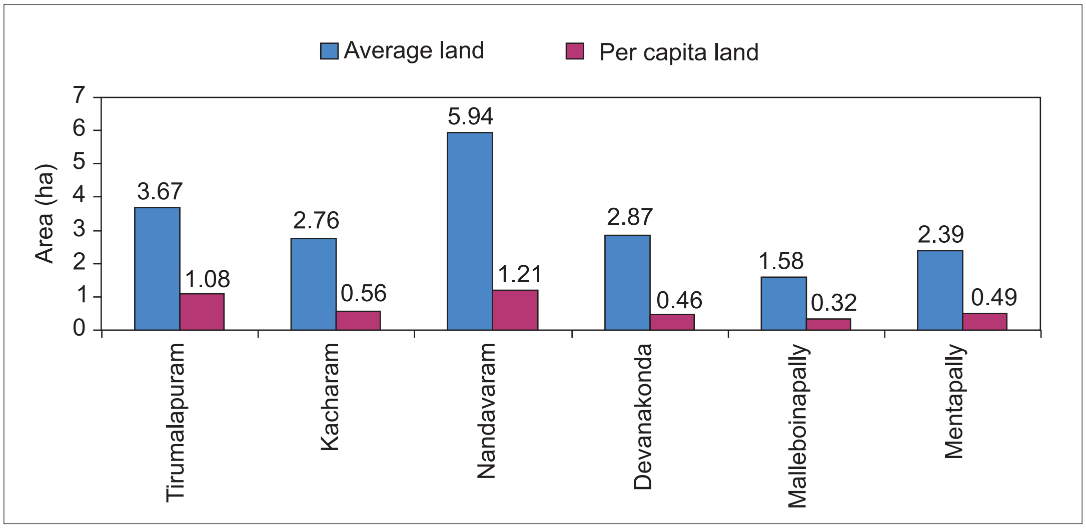

Figure 51. Average land ownership in the watersheds.

23% of the total cultivated area (Fig. 52). Inequalities in the distribution of land among the watershed households were prevalent in all the watershed areas and would play a major factor in the distribution of benefits if the agricultural potential were to be realized in the future. In general, the per capita landholding among the OCs was much higher when compared with BC and SC households.

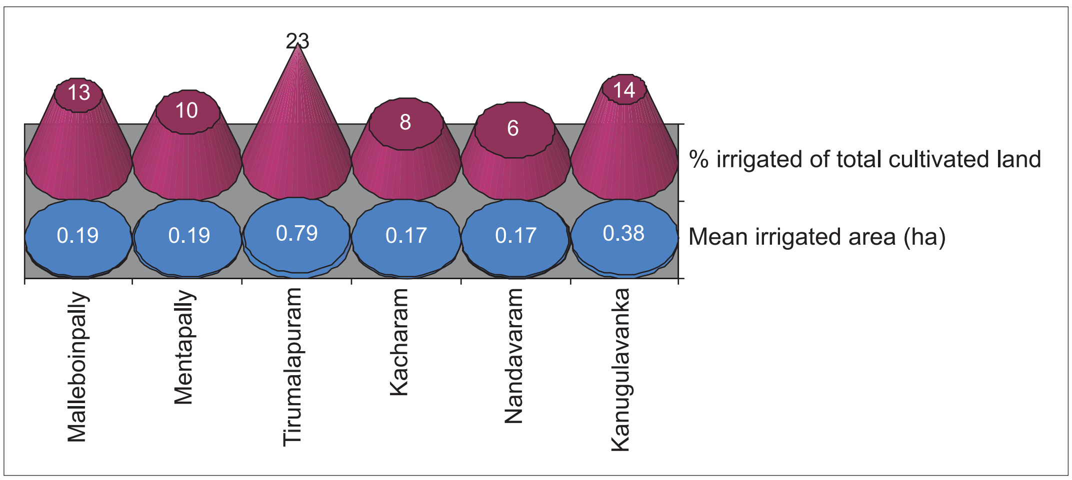

Figure 52. Irrigated cultivated land during kharif *season.*

Major crops

Dryland crops were important among all the watersheds and paddy was grown wherever assured source of irrigation existed. Castor, sorghum and maize intercropped with pigeonpea or grown as sole crops were predominant in the watersheds of Mahabubnagar and Nalgonda districts (Table 69). Cropping pattern in the selected watersheds of Kurnool district was relatively distinct. Chickpea and coriander were the important crops in Nandavaram and groundnut, sunflower and vegetable crops were the major crops in Kanugulavanka watershed. The type of crop grown in a watershed was observed to be dependent on the soils, access to irrigation and proximity to markets.

Table 69. Major crops grown in the watershed areas.

Watershed	Major crops grown
Malleboinpally	Paddy, castor, sorghum, maize, pigeonpea (intercropped with sorghum and maize)
Mentapally	Castor, paddy, sorghum, pigeonpea (intercrop), groundnut (*rabi*)
Tirumalapuram	Castor, paddy, pearl millet, pigeonpea (intercrop), sweet lemon
Kacharam	Maize, paddy, cotton, green gram, sesame, sorghum, sorghum (fodder), castor, tobacco
Nandavaram	Cotton, castor, pigeonpea (intercrop and sole), chickpea (*rabi*), coriander (*rabi*), sorghum (*rabi*)
Kanugulavanka	Groundnut, tomato, sunflower (*kharif* and *rabi*), pearl millet, *korra*, onion, cotton, paddy

Livestock production

Major livestock found in all the watersheds were milch buffaloes even though average ownership varied from 1.17 per household in Malleboinpally to 0.34 per household in Mentapally. Average milk sale per annum was highest in Kacharam at Rs 10,023. Small ruminant ownership varied across the watersheds with sheep being more in Malleboinpally, Kacharam and Nandavaram. The average ownership of goats was highest in Tirumalapuram (1.29 per household). Inequalities existed in the value of livestock assets owned in all the watersheds. In general, large farmers owned milch animals while small farmers and landless households owned small ruminants. Sometimes, rearing of small ruminants is considered an exclusive caste activity (occupation, eg, Gollas). Any livestock development intervention needs to consider the prevailing inequalities and the capacity of the farmers belonging to different socioeconomic groups to maintain livestock. For example, technological interventions that improve dairy farming have to be accompanied by specific strategies for feed and fodder supply, especially in the case of small farmers and landless.

Paddy straw is the major source of dry fodder. In watersheds where dry fodder shortage occurred, it was supplied by the state government. Major source of green fodder was crop residue from sorghum as the crop is easy to maintain and relatively drought resistant. Sorghum was exclusively grown as a fodder crop in Kacharam watershed which also leads in per capita livestock holdings. In watersheds such as Mentapally where crops failed due to drought and large-scale seasonal migration occurred, livestock holdings were also very small due to fodder and feed constraints.

Other income sources

The major income sources other than the crop and livestock incomes in the watershed areas were casual village labor, regular employment and migration income. In general, casual village labor was especially an important source of income for the BC and SC communities. In Mentapally watershed, seasonal migration through contract labor arrangements was widely prevalent. Under this arrangement, a local contractor in the village hires members of small and landless households as casual labor for a lump sum amount to work on construction activities in cities. In the micro-watersheds of Kurnool district, apart from casual village labor, regular employment, rented out bullocks and small businesses were also important sources of income. Regular employment was more common in watersheds that were nearer to the mandal headquarters, where some part time farmers also worked as teachers, etc.

Small farmers and landless households supplement their incomes through casual labor. These categories also rely on CPR for their subsistence (firewood and thatched houses) as well as livelihoods (example, making of leaf-plates and baskets).

Diversification of income sources

Income from crops was the most important source of income in Nandavaram and Devanakonda of Kurnool district accounting for about 77 and 53% of total per capita household income, respectively (Fig. 53). Livestock as a source of income was important in Kacharam and Malleboinpally (accounting for about 31 and 23% of the total household income, respectively). Non-farm sources of income were important in all the villages except in Nandavaram. In Nandavaram all the landholders of the micro-watershed were agriculturists with large landholdings cultivating coriander, chickpea and cotton that significantly contributed to the household income. In the other watersheds, most of the small farmers and landless relied on off-farm income sources such as casual labor to cope with the drought situation.

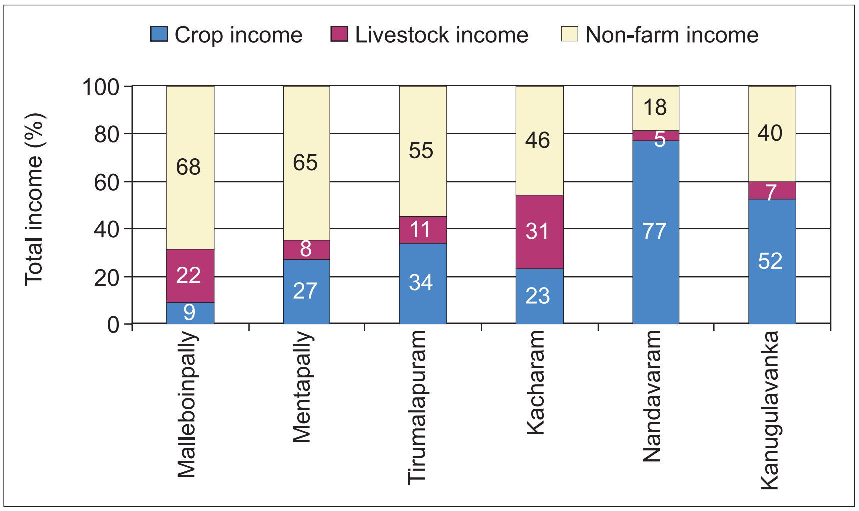

Figure 53. Major income sources in the watersheds.

Figure 54 shows the percentage of households below and above poverty line (assumed to be Rs 20,000 per annum) in the watershed areas. The household incomes in Nandavaram watershed are relatively higher as compared to those in other watersheds with almost 93% of the sample households above the poverty line. In Mentapally, about 40% of the sample households were below poverty line indicating the widespread backwardness of the village.

Groundwater resources

Groundwater levels have been declining in all the watersheds due to reduced recharge and renewal capacities because of frequent droughts and also due to excess groundwater abstraction. In all the watersheds majority of the open wells dried up (up to 100% in Mentapally, Kacharam and Nandavaram) and pressure on the groundwater has increased through tube wells (Fig. 55). Even though dryland crops were predominant in the region, water intensive crops such as paddy were very popular wherever irrigation was available. The effect of water scarcity was more pronounced in Mentapally where large number of households had migrated out of the village in search of alternative livelihoods outside of agriculture.

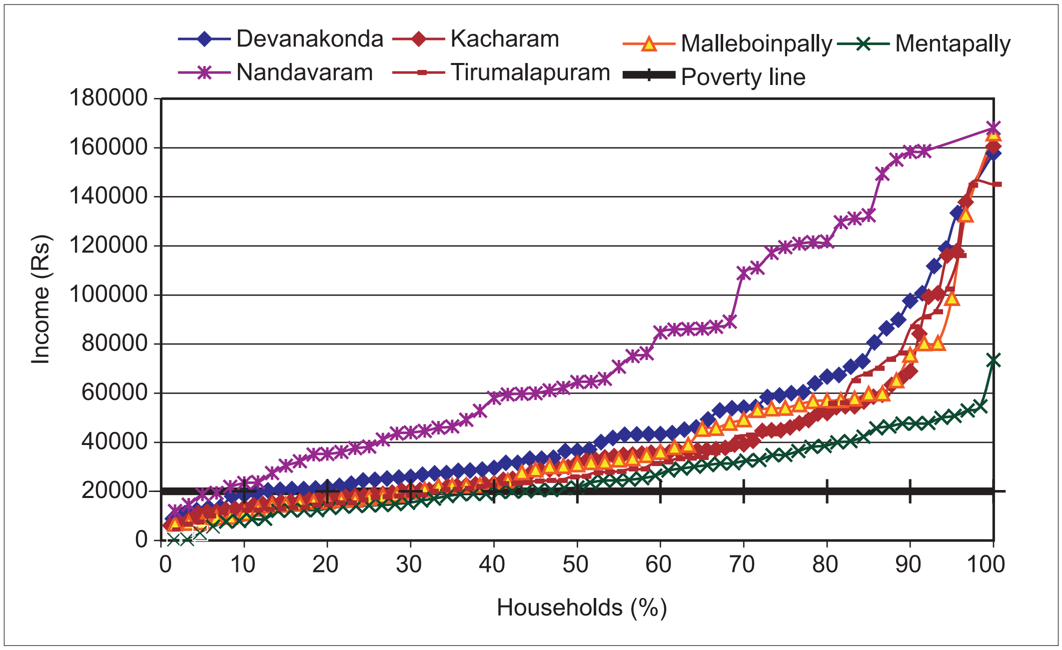

Figure 54. Income levels in the watersheds.

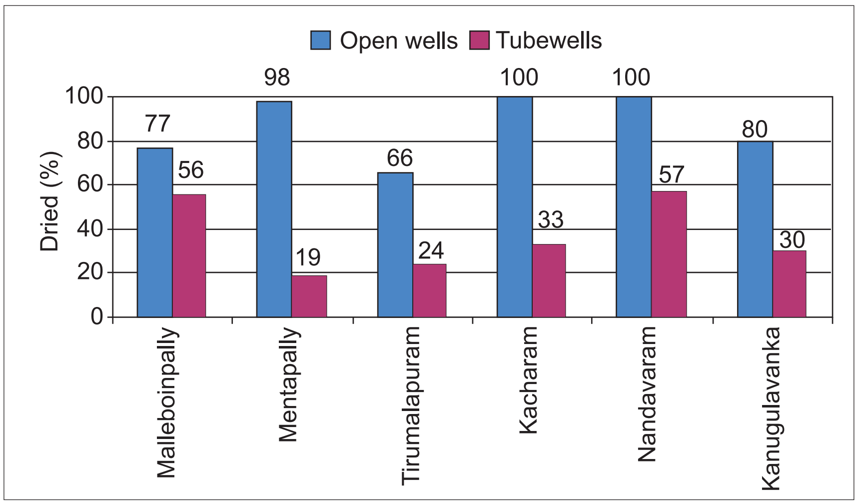

Figure 55. Proportion of wells dried up in the watersheds.

A clear policy on groundwater abstraction in terms of regulations or any other measure is important for sustained use of this critical resource. This requires a collective decision and collective action at the local community level for any effective implementation of the policies.

Income inequalities

Income inequality was highest in Tirumalapuram with a Gini coefficient of 0.5 and lowest in Kacharam with a Gini coefficient of 0.29. Inequalities existed in all the watersheds in the distribution of both land and livestock assets. Land inequalities persist in the villages historically with OCs having larger landholdings. Land inequalities were highest in Tirumalapuram and lowest in Mentapally with Gini coefficients of 0.65 and 0.38, respectively (Fig. 56). Inequalities in livestock assets occurred due to

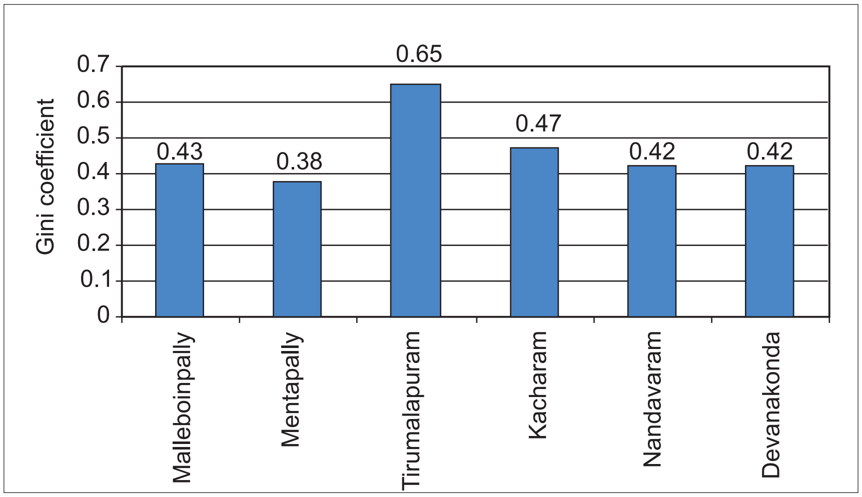

Figure 56. Land inequalities in the watershed villages.

concentration of high-value milch animals with large farmers and concentration of low value small ruminants with small farmers and landless.

Income inequality decomposition techniques were used to assess the contribution of different sources of household income towards the total income inequality. The analysis on the effect of different income sources on household income inequalities in all the watershed villages showed that income from crop cultivation had an inequality increasing effect on overall income inequality since profits accrue to those households that own large tracts of land. The increase in inequality was more predominant in Nandavaram where income from crop cultivation accounted for a major share of the total household income.

Livestock income was an inequality increasing source in some watersheds (Malleboinpally, Mentapally and Kacharam) and was an inequality decreasing source in Tirumalapuram, Nandavaram and Devanakonda. The effect was more pronounced in Kacharam as income from livestock was an important contributor to the total household income. Non-farm income was an inequality decreasing source in all the watershed areas. Non-farm income accounts for a significant share of overall inequality in the watersheds of Malleboinpally, Mentapally and Tirumalapuram (65–72%, 43–52%, and 41–42%, respectively).

Therefore, when land and livestock resources are unequally distributed, land- and livestock-based watershed interventions may not necessarily generate equitable benefits to all households. Measures should be taken to ensure equity in sharing benefits from watershed development. For example, dairy is an important component of livestock income but it is mainly undertaken by large landowners. Most of the small landowners and landless cannot afford to maintain milch animals and rely more on small ruminants. In such situations, technology interventions (appropriate feed and fodder management) should aim to increase the productivity of these livestock resources which would contribute to income of these vulnerable sections and thereby reduce any inequality increasing effect due to livestock income.

Implications for agricultural sustainability

Productivity enhancement activities of the project have a number of positive implications for agricultural sustainability in the watershed villages. The watershed program envisages number of on-farm and off-farm income generating activities that benefit all the socioeconomic communities in the village.

Participatory evaluation and cultivation of improved varieties

ICRISAT introduced improved seed to the specific watershed villages according to the requirements of the watershed farmers and evaluated by the farmers themselves as part of the entry point activity. The farm trials showed that the yields from improved cultivar seeds were much higher than the local varieties. One good example is the pigeonpea variety, Asha wherein the yields were higher (by almost 30%) as compared to local variety because of its wilt resistance characteristic. Seed of the groundnut varieties, ICGS 11, ICGS 76 and ICGV 86590, was of superior quality. The pearl millet variety ICMV 221 was popular due to good quality grain and fodder. In Tirumalapuram, pearl millet and sorghum were grown as sole crops instead of the traditional mixed or intercropping systems. Spillover benefits from the lateral spread of the improved variety seed to neighboring farmers and villages would be one of the positive externalities from introducing improved seed in the nucleus watershed villages.

Community seed production and maintenance (Village Seed Banks)

A variation of the seed bank concept was introduced in selected watersheds of Tirumalapuram of Nalgonda district and Karivemula and Devanakonda of Kurnool district to encourage market-led village seed production and maintenance using true-to-type breeder seed as the foundation. Under this concept, a village seed purchasing committee was organized and technical aspects of seed production, seed health and storage management, sampling and seed quality analysis and supply of initial breeder seed were provided by ICRISAT. The key for the success of seed banks depends on the confidence of the farmers on the seed from the seed bank. This would help the farmers to get reliable seed and avoid losses from low quality seed purchased from unscrupulous traders.

Integrated nutrient management activities

As part of the entry point activities in the watershed villages, soil samples were collected from the watersheds and analyzed and the macro and micronutrient status of soils was shared with the farmers. Deficiency of N, P, boron, sulfur and zinc was observed in majority of the farms. In the on-farm experimental trials conducted by ICRISAT, balanced nutrient application increased yields of different crops by 30–120% over farmer practice. Some of the benefits from micronutrient application included increased yields, improvement on grain quality, and correspondingly higher prices for the product in the market.

Integrated pest management activities

The basic concept of IPM is the containment of a pest below economically damaging levels, using a combination of all feasible control measures. The primary components of IPM are monitoring of insect pest populations using pheromone traps, use of tolerant varieties for pests and diseases, manipulation of farming system to minimize pest infestation, enhanced natural control process and selective use of biopesticides and/or synthetic pesticides. Mainstreaming IPM in watershed villages could require collective action and coordination of pest control practices.

The use of botanicals like neem in a number of crops and cultural operations like manual shaking of the pigeonpea crop to escape the peak pest attacks were emphasized to minimize the use of toxic chemicals. Orientation about threshold population of pests and use of NPV as biopesticides was also given to farmers in these villages.

Field trials were conducted to show the effectiveness of seed treatment in controlling diseases. Seed treatment with Benlate+Captan (1:1) at 3 g kg^{-1} seed to control seedling root rot in groundnut crop was undertaken. Practices like host plant resistance, crop rotation, seed treatment and one timely spray of chorothalonil (Kavach) at 30–40 days after sowing has effectively controlled diseases and increased pod yield by 2–3 times and crop income by 3 times.

Informational linkages for rural development

An example of successful informational linkages is the Aadarsh Mahila Samaikya Community Information Center in Addakal of Mahabubnagar District, Andhra Pradesh. The center is managed by a federation of women SHGs. The objective of the resource center is to help its members and community in the areas of agriculture and other inputs and support them in marketing aspects, organize training programs to its member families in the areas of skill building and income generation activities and mobilize funds to lend to its member groups. The resource center caters to multiple purposes that include market building and super bazaar, training hall, informal bank and office, dormitory, highway restaurant and milk chilling unit.

Income generating micro-enterprises

Some of the initiatives undertaken in the APRLP-ICRISAT project watersheds to improve income generating options in the rural areas include village-based seed banks, vermicomposting and pigeonpea dhal making unit. Vermicompost is used to improve soil fertility and crop productivity through eco-friendly farming and assistance was provided to women SHGs to set up viable vermiculture enterprise at household level. A dhal mill was set up on pilot basis in Mentapally to add value to the produce and to fetch higher price in the market and avoid middlemen.

Strategies for the future

Even though all the above productivity enhancement interventions aim to improve the performance of agriculture and allied activities, focus should also be on equity in the distribution of these benefits. Since most of the crop production activities are land based, inequity in land distribution results in inequities in distribution of technology benefits from crop production. This can be seen from the analysis in section 5, where crop income had inequality increasing effect and non-farm income had inequality decreasing effect. It is possible that farmers with large holdings would benefit much more from crop production technologies than small and landless farmers. Therefore, crop technology interventions should be backed by livestock and non-farm income generating activities to create livelihood opportunities and incentives for landless and marginal farmers. Caution should be taken so that watershed interventions do not aggravate the existing inequalities in the watershed areas as this would create conflicts and undermine incentives for collective action.

Development strategies should take into consideration the diverse geographical and biophysical characteristics of the watershed areas. It is difficult and also not possible to come up with a strategy that suits all conditions. Agricultural potential and access to markets are two of the important factors that determine the technical and also the comparative advantage of a specific location.

Malleboinpally and Mentapally watersheds were placed in low agricultural potential category but the constraints for agricultural production differ (Table 70). Major source of household income in Malleboinpally was through regular employment due to its nearness to the district and mandal headquarters and takes precedence over agriculture as primary occupation whereas in Mentapally, lack of irrigation water was the major reason for low agricultural production. Therefore, any production enhancing investments in Mentapally could yield higher marginal benefits than in Malleboinpally.

Table 70. Agricultural potential in the watershed areas.

	Agriculture potential		
Market access	Low	Medium	High
Low	Mentapally	Tirumalapuram	
Medium	Malleboinpally	Kacharam	Nandavaram, Kanugulavanka

In Tirumalapuram and Kacharam watersheds, scope for improving crop production through improved varieties and management practices exists with market access being a constraint for Tirumalapuram. Agricultural potential in Tirumalapuram could be medium to high with its relatively better water tables. Suitable cropping patterns with proper management practices could increase the agricultural production significantly. Both these watersheds have good potential for livestock production activities as long as proper strategies are devised to meet fodder and feed requirements. Sorghum for fodder and grasses such as *Stylosanthes* can be promoted in these watersheds. Interventions that improve the productivity of small ruminants could help in addressing the inequalities in the distribution of watershed benefits. Among the two watersheds, Kacharam has an advantage in terms of a well organized milk cooperative and relatively easy access to market towns.

Both Nandavaram and Kanugulavanka watersheds have high agricultural potential with good access to markets. Scope for increasing the production of high-value crops exists and with proper linkages to or establishment of agro-processing units, the potential for increasing the household income is vast.

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The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a nonprofit, non-political organization that does innovative agricultural research and capacity building for sustainable development with a wide array of partners across the globe. ICRISAT's mission is to help empower 600 million poor people to overcome hunger, poverty and a degraded environment in the dry tropics through better agriculture. ICRISAT belongs to the Alliance of Future Harvest Centers of the Consultative Group on International Agricultural Research (CGIAR).

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327-07

Acronyms

ADDRESS	Action for Development of Rural Education and Service Society
ANGRAU	Acharya NG Ranga Agricultural University
APSRAC	Andhra Pradesh State Remote Sensing Application Centre
BAIF	Bharatiya Agro Industries Foundation
BBF	broad-bed and furrow
BC	backward caste
CBO	community-based organization
CPR	common property resources
CRIDA	Central Research Institute for Dryland Agriculture
DAP	diammonium phosphate
DFID	Department for International Development
DPAP	Drought Prone Area Programme
DRDA	District Rural Development Agency
DWMA	District Water Management Agency
FYM	farmyard manure
ICRISAT	International Crops Research Institute for the Semi-arid Tropics
INM	integrated nutrient management
IPM	integrated pest management
IWM	integrated watershed management
KVK	Krishi Vigyan Kendra
N	nitrogen
NARS	national agricultural research system
NGO	non-governmental organization
NPV	nuclear polyhedrosis virus
NRSA	National Remote Sensing Agency
OC	forward caste
P	phosphorus
PIA	project implementing agency
SC	scheduled caste
SDDPA	Society for Development of Drought Prone Area
SHG	self-help group
ST	scheduled tribe

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