Global Theme on Agroecosystems

Report no. 29

Crop-Livestock Linkages in Watersheds of Andhra Pradesh

International Crops Research Institute for the Semi-Arid Tropics

International Livestock Research Institute

Citation: Subrahmanyam S, Bezkorowajnyj Peter, Shiferaw Bekele, Wani SP, Parthasarathy Rao P and Nageswara Rao GD. 2006. Crop-livestock linkages in watersheds of Andhra Pradesh. Global Theme on Agroecosystems Report no. 29. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 52 pp.

Abstract

There are a number of studies that have looked at the impact of watershed programs on rural livelihoods with a focus on crops and related activities but few have considered the importance of livestock. This study focuses on the crop-livestock linkages in dryland villages under watershed programs and concentrates on the impact of watershed interventions on crop-livestock linkages and the implication to rural livelihoods. For this study, baseline data collected from six watershed villages in the state of Andhra Pradesh, India under the Andhra Pradesh Rural Livelihoods Programme (APRLP) were analyzed with a focus on livestock production systems, size and composition of livestock holdings, milk production and marketing, and the availability and utilization of feed within the context of the socioeconomic, agroclimatic and agricultural backdrop of the villages.

The impact of a watershed program on the crop-livestock system was studied by selecting two villages with the same agroclimatic conditions: one with a watershed intervention and the other without any intervention. The findings indicate that the bovine sector is more advanced in the watershed village compared to the control village with a shift in composition from work or draft animals to milch animals. Total increase in milk production in the watershed village is attributed to household level improvements in productivity, as a result of a better feeding regime. On a dry matter basis the quantity of fodder fed per adult livestock unit was 65–70% higher in the watershed village compared to the control village. In addition there was a dramatic increase in the quantity of greens fed which substituted for the use of concentrate feed usually composed of agro-industrial by-products. Conclusions indicate that the higher production of green biomass could be attributed to more intensive cropping resulting from improved moisture budgeting in the soils following the watershed intervention.

Finally, the report suggests a few simple indicators that can be easily used to measure the impact of watershed programs on rural livelihoods with particular reference to crop-livestock linkages.

This publication is an output from the research project “Enhancing Livelihoods of Poor Livestock Keepers through Increasing Use of Fodder” funded by the United Kingdom Department for International Development (DFID) and ICRISAT for the benefit of developing countries.

Global Theme on Agroecosystems
Report no. 29

Crop-Livestock Linkages in Watersheds of Andhra Pradesh

S Subrahmanyam, Peter Bezkorowajnyj, Bekele Shiferaw, SP Wani, P Parthasarathy Rao and GD Nageswara Rao

ICRISAT
International Crops Research Institute for the Semi-Arid Tropics
Patancheru 502 324, Andhra Pradesh, India

International Livestock Research Institute
c/o ICRISAT, Patancheru 502 324, Andhra Pradesh, India

About authors

S Subrahmanyam	Centre for Economic and Social Studies, Khairtabad, Hyderabad, India (Formerly Consultant, ILRI-South Asia Project, c/o ICRISAT-Patancheru)
Peter Bezkorowajnyj	Project Manager, "Enhancing Livelihoods of Poor Livestock Keepers through Increasing Use of Fodder" implemented in India and Nigeria, International Livestock Research Institute (ILRI), c/o ICRISAT, Patancheru 502 324, Andhra Pradesh, India
Bekele Shiferaw	Scientist (Economics), ICRISAT-Nairobi, PO Box 39063, Nairobi, Kenya
SP Wani	Principal Scientist (Watersheds) and Regional Theme Coordinator (Asia), Global Theme on Agroecosystems, ICRISAT, Patancheru 502 324, Andhra Pradesh, India
P Parthasarathy Rao	Senior Scientist (Economics), Global Theme on Markets, Policy and Impacts, ICRISAT, Patancheru 502 324, Andhra Pradesh, India
GD Nageswara Rao	Senior Scientific Officer, Global Theme on Markets, Policy and Impacts, ICRISAT, Patancheru 502 324, Andhra Pradesh, India

Acknowledgments

Many people have contributed to this study. We are grateful to the survey households who spared their valuable time in responding to our comprehensive and far-reaching questions. We thank Dr AK Mishra, Senior Scientist (LPM), Central Research Institute for Dryland Agriculture (CRIDA) for his review and valuable comments on the manuscript and Mr E Jagadeesh for his valuable assistance in verifying and processing the data. We also thank all the field investigators for their support under trying conditions. Financial support for the overall umbrella project from the Andhra Pradesh Rural Livelihoods Programme (APRLP) through ICRISAT and DFID [through Systemwide Livestock Program (SLP)] for this component under the Fodder Innovation Project is gratefully acknowledged. We are indebted to Ms Sheila Vijayakumar for editing the manuscript and Mr KNV Satyanarayana for page-setting the manuscript.

Contents

Executive Summary

Watershed program is an important intervention in dryland areas to improve crop as well as livestock productivity. The Indian state of Andhra Pradesh is the forerunner in watershed program accounting for more than 30% of the total watershed projects implemented in the country. An understanding of the processes of change consequent to the implementation of the watershed program helps in understanding the impact of the program on rural livelihoods. It also helps to introduce correctives wherever necessary. This study provides a baseline for six watersheds implemented under the Andhra Pradesh Rural Livelihoods Programme (APRLP)[1]. The data pertains to 2002–03, the first year of implementation of the project. Besides providing the baseline scenario of these six villages, the study focuses on the changes that are taking place in the crop-livestock sectors after the introduction of the watershed program. For this purpose data collected from two villages, one village with watershed program under implementation since 1999 and another village with similar agro-ecological features, but no watershed program under implementation are used.

Socioeconomic features of the watershed villages

Caste composition

Of the six villages considered, Thirumalapuram has a very high proportion of scheduled castes (SCs) and scheduled tribes (STs) and Devanakonda has dominance of backward castes. The other four villages have a balanced distribution of castes. However, Nandavaram and Devanakonda have a low proportion of SCs and STs.

Levels of education

Malleboinpally, Mentapally and Thirumalapuram have low level of literacy among the heads of the households. However, a significant proportion of heads of households in Malleboinpally has secondary and above levels of education. Among the six villages, Nandavaram and Devanakonda have higher levels of education than the other four villages. These villages also have a low proportion of SCs and STs.

Rainfall

Four of the six villages (Malleboinpally, Mentapally, Nandavaram and Devanakonda) receive about 600 mm per annum. Thirumalapuram receives as low as 571 mm per annum and Kacharam receives a high rainfall of more than 800 mm per annum. However, both these villages and Devanakonda suffered severe drought during 2002–03 with a shortfall of more than 40% in rainfall. Though the villages differ in terms of rainfall received per annum, all of them receive less than the state average rainfall of 940 mm in Andhra Pradesh.

Irrigation

All the six villages have very low irrigation ratio of less than 25%. However, two villages, viz, Nandavaram and Devanakonda, have the lowest irrigation ratio of 3.9% and 14.7%, respectively. In the remaining

1. On request from the Government of Andhra Pradesh, the United Kingdom Department for International Development (DFID) is a partner in the scaling-up of watershed activity by providing financial support for capacity building, livelihood support and convergence of other schemes and services, through the Andhra Pradesh Rural Livelihoods Programme (APRLP). APRLP aims to reduce poverty by building effective and sustainable rural livelihoods in three of the state's drought-prone districts (Kurnool, Mahabubnagar, Nalgonda), taking watersheds as an initial entry point. The project's broader goal is that more effective and sustainable approaches are adopted by government agencies and other stakeholders to eliminate poverty in drought-prone areas of Andhra Pradesh.

four villages irrigated area forms about 20% of the net area sown. However, in the year of survey most of the wells were dried up.

Land distribution

Thirumalapuram has the highest proportion (more than 30%) of landless households followed by Malleboinpally, Kacharam and Devanakonda (10–14%). Menatapally and Nandavaram have an exceptionally low proportion of landless households (about 5%). Nanadavaram has very high land resource with 80% of the households belonging to the category of medium and large farmers. Devanakonda and Mentapally also have a high proportion of medium and large farmers. Malleboinpally has a high proportion of marginal and small farmers.

Cropping pattern

Pulses are the dominant crops accounting for 30 to 40% of the area in all the villages except Devanakonda. Paddy is insignificant in all the villages except Thirumalapuram and Malleboinpally where it has a share of more than 12%. Devanakonda has a high proportion of area (65%) under oilseeds and horticultural crops. In Nandavaram, horticultural crops and cotton are dominant. Oilseeds are important in Mentapally and Thirumalapuram.

Per capita income and incidence of poverty

Nandavaram has highest per capita income and lowest incidence of poverty. The high proportion of large farmers and favorable monsoon are responsible for this high position. Thirumalapuram occupies second position in per capita income, but incidence of poverty is relatively high. The high proportion of the landless in this village appears to be responsible for high poverty. Kacharam has moderate level of per capita income, but incidence of poverty is relatively lower as compared to its per capita income. Dairying is highly developed in the village and it is responsible for low incidence of poverty with a moderate size of landholding. Livestock sector contributes 30% of the household income. Malleboinpally and Devanakonda have per capita income of Rs 7850 and Rs 7510, respectively, but the latter has significantly lower incidence of poverty than the former. This is because of the high proportion of medium and large farmers in Devanakonda. Malleboinpally has very low proportion of households belonging to the category of medium and large farmers. Mentapally occupied lowest position among the six villages in per capita income and incidence of poverty. This is neither due to drought nor due to 'landlessness'. Livestock sector is highly backward, contributing only 7% to household income.

Inequality in assets and income

Inequality in per capita income is similar to that in assets in all villages except Thirumalapuram. Distribution of livestock is more unequal than land in all the villages except Thirumalapuram. Livestock sector in dryland areas is biased towards large farmers.

Livestock production systems in the watershed villages

Production systems

Participation in bovine activity is high in Nandavaram and Thirumalapuram and low in Malleboinpally and Devanakonda. Kacharam specializes in milk production and there is no work system in the

village. Milk production is predominant in Thirumalapuram, Malleboinpally and Nandavaram with equal importance for milk and mixed systems. Devanakonda and Mentapally are backward in milk production and have a high proportion of work animal holdings.

Buffalo is the dominant milch animal in all the villages. However, Malleboinpally and Nandavaram specialize in buffalo milk production with eight buffaloes for each cow. On the other hand, Thirumalapuram has equal number of cows and buffaloes. In the remaining three villages cows also exist along with buffaloes in the ratio of one cow for two buffaloes.

Milk production

Milk yield per animal is very high in Kacharam and Devanakonda and low in Thirumalapuram and Mentapally. Both the villages have crossbred cows. Buffalo is predominant in Malleboinpally and Nandavaram, which occupy the middle position in milk yield. Poor performance of Mentapally and Thirumalapuram is due to the predominance of local cows with very low milk yield. When milk production per household is considered, Kacharam again stands at the top and Malleboinpally occupies second position pushing Devanakonda to the third position.

The distribution of milch animals by milk yield indicates the development of the dairy sector. Only Kacharam has a large proportion (65%) of cows with yield more than 3 liters. In all the other villages average yield of most of the cows is less than 2 liters per day. Devanakonda shows its superiority in milk yield of buffalo milk with nearly 50% of the buffaloes producing more than 3 liters per day. Malleboinpally and Kacharam also have a significant proportion of buffaloes (more than 20%) with high milk yield. A majority of buffaloes in Malleboinpally, Thirumalapuram and Nandavaram produce 1–2 liters per day and a majority in Mentapally and Kacharam produce 2–3 liters per day.

Draft animals

Density of draft animals is highest in Mentapally (1.14 per ha) and lowest in Nandavaram and Devanakonda (0.49 per ha). The other three villages occupy a middle position (0.74 per ha). Except in Thirumalapuram the density of draft animals is lower on small farms than on large farms.

Availability and utilization of feed

Feeding of concentrates is almost absent in Mentapally, Nandavaram and Thirumalapuram. The use of green fodder is also not high except in Nandavaram. The feeding levels are higher in Kacharam, Nandavaram and Devanakonda with an average quantity of 2.5 kg dry matter per adult unit per day. Availability of straw is 0.67 t per ha in Mentapally, Thirumalapuram and Devanakonda. But availability per animal varies across these villages because of the differences in the density of animals. Thirumalapuram has low availability of straw per animal because of high density of animals.

Impact of watershed program

Impact of watershed program is estimated by adopting with and without approach. The differences between the two villages relating to crop and livestock sectors are attributed to the program.

Rural income and its composition

Watershed program has a significant positive impact on per capita income, which is contributed by crop and livestock sectors, more specifically by the livestock sector. The yields of all the crops, except

those of paddy and minor millets, have improved. Per capita income is higher by 39.2% and this is due to the development of crop and livestock sectors. Per capita income from livestock sector improved by 79.7% and its share in total income increased from 12.2 to 15.7%. Non-farm income is similar in both the villages.

Size and composition of livestock sector

Watershed program has a significant impact on the size and composition of the livestock sector. Small ruminant activity is replaced by the bovine activity and even in the bovine sector; the focus has shifted from the production of draft animal power to milk production. All these changes came because of the improvement in the availability of green fodder. The proportion of bovine holdings producing milk increased steeply from 53 to 78%; the density of work animals declined from 61.5 to 43.5 per 100 ha of net area sown and the proportion of small farmers maintaining work animals declined from 28.2 to 16.1%. The increase in milk production came through the increase in the productivity rather than increase in the number of animals. Milk yield per animal increased by 24.7% and the value of milk produced per household increased by 14.7%.

Fodder availability and feeding levels

The availability of crop residues per ha and per bovine doubled. This increase is partly due to shift in cropping pattern towards food grains and partly due to higher yields of straw. There is significant increase in the quantity of greens fed. Concentrate feed is substituted by green fodder. The quantity of dry matter fed increased by 75% and this improvement is mainly due to increase in the availability of green fodder.

Livestock development in dryland agriculture

Agriculture, rural income and poverty

Distribution of land is highly inequitable in dryland agriculture. Top 25% of the households own 63.9% of the cultivated land. However, irrigation ratio is more favorable to small farmers than to the large farmers. Despite this favorable situation, marginal farmers accord lower priority to cultivation and show more interest in wage employment than cultivation of their land. As a result, they leave a significant proportion of their land as fallow. In the case of other farmers, the proportion of area kept as fallow increases with farm size. Agriculture is not viable to the marginal farmers in the dryland areas. Incidence of poverty is higher among marginal farmers than agricultural laborers.

Size and composition of livestock

Livestock sector is not favorable to the marginal and small landholdings in the dryland areas. Income from livestock sector increases with increase in the size of landholding. Small ruminant activity is also less developed in the villages with backward dairy sector. In the absence of technological changes in the small ruminant sector, the activity is confined to socially backward communities.

Productivity of livestock sector

The distribution of high-yielding cows is biased towards large holdings and that of buffaloes towards medium size holdings. Thus, the small and marginal farmers maintain low productive milch animals.

However, the maintenance of low productive milch animals is not because of the compulsion to maintain work animals. They rarely maintain work animals because of the availability of hire services.

Availability and utilization of feed and fodder

Grazing provides 40% of the feed requirement of the animals. Feeding of concentrates is quite negligible. About two-thirds of the farmers feed less than 2 kg of green fodder a day and this proportion is as high as 93% among the landless and 83% among the marginal farmers, indicating that these two categories depend heavily on grazing. High dependence on grazing makes the activity unattractive for the poor as the opportunity cost of labor engaged in grazing is very high. Feed scarcity is the major constraint for the poor to take up dairy activity. Interventions have to focus on improving the availability of feed and fodder to the landless and marginal farmers.

1. Introduction

Livestock sector plays an important role in the rural economy of India with a high contribution to the gross domestic product (GDP) and a high absorption of female labor. The sector accounts for 5.59% to the GDP and 27.7% of the income from agriculture in India in 2001–02. In absolute terms, the sector has contributed 84.6 million t of milk, 50.7 million t of meat and 34 billion eggs and significant amount of organic manure. The livestock sector has greater potential for female employment than crop farming. While females perform only 35% of the work in the crop sector, they contribute as high as 69% of the work in livestock sector (Government of India 2003). Though India is the largest producer of milk in the world, the sector is imposing heavy pressure on land. With a share of only 0.5% of the world's grazing land, the country supports as high as 18% of world's cattle population.

The benefits of the green revolution were confined to irrigated areas and the expansion of irrigation slowed down in the 1990s. While net irrigated area remained constant around 55 million ha or 40% of the net area sown after mid-nineties, more and more area is being shifted from surface to groundwater. The share of wells in net irrigated area increased steeply from 50% in the early 1990s to 61% in 2000–01. A large proportion of wells in low rainfall areas dried up. Future growth of agriculture depends on the performance of dryland agriculture, which accounts for 60% (85.6 million ha) of the net area sown. Even if the recent trend in irrigation expansion is continued for the next 25 years, there will remain 65 million ha of dryland. Several programs have been initiated for the development of dryland agriculture after the introduction of the Drought Prone Area Programme (DPAP) in 1973–74 with the main objective of conservation of soil moisture. The Desert Development Programme (DDP) of 1977–78, the Integrated Wasteland Development Programme (IWDP) of 1989–90 and the National Watershed Development Programme for Rainfed Areas (NWDPRA) of 1990–91 were the subsequent interventions in dryland agriculture. Improving agricultural production and restoring ecological balance are the twin objectives of these programs. All these programs presently adopt watershed approach and focus on integrated farming systems and management of common property resources to augment family income and improve nutritional levels of communities participating in watershed programs. The treatment of the watershed is expected to improve agricultural as well as livestock productivity. However, several studies show that the benefits are not uniform across regions.

The state of Andhra Pradesh in India has a very high coverage of watershed development program. Almost 30% of the total watersheds taken up in the country are located in this state. These projects are taken up under various rural development programs. DPAP is implemented in 11 districts covering 94 blocks. Another district, Anantapur, is covered under the DDP. Both these programs are centrally sponsored schemes with 75% Central assistance. These two programs together cover 1.76 million ha. Another important program is the IWDP. The project is being implemented in 17 districts covering an area of 0.5 million ha. Employment Assurance Scheme (EAS) is another important program under which 1884 watershed projects have been taken up. The Central government bears 75% of the expenditure on the program. Another rural development program, Rural Infrastructure Development Fund (RIDF-VI), is implemented under the assistance of the National Bank for Agriculture and Rural Development (NABARD). The State Government contributes only 10% of the cost of the project. This program covered 1345 watershed projects till the end of March 2004. Andhra Pradesh Hazard Mitigation and Emergence Cyclone Recovery Project (APHM & ECRP) was implemented during July 1997 and July 2002 in five districts, viz, Adilabad, Chittoor, Anantapur, Nellore and Karimnagar. The project covered 20 watersheds in each district (Government of Andhra Pradesh 2004). Thus, almost all the development programs are implemented on watershed basis. To understand the impact of

these projects on the livelihoods of the people, a careful analysis of the base situation is essential. Such an analysis provides a baseline for concurrent evaluation to be carried out during the implementation of the project and impact evaluation to be taken up after the completion of the program.

This study analyzes the economic conditions of the people living in six watershed villages in Andhra Pradesh in the first year of implementation under the Andhra Pradesh Rural Livelihoods Programme (APRLP). The focus of the study is to characterize the watersheds in terms of agriculture and livestock development. Since watershed development is expected to improve the feed and fodder situation and facilitate dairy development, special attention is focused on the livestock sector.

1.1 Objectives

The following are the specific objectives of the study:

1. Analyze the socioeconomic features of the villages and characterize the farming and livestock production systems;
2. Examine the asset and income distribution, sources of income and incidence of poverty;
3. Examine linkages between crop and livestock sectors through input supply—feed and fodder by the crop sector to the livestock sector and animal draft power and manure by the livestock sector to the crop sector;
4. Study the impact of watershed development on crop and livestock sectors in terms of improving the livelihoods of the poor;
5. Identify the indicators for monitoring the impact of watershed management on the livestock sector.

1.2 Methodology

The study uses the data collected from six villages in Andhra Pradesh where watershed program has been initiated under APRLP. Data were collected for 2002—03, the year of initiation of the program. The characteristics of each village were recorded in terms of size distribution of landholdings, caste composition, availability of irrigation, rainfall, cropping pattern, size and composition of bovines, fodder availability, livestock feeding patterns, milk yield, income from different sources, income distribution and incidence of poverty.

The impact of watershed development on crop and livestock sectors is examined by analyzing the data pertaining to two villages (Rangareddy district), one where watershed programs are on-going since 1999 and the other from outside the program area. To obtain a broad perspective on agrarian structure and rural income distribution in dryland agriculture, the data from the six watersheds is combined. This analysis throws light on the situation of agriculture in drought-prone areas. The non-watershed village has the same agroclimatic factors as the watershed village. A sample of 60 households is selected randomly from each of these villages.

1.3 Scheme of presentation

The report is organized in six sections. Objectives, methodology and data sources are already discussed in section 1. Section 2 focuses on socioeconomic characteristics of the six watershed villages. In the

characterization of watersheds important variables like caste composition of the population, size distribution of landholdings, ownership of assets, per capita income and its sectoral composition and incidence of poverty are considered. Section 3 focuses on the livestock production systems and the linkages between crop and livestock sectors. Feed and fodder availability from the crop sector to the livestock sector and availability of animal power and organic manure from the livestock sector to the crop sector are analyzed in this section. Section 4 deals with the impact of watershed program on crop and livestock sectors using the data pertaining to the watershed village and the control village. The impact of watershed development is delineated by considering the differences between the watershed and control villages in the livestock production systems, cropping pattern and milk yield, household income and incidence of poverty. Section 5 focuses on the structure and problems of dryland agriculture. For this purpose, the data pertaining to the six villages are aggregated. Livestock production systems and income distribution are examined in this section. Section 6 deals with the indicators to be used for monitoring the crop and livestock development in the six villages during the period of implementation of the program.

2. Agro-economic Characteristics of the Watersheds

2.1 Introduction

This section focuses on the agro-economic features of the six villages. Since data on rainfall, irrigation, land use and livestock are not available at the village level, data pertaining to the respective mandals are analyzed. The sample forms about 25 to 30% of the universe for four villages and 4 to 5% for the remaining two villages (Table 2.1).

Table 2.1. Particulars of sample villages and sample size.

Village	Mandal	District	Households in the sample	Households in the village
Malleboinpally	Jadcherla	Mahabubnagar	60	230
Mentapally	Wanaparthy	Mahabubnagar	65	235
Thirumalapuram	Chintapally	Nalgonda	72	NA[1]
Kacharam	Yadagirigutta	Nalgonda	90	324
Nandavaram	Banaganapally	Kurnool	63	1234
Devanakonda	Devanakonda	Kurnool	70	1798

1. NA = Data not available.

2.2 Social and educational characteristics

Thirumalapuram of Nalgonda district and Mentapally of Mahabubnagar district have a high proportion of scheduled castes (SCs) and scheduled tribes (STs) (61.1% and 41.5%, respectively). Kacharam of Nalgonda and Malleboinpally of Mahabubnagar have a balanced distribution of castes. Of the two villages in Kurnool district Devanakonda has a high proportion of backward castes (78.6%) and Nandavaram has a high proportion of forward castes (Table 2.2).

Table 2.2. Percentage distribution of households by broad caste groups.

Village	SC & ST[1]	Backward castes	Other castes	Muslim
Malleboinpally	23.3	53.3	21.7	1.7
Mentapally	41.5	32.3	24.6	1.5
Thirumalapuram	61.1	4.2	34.7	0.0
Kacharam	23.3	47.8	25.6	3.3
Nanadavaram	1.6	41.3	50.8	6.4
Devanakonda	2.9	78.6	5.7	12.9

1. SC & ST= Scheduled castes and scheduled tribes.

The villages differ also in educational levels and these differences are rooted in the caste composition. Mentapally and Thirumalapuram have very low literacy rate (less than 50%), which may be due to the high proportion of SCs and STs in the population of these villages. A very small proportion of the heads of the households completed secondary education (Table 2.3). Malleboinpally and Kacharam, which have a balanced caste composition, have a high proportion of heads with low as well as high levels of education. Nandavaram and Devankonda, which have a high proportion of population belonging to forward and backward castes, have same educational levels with a high proportion of above primary level. The results indicate that the difference between backward castes and forward castes is thin in

Table 2.3. Percentage distribution of households by level of education of head.

Village	Illiterate	Literate but below primary	Below secondary	Secondary and above
Malleboinpally	50.0	6.7	16.7	26.7
Mentapally	61.5	15.4	9.2	13.9
Thirumalapuram	54.2	22.2	11.1	12.5
Kacharam	24.4	40.0	16.7	18.9
Nandavaram	36.5	7.9	30.2	25.4
Devanakonda	31.4	11.4	31.4	25.7

Table 2.4. Percentage of workers in total population.

Village	Major caste group	Work participation rate	Share of females in workers
Malleboinpally	All	62.7	47.2
Mentapally	SC & ST[1]	56.4	49.8
Thirumalapuram	SC & ST	59.1	46.6
Kacharam	All	66.2	44.4
Nandavaram	Other castes	67.0	42.9
Devanakonda	Backward castes	62.5	46.9

1. SC & ST = Scheduled castes and scheduled tribes.

terms of educational achievements, whereas the difference between SCs/STs and forward castes is very high. Between SCs and STs, the latter are more educationally backward.

Work participation rates vary significantly across the villages. Mentapally and Thirumalapuram have low work participation rate of less than 60% and Nandavaram and Kacharam have high work participation rate of about 67% (Table 2.4). Malleboinpally and Devanakonda have moderate rate (about 62.5%). The association between per capita income and work participation rate is also not strong, indicating that there is no backward bending supply curve of labor in these villages. Female work participation rates show lower variation than male rates. These rates are not strongly associated with caste composition, except in the case of the village with the dominance of forward castes where female work participation rate is lowest. However, this village also has the highest level of per capita income. Mentapally, Devanakonda and Malleboinpally, which have a low per capita income, have high female participation rate. Thus, the results indicate that female participation rates are more sensitive to income than male rates.

2.3 Agricultural characteristics

2.3.1 Fallow land and cropping intensity

One of the major features of dryland agriculture is a high proportion of fallow land. Several factors have been identified in research studies for keeping land under fallow. Information on fallow land is available for the mandals from which sample villages are selected. A low proportion of fallow land in geographical area and a high cropping intensity are indicators of highly efficient land use. The proportion of fallow land is high in the two mandals in Nalgonda district (60% and 43%) and low in

the two mandals in Kurnool district. Devanakonda mandal in this district has a negligible extent of fallow land. The two mandals in Mahabubnagar district also have a significant proportion (one-third) of land under fallow.

Cropping intensity is a good measure of efficiency in land use efficiency. It is measured in two ways. One method is to take the ratio of gross cropped area to net area sown. But this method ignores current fallow in the calculation of cropping intensity. While gross cropped area, the numerator of the ratio, takes into account land used more than once in a year, net area sown, the denominator of the ratio, ignores the agricultural land not used even once during the year. Hence this ratio will always be greater than unity and will reflect the current fallow. The second method is to use operated land, the sum of net area sown and current fallow, as the denominator of the ratio. This ratio can also be less than unity and is a good measure of cropping intensity. Both the ratios are computed to find out the land use efficiency in the mandals under study. The results indicate that the ranking of the mandals is reversed with change in the definition. When the ratio of gross area to net area is considered, Yadagirigutta in Nalgonda occupies the top position with highest cropping intensity. Banaganapally and Devanakonda mandals in Kurnool are lowered to the bottom position. But when the ratio of gross area to operated land is considered, the two mandals in Nalgonda district are lowered to the bottom position and the two mandals in Kurnool occupy the top position. The two mandals in Mahabubnagar district occupy middle position. It is significant to note that cropping intensity is as low as 21.6% in Yadagirigutta. The two mandals in Kurnool district have a cropping intensity of 79.4 and 92.0% (Table 2.5). The other three mandals have a cropping intensity of around 50%. Thus, the dryland agriculture suffers from a large extent of current fallow and a low extent of area sown more than once. A good measure of the success of watershed development is reduction in current fallow and increase in area sown more than once.

Table 2.5. Land use pattern in study area mandals.

Mandal	Forest[1] (%)	Current fallow[1] (%)	Total fallow[1] (%)	Net area sown[1] (%)	Cropping intensity (%) (Gross/net)	Cropping intensity (%) (Gross/operated)
Jadcherla	11.4	31.3	32.9	37.8	54.7	104.4
Wanaparthy	18.5	26.8	32.7	31.9	54.3	114.2
Chintapally	0.6	38.4	43.0	32.3	45.7	106.8
Yadagirigutta	–	56.1	59.6	15.5	21.6	117.1
Banaganapally	19.5	14.2	18.0	54.7	79.4	100.1
Devanakonda	6.6	5.0	5.0	58.0	92.0	103.9

1. Percentage of geographical area.

2.3.2 Rainfall and irrigation

Land use efficiency depends on rainfall and irrigation. Rainfall is low in the study area as compared to the state average. The normal rainfall in the study area ranges between 571 mm and 815 mm as against the state average of 940 mm. The two mandals in Mahabubnagar district and the two mandals in Kurnool district receive the same rainfall. Only Wanaparthy mandal in Mahabubnagar district has a slightly higher rainfall of 685 mm as compared to the other three mandals, whose rainfall lies in the narrow range of 612 mm and 630 mm. On the other hand, the two mandals in Nalgonda district differ significantly in the rainfall received. While Chintapally received the lowest rainfall of 571 mm, Yadagirigutta received the highest rainfall of 815 mm (Table 2.6).

Table 2.6. Rainfall in the study area mandals.

Mandal	Normal (mm)	Actual 2002–03 (mm)	Deviation (%)
Jadcherla	630	652	+3.5
Wanaparthy	685	675	−1.5
Chintapally	571	299	−47.6
Yadagirigutta	815	496	−39.1
Banaganapally	624	745	+19.4
Devanakonda	612	319	−47.9

Since the study was conducted for 2002–03, agricultural performance in this year may not reflect normal situation. To understand the agricultural situation in the year, the gap between actual and normal rainfall is examined. The two mandals of Mahabubnagar district (Jadcherla and Wanaparthy) received normal rainfall (Fig. 2.1). The two mandals of Nalgonda district (Chintapally and Yadagirigutta) and Devanakonda mandal of Kurnool district experienced severe drought with a shortfall of more than 40%. Banaganapally mandal of Kurnool district received 20% more rainfall than its normal level.

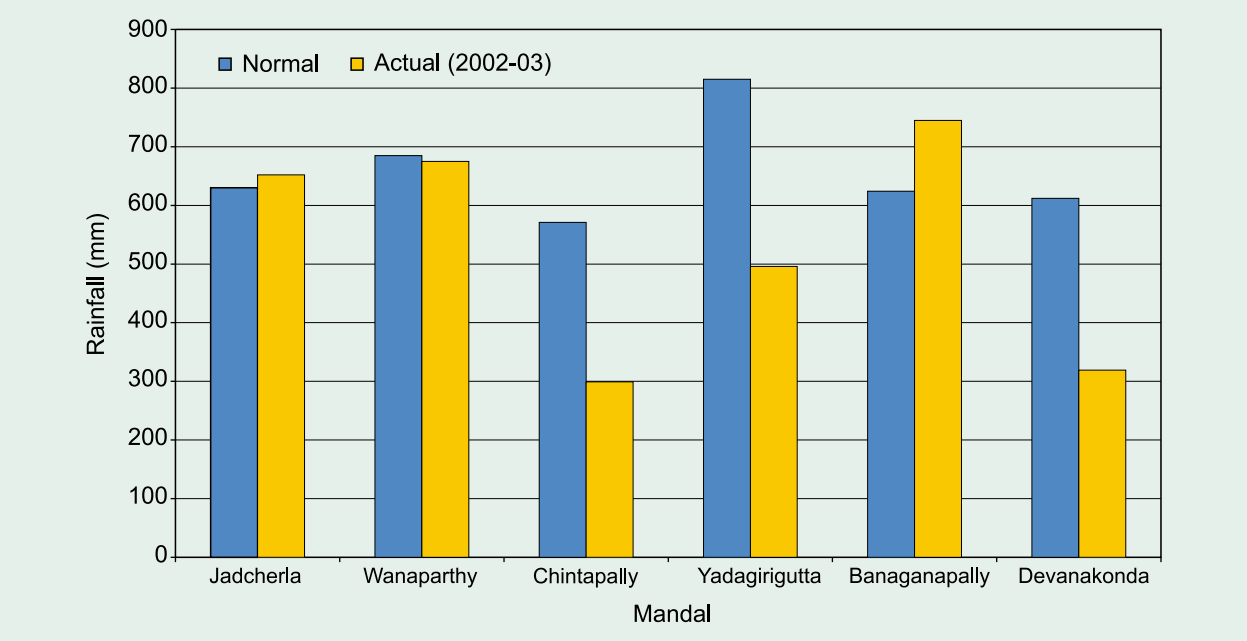

Figure 2.1. Annual rainfall in the study area mandals in Andhra Pradesh, India.

The villages differ significantly in irrigated area. Surface irrigation is absent in all the villages. Irrigation is available only through wells. Irrigation ratio is around 22% in the four villages of Mahabubnagar and Nalgonda districts while it is low in the two villages in Kurnool district (Table 2.7). However, the village with the lowest irrigation ratio received the highest amount of rainfall (745 mm) among the six villages.

Information from the villages also reveals that a large number of wells have become dry because of the poor recharge of groundwater. Low rainfall, absence of surface irrigation and high density of wells lead to low recharge of groundwater. Most of the open wells became dry because of the increase in tube wells. Two-thirds of the open wells in the three villages and all the open wells in the remaining

three became dry. Even the bore-wells are becoming dry and farmers are forced to deepen further. Nearly 60% of the tube wells became dry in Malleboinpally and Nandavaram and in the remaining four villages, 24 to 36% of the tube wells became dry (Table 2.7). Thus, the area suffers from low and fluctuating irrigated area and the watershed program is expected to provide adequate recharge for the wells. This is one of the indicators of success of the watershed program.

Table 2.7. Extent of irrigated area and status of wells in sample villages.

Village	Irrigation ratio (%)	Tube wells (No.)	Tube wells dried (%)	Open wells (No.)	Open wells dried (%)	Increase during 1990–2003 (%)	
						Tube wells	Open wells
Malleboinpally	23.7	62	56.4	35	77.1	55.0	–
Mentapally	22.3	74	32.4	110	98.1	131.3	144.4
Thirumalapuram	21.9	70	24.2	35	65.7	75.0	–
Kacharam	22.1	54	33.3	85	100.0	116.0	18.0
Nandavaram	3.9	24	58.3	60	100.0	60.0	80.0
Devanakonda	14.7	110	36.3	53	79.2	57.1	76.7

Source: Irrigation ratio is computed from sample data. Other variables are taken from Shiferaw et al. (2003).

2.3.3 Distribution of households by size of landholding

The sample villages differ significantly in size of landholding. The proportion of landless households is high at 32% only in Thirumalapuram. In all the other villages the proportion ranges between 5 and 14% (Table 2.8). Mentapally and Nandavaram have a very low proportion of about 5%. The remaining three villages have a moderate proportion of landless households (10 to 14%).

Table 2.8. Percentage distribution of sample households by size of operational holding.

Village	Landless households	Marginal and small farmers	Medium and large farmers
Malleboinpally	13.3	80.7	19.3
Mentapally	6.2	54.9	45.9
Thirumalapuram	31.9	59.2	40.8
Kacharam	14.4	58.4	41.6
Nandavaram	4.8	15.0	85.0
Devanakonda	10.0	41.2	58.8

Based on size of land holding, Malleboinpally has a very high proportion of marginal and small farmers (80.7%) (Fig. 2.2). Nandavaram has a very high proportion of medium and large farmers (85%) followed by Devanakonda (58.8%). In the remaining villages marginal and small holdings account for 55 to 59% of the total holdings (Table 2.8).

2.3.4 Cropping pattern

Paddy is not an important crop in any of the villages. Only Malleboinpally and Thirumalapuram have more than 10% of the cropped area under paddy (Table 2.9). Except in Devanakonda, all the other five villages have a high proportion of cropped area (30 to 40%) under pulses. Maize and other millets account for more than 20% in Malleboinpally, Mentapally and Kacharam. Devanakonda and

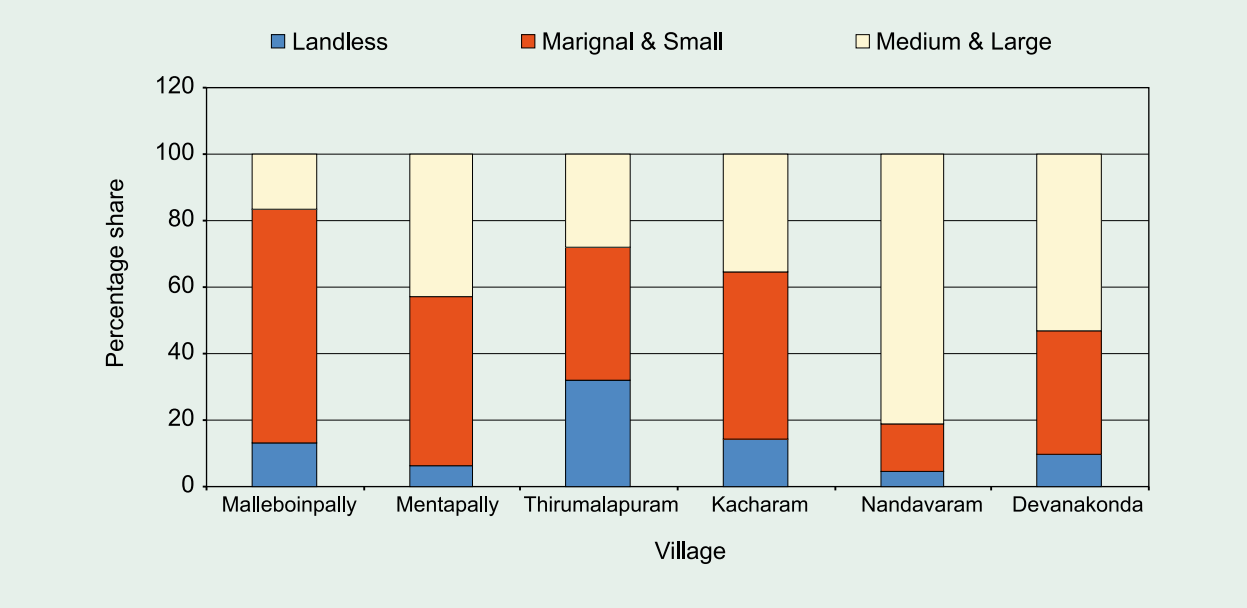

Figure 2.2. Distribution of sample households by size of operational holding.

Table 2.9. Percentage of area under food crops.

Village	Paddy	Maize	Other millets	Pulses	Food grains
Malleboinpally	11.9	13.8	27.3	28.9	81.9
Mentapally	8.5	7.3	15.5	36.4	67.7
Thirumalapuram	15.0	0.0	9.4	40.8	65.2
Kacharam	6.5	20.4	7.4	36.2	70.4
Nandavaram	3.3	0.3	11.1	38.9	53.6
Devanakonda	1.5	0.0	14.0	15.5	31.0

Nandavaram have a low proportion of area under food grains. Devanakonda has a high proportion of area under oilseeds and horticultural crops. Nandavaram has a high proportion of area under horticulture and cotton. All the remaining villages have a high proportion of area under oilseeds. As groundnut is the major crop among oilseeds, straw is for feeding the livestock. Fodder cultivation is generally not present in all the villages except Kacharam. In this village, only 2.5% of the area is under fodder crops (Table 2.10).

Table 2.10. Percentage of area under non-food crops.

Village	Oilseeds	Horticulture	Cotton	Fodder	Non-food
Malleboinpally	16.6	0.8	0.4	0.3	18.1
Mentapally	31.0	0.0	1.3	0.0	32.3
Thirumalapuram	27.3	6.6	0.0	0.9	34.8
Kacharam	18.9	1.0	7.1	2.5	29.6
Nandavaram	2.7	26.4	17.4	0.0	46.4
Devanakonda	47.8	17.1	4.2	0.0	69.0

2.3.5 Levels of living and poverty

The level of development is reflected in per capita income and incidence of poverty. Poverty line for the year 2002–03 is computed by updating the poverty line for rural Andhra Pradesh estimated by Deaton for the year 1999–2000 (Deaton 2001). Consumer price index for agricultural laborers is used for this adjustment. Poverty line is found to be Rs 4350 per capita per annum.

Per capita annual income is highest and incidence of poverty is lowest in Nandavaram (Rs 18547 and 6.3%, respectively). This highest position of Nandavaram is due to the large size of landholding. Incidence of poverty is higher (40%) in Malleboinpally than in Devanakonda (28.6%). Mentapally occupies the lowest position among the six villages in per capita income as well as incidence of poverty (Table 2.11).

Table 2.11. Per capita income and incidence of poverty across sample villages.

Village	Per capita annual income (Rs)	Head count poverty (%)	Poverty gap (%)	Squared poverty gap (%)
Malleboinpally	7848	40.0	11.1	4.9
Mentapally	5316	50.8	19.9	10.8
Thirumalapuram	11790	26.4	8.4	3.1
Kacharam	8220	20.0	5.8	2.3
Nandavaram	18547	6.3	1.5	0.4
Devanakonda	7509	28.6	7.2	2.6

2.3.6 Income from different sources

Household income is classified into crop, livestock and other income. The share of crop income is positively associated with the average size of landholding. Crop income accounts for a high share in Nandavaram and Devanakonda (68.9% and 51.4%, respectively) and a very low share (9.6%) in Malleboinpally. In the remaining villages the share of crop income is moderate around 25% (Table 2.12). Income from livestock forms a significant proportion in Kacharam and Malleboinpally (29.5% and 18.3%, respectively) but it is very low (less than 10%) in the remaining four villages. The share of non-farm income is not associated with the level of per capita income. The two villages with high per capita income have divergent shares of non-farm income. While the share of non-farm income is low at 25.48% in Nandavaram, the share is as high as 62.55% in the other rich village, Thirumalapuram (Table 2.12).

Table 2.12. Income from different sources.

Village	Average size of holding (ha)	Crop income (%)	Livestock income (%)	Non-farm income (%)	Household income (%)
Malleboinpally	1.52	9.60	18.32	72.09	100.0
Mentapally	2.62	22.50	7.02	70.48	100.0
Thirumalapuram	2.27	26.87	10.58	62.55	100.0
Kacharam	2.57	22.92	29.47	47.62	100.0
Nandavaram	7.27	68.90	5.61	25.48	100.0
Devanakonda	3.82	51.41	7.32	41.27	100.0

2.3.7 Inequality in the distribution of income and assets

Inequality in income and assets is measured with the help of Gini coefficient of concentration for the individual observations. The results indicate certain significant features. First, income distribution is less unequal than asset distribution. While inequality in income varies between 0.32 and 0.55, inequality in asset distribution varies between 0.35 and 0.79. Inequality in land is slightly less than that of total assets. Second, ownership of livestock is more unequal than ownership of land (Fig. 2.3). This is opposite to the general impression. This will not indicate higher inequality in income from livestock. Agriculture in these areas is carried out by animal power. The larger the size of landholding, the larger will be the number of work animals maintained. While inequality in livestock ranges between 0.56 and 0.72, inequality in land ranges between 0.37 and 0.73. Further, in five of the six villages inequality in livestock ownership is higher than the inequality in land. Third, there is a close positive association between inequality in income, assets, land and livestock ownership. Finally, Thirumalapuram has distinctly high inequality in income as well as assets across villages (Table 2.13).

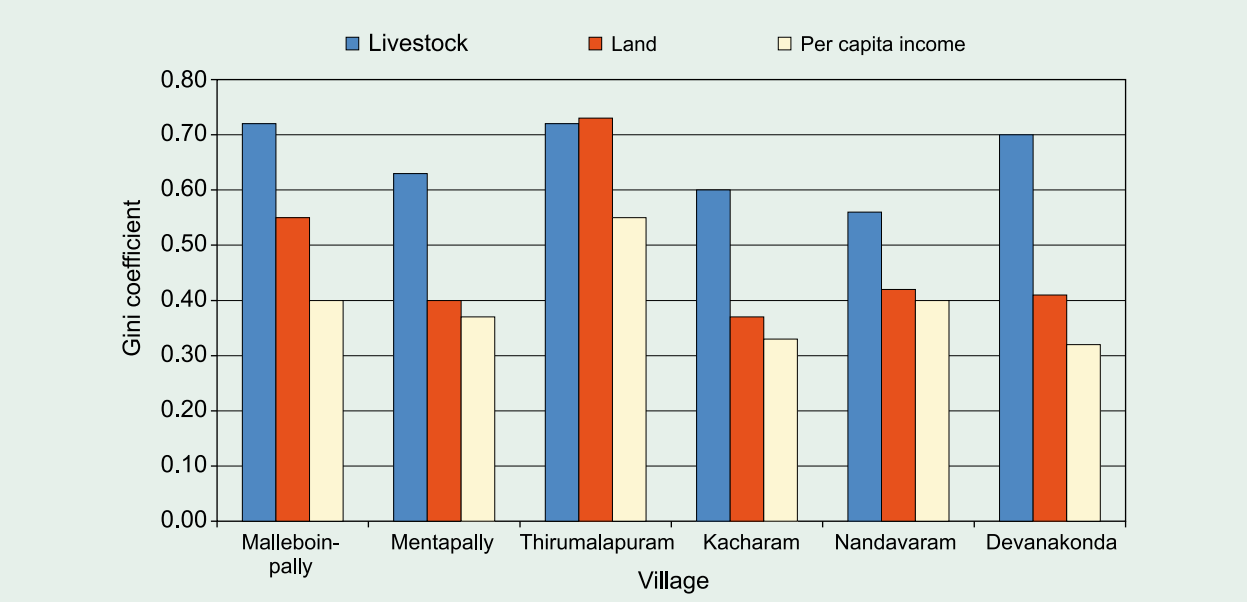

Figure 2.3. Gini coefficient of concentration of land and livestock.

Table 2.13 Gini coefficient of concentration of land, livestock and total assets.

Village	Per capita annual income	Per capita assets	Per capita land	Per capita livestock
Malleboinpally	0.40	0.43	0.55	0.72
Mentapally	0.37	0.35	0.40	0.63
Thirumalapuram	0.55	0.79	0.73	0.72
Kacharam	0.33	0.38	0.37	0.60
Nanadavaram	0.40	0.38	0.42	0.56
Devanakonda	0.32	0.41	0.41	0.70

2.4 Summary

The six villages selected for the study belong to three districts in Andhra Pradesh. The study is intended to provide a statistical base for the initial conditions in the watershed villages so that the impact of the program on crop and livestock sectors can be analyzed at a later stage.

The two villages from Mahabubnagar district have a high incidence of poverty. Mentapally is the most backward village with head count poverty of 50% and lowest per capita income. As the monsoon during the year of study was normal, the high incidence of poverty is chronic in nature. It has a high proportion of SCs and STs and a very low literacy rate. Though the village has a large number of open and tube wells, almost all the open wells and one-third of the tube wells became dry. Pulses, maize, other millets and oilseeds are the major crops. The high incidence of poverty is not due to 'landlessness' or high pressure of population on land. It is only due to backwardness in crop as well as livestock sectors. A high proportion of income is derived from non-farm activities. Improvement in the groundwater availability goes a long way in improving the income of the people. The second village in the district, Malleboinpally also has a high incidence of poverty, but average per capita income is not low. Sample villages with the same level of income have a much lower incidence of poverty. Though literacy rate is low, a significant proportion of heads of households completed secondary level of education. The high poverty in this village is also of chronic nature because the monsoon was normal. The high poverty is because of the predominance of marginal and small landholdings. Food grains, millets and pulses dominate the cropping pattern. The village has a low per capita income and a high incidence of poverty.

The two villages from Nalgonda district are more developed than the villages from Mahabubnagar district. Despite severe drought, the incidence of poverty was moderate at 26.4% and 20.0%. Between the two villages, Thirumalapuram has a higher incidence of poverty. The village has a very high proportion of SCs and STs. Literacy rate is low and the proportion of landless households is high. Pulses and oilseeds are the major crops in the village. This is an important factor for low incidence of poverty. The village has the highest inequality in assets and income. The other sample village in the district, Kacharam, has a balanced distribution of castes and a high literacy rate. Groundwater situation is very bad. As the wells have dried, farmers have installed bore wells. The village has a significant proportion of landless households. The low poverty in the village, despite the failure of monsoon, is due to high dependence of the people on livestock. While agriculture contributes 23% of the household income, livestock sector contributes as high as 30%. Pulses and maize are the important crops in the village. Oilseeds and cotton are also important.

The two villages from Kurnool district differ significantly in the incidence of poverty as well as levels of per capita income. Nandavaram has the highest per capita income among the six villages. The incidence of poverty is negligible in this village. This is partly due to favorable monsoon. Further, the average size of landholding is highest among the six villages. It is more than double than that of the other villages. It has a low proportion of SCs and STs and high educational levels. Cotton and horticulture are the important crops in this village. But irrigation ratio is very low at 3.9%. The favorable monsoon might have compensated for the low irrigation ratio. In such a case, incidence of poverty will be significant even in the normal years. The second village, Devanakonda, has low per capita income and high incidence of poverty. This high incidence is due to the failure of monsoon during the year. All other factors such as education and size of landholding are favorable.

3. Livestock Production Systems in the Watersheds

3.1 Introduction

The six watershed villages under study have been found to be distinct in terms of agro-economic characteristics. These differences are likely to have an impact on the livestock sector. Livestock systems can be broadly divided into small ruminant and bovine systems. Bovine systems differ in the types of bovines maintained. Given the data available, it is possible to classify the bovine systems into milk, work and mixed systems. If a household maintains only milch animals and meets the draft power requirements with hired animal power or tractor power, the system is designated as milk system. If a household maintains only draft animals, the system is designated as work system. If both milch animals and work animals are maintained, the system is designated as mixed system. There is another system in which only calf or dry animal is maintained. However, it is not considered here separately as there are very few households in this category. This section examines the livestock production systems existing in the six villages.

3.2 Size and composition of livestock

3.2.1 Participation in livestock sector

The sex and species composition and density of bovines vary significantly across the villages in the study area. An understanding of these features is important for interventions in the livestock sector. Since the data on these two features is also available at mandal level, we will first focus on the mandals to which sample villages belong. Density is calculated using geographical area. Bovines and small ruminants are aggregated into livestock units by treating five small ruminants as one bovine unit (Table 3.1).

Table 3.1. Density and composition of livestock population across mandals.

Mandal	Density per 100 ha of geographic area		Females per male	Livestock units	Cattle per buffalo	
	Bovine	Small ruminants			Female	Overall
Jadcherla	111.18	247	1.175	160.48	1.187	2.280
Wanaparthy	78.06	259	0.428	129.76	1.052	1.499
Chintapally	39.96	114	2.069	62.68	0.124	0.653
Yadagirigutta	31.02	103	1.399	51.62	2.907	5.279
Banaganapally	18.04	23	0.948	22.54	1.645	4.096
Devanakonda	23.99	26	1.829	29.19	0.568	1.038

Density of both bovines and small ruminants is very high in Jadcherla mandal in Mahabubnagar district at 1.11 and lowest in Banaganapally mandal in Kurnool district at 0.18 ha^{-1}. Wanaparthy mandal of Mahabubnagar district has the highest density of small ruminants at 2.59 ha^{-1} and Banaganapally mandal of Kurnool district has the lowest density at 0.23 ha^{-1}. Livestock density is high in Mahabubnagar district and low in Kurnool district.

Female bovines are maintained mainly for milk production, though they are sometimes used for draft purpose. Male bovines are maintained for traction or cart pulling. Male bovines are associated with agriculture and females are associated with dairy activity. If the ratio of female to male is more

than unity, the mandal is considered as specializing in milk production. Chintapally and Yadagirigutta in Nalgonda district, Devanakonda in Kurnool district and Jadcherla in Mahabubnagar district specialize in milk production. Chintapally and Devanakonda specialize in buffalo milk production, and Yadagirigutta specializes in cow milk production. Yadagirigutta and Banaganapally have high cattle to buffalo ratio of 4:1. The ratio is 3:4 in Wanaparthy and Jadcherla. In the remaining three mandals buffalo is more important than cow.

Participation in livestock sector at household level is measured in terms of the proportion of households maintaining bovines and small ruminants. A wide variation is observed in the proportion of households owning bovines not only between districts but also between villages in each district. Participation is high in Nandavaram and Thirumalapuram with more than two-thirds of the households maintaining bovines and low in Malleboinpally and Devanakonda with only about 50% of the households maintaining bovines. Kacharam and Mentapally have a moderate level of bovine activity with about 60% of the households maintaining bovines (Table 3.2).

Table 3.2. Percentage of households maintaining bovines in sample villages.

Village	Bovine households	Non-bovine households
Malleboinpally	51.7	48.3
Mentapally	58.5	41.5
Thirumalapuram	67.6	33.8
Kacharam	62.9	38.2
Nandavaram	71.4	28.6
Devanakonda	47.1	52.9

Participation of the households in small ruminant production is substantially lower than their participation in the bovine sector. However, the activity is significant in three of the six villages, viz, Thirumalapuram, Malleboinpally and Kacharam with 13 to 19% of the households maintaining small ruminants (Table 3.3). Further, maintenance rate is positively associated with size of landholding, indicating that the activity is biased towards resource-rich farmers.

Table 3.3. Percentage of households maintaining small ruminants.

Village	Marginal and small farmers	Medium and large farmers	All households
Malleboinpally	15.0	20.0	16.7
Mentapally	3.5	5.7	4.6
Thirumalapuram	22.2	21.9	19.4
Kacharam	13.6	14.3	13.3
Nandavaram	–	7.7	7.9
Devanakonda	3.7	5.6	4.3

3.2.2 Production systems

Kacharam specializes in milk production. There is no work system in the village. All bovine holdings produce milk either in milk system or in mixed system. Milk production is predominant in Thirumalapuram, Malleboinpally and Nandavaram with equal importance for milk and mixed systems. Devanakonda and Mentapally are backward in milk production with a high proportion of work animal holdings. The latter has very few holdings in milk system and milk production is taking place mostly in mixed system (Table 3.4).

Table 3.4. Percentage of households by production system.

Village	Milk	Mixed	Total milk	Work
Malleboinpally	54.8	32.3	87.1	12.9
Mentapally	10.5	44.7	55.2	44.7
Thirumalapuram	43.8	43.8	87.6	12.5
Kacharam	42.9	57.1	100.0	–
Nandavaram	17.8	57.8	75.6	24.4
Devanakonda	45.5	22.3	67.8	27.3

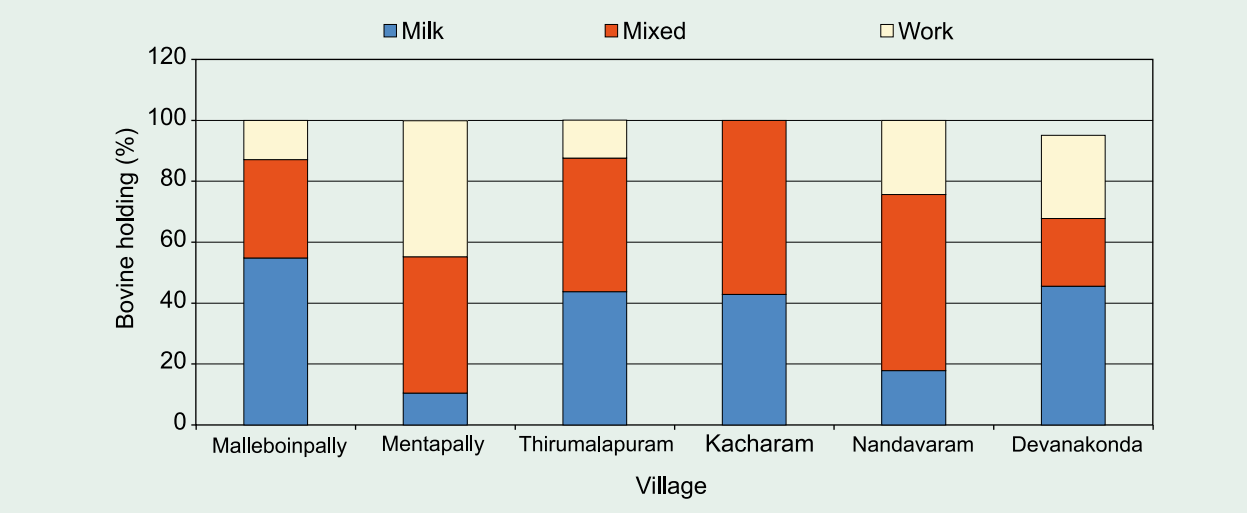

Figure 3.1 Percentage of bovine holdings by production system.

The size of bovine holding varies across villages (Fig. 3.1). These differences partly arise due to variations in production systems. The average size of bovine holding is high in villages with a large proportion of mixed system. On the other hand, the size of bovine holding is small in villages with a large proportion of work system. Kacharam, Thirumalapuram and Malleboinpally have a high herd size of more than 5.6 and the other three villages have a low herd size of less than four. Of these three villages with low herd size, one is in Mahabubnagar and the other two are in Kurnool district. Mixed system also has a low herd size in these three villages indicating that bovine maintenance is difficult in these villages (Table 3.5).

Table 3.5. Average number of bovines per holding.

Village	Milk	Mixed	Work	All
Malleboinpally	5.29	7.60	2.00	5.61
Mentapally	2.00	4.76	2.47	3.45
Thirumalapuram	3.38	9.14	2.17	5.71
Kacharam	3.38	7.84	–	5.84
Nandavaram	2.88	5.08	2.00	3.93
Devanakonda	3.47	5.33	2.00	3.58

The size of milch animals is higher in the mixed system than in milch system in all the villages. This is because mixed system is adopted by resource-rich farmers and feed and fodder is not a problem for them. Mentapally and Devanakonda have low milch animal population of less than two per household. Malleboinpally has a large herd size of four milch animals per household. Kacharam, Thirumalapuram and Nandavaram occupy a middle position with about two milch animals per household.

Buffalo is the dominant milch animal in all the villages. However, the ratio of cows to buffalo varies widely across the villages. Malleboinpally and Nandavaram specialize in buffalo milk production with only 12 to 14 cows per 100 buffaloes. On the other hand, Thirumalapuram has a significant proportion of cows (74 per 100 buffaloes) among milch animals. The remaining three villages, viz, Mentapally, Kacharam and Devanakonda have about 45 cows per 100 buffaloes (Table 3.6).

Table 3.6. Milch animals per holding and cow buffalo ratio.

	Milk		Mixed		All	
Village	Cows/100 buffaloes	Milch animals/ household	Cows/100 buffaloes	Milch animals/ household	Cows/100 buffaloes	Milch animals/ household
Malleboinpally	16	3.82	11	4.90	14	4.22
Mentapally	–	1.25	59	2.05	48	1.90
Thirumalapuram	161	1.85	47	3.29	74	2.57
Kacharam	15	2.17	68	3.57	47	2.97
Nandavaram	36	1.88	23	2.34	12	2.23
Devanakonda	29	2.07	60	1.78	38	1.97

3.2.3 Milk production and marketing

Since the price of buffalo milk is higher than that of cow milk, yield and production are expressed in terms of value computed with the help of local price of milk. Value of milk produced per animal is highest in Kacharam at about Rs 5600 followed by Devanakonda at Rs 4600 per annum (Table 3.7). Milk yield is lowest in Thirumalapuram and Mentapally villages at less than Rs 2400. Malleboinpally and Nandavaram occupy middle position with a yield of Rs 3000 per annum. Kacharam and Devanakonda have a significant proportion of cows among milch animals. These are crossbred cows with high milk yield. Buffaloes maintained in these villages are graded. The good performance of Malleboinpally and Nandavaram is due to buffaloes. The poor performance of Mentapally and Thirumalapuram is due to the predominance of low yield local cows. A comparison of milk yield in milk and mixed systems reveals that the former has relatively higher yield than the latter, except in Thirumalapuram and

Table 3.7. Value (Rs) of milk produced per animal and per household.

	Milk		Mixed		Overall	
Village	Per animal	Per household	Per animal	Per household	Per animal	Per household
Malleboinpally	3208	12265	2525	12372	2955	12305
Mentapally	4260	5325	1911	3935	2357	4199
Thirumalapuram	1650	3064	2380	7821	2015	5442
Kacharam	5866	12709	5432	19351	5608	16502
Nandavaram	2317	4344	2971	6970	2817	6353
Devanakonda	5110	10560	3547	6306	4596	9160

Nandavaram. The quality of animals is higher in mixed system as compared to the milk system in these two villages. The mixed system in Thirumalapuram has a larger proportion of cows than milk system indicating that some of these cows are crossbred. The superiority of the mixed system in Nandavaram is due to the existence of a larger proportion of buffaloes than in the milk system.

The ranking on total milk production per household is different from the ranking on yield. Malleboinpally occupies second position in total milk production though its rank is third in milk yield. Devanakonda goes down to the third position. This is due to larger herd size in Malleboinpally. A similar change in rank is observed between Mentapally and Thirumalapuram.

Differences in milk yield are reflected to some extent in the value of the animal. The value of cow ranges between Rs 2417 and Rs 7630 (Table 3.8). Kacharam has the highest value and Mentapally the lowest. The range of the value of buffalo is quite narrow between Rs 4795 and Rs 5400. There is not much difference in the value of draft animal across villages except Nandavaram, where the value is abnormally high at Rs 8613. The high value in this village is due to large average size of landholding.

Table 3.8. Average value (Rs) of animal.

		Milch animals	
Village	Draft animal	Cows	Buffaloes
Malleboinpally	3900	3400	5400
Mentapally	4520	2417	4795
Thirumalapuram	4904	3633	5050
Kacharam	5109	7630	5142
Nandavaram	8693	3000	5022
Devanakonda	5619	3125	5143

The distribution of cows by milk yield shows that a high proportion of cows belong to low yield category in all the villages except Kacharam where about two-thirds of the cows produce more than three liters of milk a day. It is to be noted that this village has a large number of cows (Table 3.9). In the case of buffaloes, only Devanakonda has a high proportion of animals with an average yield of more than 3 liters per day (Table 3.10). Kacharam and Malleboinpally have 20% of the buffaloes belonging to this category. Most of the buffaloes (more than 55%) in Malleboinpally, Nandavaram and Thirumalapuram produce about one to two liters a day. Mentapally and Kacharam have a concentration of buffaloes with two to three liters per day.

Table 3.9. Distribution of cows by level of milk yield[1].

Village	<1 L	1–2 L	2–3 L	>3 L	Total
Malleboinpally	3 (30.0)	4 (40.0)	3 (30.0)	0 (0.0)	10 (100.0)
Mentapally	3 (50.0)	3 (50.0)	0 (0.0)	0 (0.0)	6 (100.0)
Thirumalapuram	5 (31.3)	11 (68.7)	0 (0.0)	0 (0.0)	16 (100.0)
Kacharam	3 (5.9)	1 (2.0)	14 (27.5)	33 (64.7)	51 (100.0)
Nandavaram	0 (0.0)	6 (100.0)	0 (0.0)	0 (0.0)	6 (100.0)
Devanakonda	0 (0.0)	9 (75.0)	2 (16.7)	1 (8.3)	12 (100.0)

1. Percentage values are given in parenthesis.

Table 3.10. Distribution of buffaloes by level of milk yield[1].

Village	<1 L	1–2 L	2–3 L	>3 L	Total
Malleboinpally	0 (0.0)	50 (70.4)	5 (9.8)	16 (22.5)	71 (100.0)
Mentapally	1 (4.2)	3 (12.5)	17 (70.8)	3 (12.5)	24 (100.0)
Thirumalapuram	0 (0.0)	28 (56.0)	18 (36.0)	4 (8.0)	50 (100.0)
Kacharam	1 (1.0)	17 (16.7)	63 (61.2)	22 (21.4)	103 (100.0)
Nandavaram	0 (0.0)	43 (63.2)	23 (33.8)	2 (2.9)	68 (100.0)
Devanakonda	0 (0.0)	6 (20.7)	9 (31.0)	14 (48.3)	29 (100.0)

1. Percentage values are given in parenthesis.

Development of market is also an important contributory factor for the development of the dairy sector. Mentapally is highly backward in marketing with only 23.2% of the milk being disposed within the village. Malleboinpally is also backward in marketing despite its high performance in production (Table 3.11). Thus, the two villages in Mahabubnagar district are backward in marketing. If the sector is highly developed, marketing facilities will be developed automatically. But in the villages with backward agriculture, intervention in the infrastructure and development of market should go hand in hand with the development of production for the development of the sector.

Table 3.11. Quantity (%) of milk sold inside and outside the village.

Village	Inside village	Outside village
Malleboinpally	58.2	41.8
Mentapally	23.2	76.8
Thirumalapuram	92.0	8.0
Kacharam	100.0	–
Nandavaram	100.0	–
Devanakonda	100.0	–

3.3 Draft animal power in agriculture

In backward agriculture, bovines are maintained mainly for draft animal power and milk production is secondary. In some areas bovines are maintained for manure production. This is possible when grazing land is available in plenty where common grazing lands are declining. Development of dairy sector is dependent on mechanization of agriculture. A low proportion of farmers maintaining work animals and a low density of work animals is an indication of mechanization of agriculture. Nandavaram and Devanakonda have the lowest density of work animals at 49.4 per 100 ha (Table 3.12). On the other hand, Mentapally has the highest density of 113.7 animals per 100 ha. The remaining three villages have a density of about 71.7 to 76.6 work animals per 100 ha. The development of dairy is not related to the density of work animals. Though the need for animal draft is reduced through mechanization, there is no guarantee that dairy development takes place. Other conditions like availability of feed and fodder and demand for milk should also exist for the growth of dairy sector.

Table 3.12. Maintenance rate and density of draft animals.

Village	Farmers[1] maintaining draft animals (%)			Draft animals per 100 ha		
	Small	Large	All	Small	Large	All
Malleboinpally	17.1	53.9	25.9	66.7	79.1	74.1
Mentapally	31.0	71.4	53.1	113.7	116.1	113.7
Thirumalapuram	25.0	67.9	48.1	126.0	69.2	76.6
Kacharam	9.1	70.0	38.1	39.5	79.1	71.7
Nandavaram	11.1	70.6	61.7	44.5	49.4	49.4
Devanakonda	11.5	40.5	28.6	39.5	51.9	49.4

1. Small = Up to 2 ha; Large = More than 2 ha.

Studies show that small farmers maintain more work animals per ha than large farmers because of the indivisibilities involved in it. But when mechanization is introduced this pattern may disappear. The results show that, except in Mentapally and Thirumalapuram where more than 25% of the small farmers own work animals, a very small proportion own work animals and the density is also lower than on the large farms.

The use of farmyard manure (FYM) is also not much. It is as low as 0.41 t ha^{-1} in Mentapally and 6.45 t ha^{-1} in Nandavaram (Table 3.13). There is no market for FYM. The share of purchased manure is not more than 8% in any of the villages and there is no use of purchased FYM in two villages. The main reason for the absence of market is the high cost of transportation. A farmer generally uses own manure for which transport cost will be less.

Table 3.13. Use of farmyard manure (FYM) in agriculture.

Village	FYM (t ha^{-1})	Own (%)
Malleboinpally	1.02	100.0
Mentapally	0.41	100.0
Thirumalapuram	1.16	93.5
Kacharam	1.37	92.4
Nandavaram	0.65	95.0
Devanakonda	1.19	95.9

3.4 Feed availability and utilization

Information on feeding is rough and is not dependable because it is collected at one point of time for the entire herd. However, data on crop residues is available and it also provides an indication about feed and fodder situations. Feeding of concentrates is almost absent in Mentapally, Nandavaram and Thirumalapuram (Table 3.14). Less than 6% of the households feed the animals with concentrates. The

Table 3.14. Percentage of holdings feeding green fodder and concentrates.

Village	Green fodder	Concentrates
Malleboinpally	35.5	19.4
Mentapally	12.8	2.6
Thirumalapuram	8.2	6.1
Kacharam	96.5	61.4
Nandavaram	71.1	4.4
Devanakonda	85.3	67.7

use of green fodder is also not high in any of the villages except Nandavaram. On the basis of the feeding concentrates, Kacharam and Devanakonda are highly developed, Nandavaram and Malleboinpally are moderately developed and Thirumalapuram and Mentapally are highly backward.

The quantity of feed per animal is calculated by converting all the animals into adult units treating young stock as 0.5 adult. All feeds are converted into dry matter by taking 0.25 of green fodder and 0.9 of dry fodder as well as concentrates as dry matter. Information available reflects only stall-feeding as data on feeding through grazing is not available. The feeding levels are high in Kacharam and Nandavaram (Table 3.15). The average quantity of dry fodder fed per adult animal is more than 2.5 kg day^{-1}. In Malleboinpally, Mentapally and Thirumalapuram the quantity of dry fodder as well as concentrates fed is low.

Table 3.15. Quantity (kg day^{-1}) of feeds fed per adult unit.

Village	Dry fodder	Green fodder	Concentrates	Dry matter
Malleboinpally	1.14	0.51	0.18	1.32
Mentapally	2.09	0.04	0.13	2.01
Thirumalapuram	1.76	0.34	0.02	1.69
Kacharam	2.52	0.96	0.35	2.83
Nandavaram	3.96	0.01	0.36	3.89
Devanakonda	2.00	1.48	0.42	2.54

The distribution of bovine holdings according to the quantity fed per adult animal indicates the proportion of households facing feed scarcity. In the three backward villages, only 10% of the households are able to feed their bovines with more than 4 kg day^{-1} and 50 to 74% of the households feed less than 2 kg day^{-1}. In the developed villages 25 to 38% of the households feed more than 4 kg day^{-1}. However, there is a significant proportion of households (18 to 35%) with feeding levels less than 2 kg day^{-1} (Table 3.16).

Table 3.16. Percentage distribution of holdings by dry matter fed per day.

Village	<2 kg	2–4 kg	≥4 kg	Total
Malleboinpally	74.2	16.1	9.7	100.00
Mentapally	48.7	41.0	10.3	100.00
Thirumalapuram	59.2	30.6	10.2	100.00
Kacharam	31.6	43.9	24.6	100.00
Nandavaram	17.8	44.4	37.8	100.00
Devanakonda	35.2	32.4	32.4	100.00

The low levels of feeding may be due to low production of crop residues per ha or due to high density of bovines per ha. Cropping pattern has a significant impact on the availability of crop residues since straw is available only from certain crops and straw yield also varies significantly across crops. Availability of straw per ha of operated area does not vary much. It is about 0.67 t ha^{-1} in Mentapally, Thirumalapuram and Devanakonda (Table 3.17). But the availability per adult animal varies significantly across these three villages. These differences are due to differences in density of animals per ha of operated area. Nandavaram has the lowest availability of 0.48 t ha^{-1} of operated land, but high availability of 1.01 t per adult bovine. Low availability per ha is due to absence of cereal crops especially paddy and high availability per animal is due to low density of bovines per ha of cropped land. Kacharam has favorable conditions in terms of cropping pattern as well as bovine density. As paddy is not suitable for these areas due to scarcity of water, there is a need to reduce the density of

Table 3.17. Crop residues (t) available per hectare and per adult bovine.

Village	Per hectare of operated land	Per adult bovine
Malleboinpally	0.92	0.42
Mentapally	0.66	0.71
Thirumalapuram	0.68	0.50
Kacharam	1.15	0.74
Nandavaram	0.48	1.01
Devanakonda	0.68	1.30

bovines in these areas. For instance, Malleboinpally has a high availability of residues at 0.92 t ha^{-1}, but the availability per animal turned out to be the lowest among the six villages.

3.5 Summary

Among the six mandals in the study area, the two mandals in Mahabubnagar district have high density of both bovines and small ruminants and the two mandals in Kurnool district have the lowest density. While buffalo is important in Chintapally and Devanakonda mandals, cow is important in the remaining four mandals.

A very high proportion of households maintain only milch animals in four of the six sample villages, viz, Malleboinpally, Devanakonda, Thirumalapuram and Kacharam. However, Kacharam stands at the top in dairy sector with all the bovine holdings undertaking milk production. In other words there are no work animal holdings.

The ratio of cow to buffalo is high in Thirumalapuram and low in Malleboinpally and Nandavaram. The remaining three villages, viz, Mentapally, Kacharam and Devanakonda occupy a middle position with forty to fifty cows per hundred buffaloes. The value of milk produced per household is exceptionally high in Kacharam followed by Malleboinpally and Devanakonda. The value of milk produced per household is more than Rs 9000 in these three villages. Mentapally occupies bottom position in milk production per household. The value of milk produced per animal is also higher in these three villages as compared to the other villages. Kacharam occupies top position even in milk yield. However, Malleboinpally is far behind Devanakonda in this respect. The distribution of cows by milk yield indicates that about two-thirds of the cows in Kacharam produce more than three liters per day. In all the other villages milk yield of cows is less than two liters per day. Similarly Devanakonda has a very high proportion (about 50%) of buffaloes with yield more than three liters per day. However, Malleboinpally and Kacharam also have a significant proportion of high-yielding buffaloes.

Density of work animals and milk production are inversely related. Mentapally, which occupies bottom position in milk production, has highest density of draft animals. The density of draft animals is lower on small farms as compared to large farms in the villages with high milk production.

Feeding of concentrates is prevalent in the two intensive dairy villages (Kacharam and Devanakonda) and negligible in Mentapally, Thirumalapuram and Nandavaram. Malleboinpally also has a significant proportion of households with no concentrate feeding. The quantity of dry matter fed per animal is not related to the development of dairy activity because of the high dependence of the households on grazing. The quantities provided in stall-feeding are positively related to the density of bovines. Because of the low density, the availability of crop residues per animal is high in Nandavaram and Devanakonda. Malleboinpally and Thirumalapuram appear to be facing severe shortage of feed and fodder as more than 60% of the households feed less than 2 kg of dry matter per animal per day.

4. Impact of Watershed Program on Crop-Livestock System

4.1 Introduction

The watershed program focuses on soil and water conservation and is expected to improve crop yields and green fodder availability. This, in turn, is likely to have an impact on milk production. To understand the impact of the program, we adopted with and without approach and analyzed the data relating to a village that has been covered under watershed program since 1999 and a nearby village with the same agroclimatic conditions and not covered under the watershed program. The sample for each of the two categories consists of 60 households. The questionnaire canvassed for the baseline survey of the watershed villages is also used for these two areas. The socioeconomic features of the two villages are compared considering caste, education and work participation rate. Then the performance of agriculture is examined to understand the impact of the watershed program on agriculture. Finally, the impact of the program on the performance of the livestock sector is considered.

4.2 Socioeconomic features

First, the socioeconomic features of the two villages are compared considering caste, education and work participation rate. The watershed village is socially more advanced than the control village (Fig. 4.1). The proportion of SCs and STs is lower and the levels of education are higher (Table 4.1).

Table 4.1. Socioeconomic characteristics of the two sample villages.

Item	Watershed village	Control village
Scheduled caste/scheduled tribe population (%)	18.3	31.7
Backward caste population (%)	56.7	51.7
Forward caste/Muslim population (%)	25.0	16.7
Illiterate heads (%)	51.7	63.3
Heads with below primary level education (%)	15.0	15.0
Heads with below secondary level education (%)	16.6	13.3
Heads with secondary level and above education (%)	16.7	8.3
Work participation rate (%)	62.8	59.6
Share of females in total workers (%)	45.9	45.7

While only 18.3% of the households belong to SC/ST in the watershed village, the corresponding proportion in the control village is as high as 31.7%. Similarly, while 16.7% of the heads of households possess secondary and above level of education in the watershed village, only 8.3% possess this level of education in the control village. No significant differences are noticed between the two villages in work participation rate.

4.3 Land and water resources

As the two areas are geographically close to each other, there in no significant difference in rainfall. But differences are observed in irrigation, land distribution and cropping pattern. The watershed village has less irrigation than the control village indicating that the former is likely to be more backward than the latter. But the pressure of population on land is less in the watershed village as compared to the control. This can be seen from the fact that households with less than 2 ha of land account for 50% of the total households as compared to 61.7% in the control village (Table 4.2). The

availability of cultivated land (net area) per capita is 0.337 ha in the watershed village as compared to 0.241 ha in the control village.

Table 4.2. Land characteristics of the two villages.

Item	Watershed village	Control village
Irrigated area (%)	18.0	25.0
Current fallow (%)	27.9	28.2
Landless households (%)	5.0	8.3
Marginal/Small households[1] (%)	50.0	61.7
Medium/Large households (%)	45.0	30.0

1. Less than 2 ha.

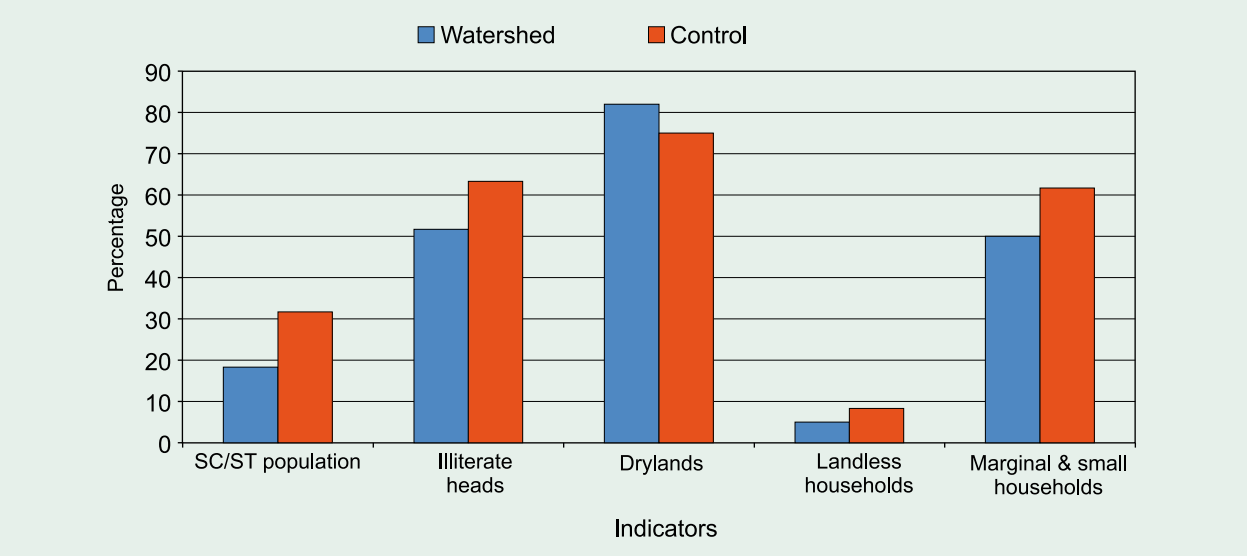

Figure 4.1. Socioeconomic characteristics of two sample villages.

4.4 Cropping pattern and crop yields

The villages differ in the cropping pattern. The watershed village has a higher proportion of area under food grains as compared to the control village and this is due to higher allocation for maize. While 71.3% of the gross cropped area is under food grains in the watershed village, it is only 61.5% in the control village (Table 4.3). This has an implication on the availability of straw for feeding the livestock. As shown in the later discussion, the watershed village has greater availability of dry fodder. Paddy accounts only for about 5.5% in both the villages. Among the non-food crops, cotton is important in the watershed village and horticulture in the control village. Perhaps the improvement in the soil moisture may have led to cultivation of high-valued crops like maize and cotton in place of horticulture.

Table 4.3. Cropping pattern and crop yields in the two villages.

Crop	Crop area (%)		Crop yield (kg ha^{-1})	
	Watershed village	Control village	Watershed village	Control village
Food grains	71.3	61.5	–	–
Paddy	5.5	5.4	5541	5515
Maize	23.5	15.9	1983	1498
Other millets	14.2	13.1	501	487
Pulses	28.0	27.1	292	135
Non-food crops	28.8	38.5	–	–
Oilseeds and spices	6.3	6.3	–	–
Horticulture	8.4	26.8	–	–
Cotton	14.1	5.3	1060	874
Gross cropped area	100.0	100.0	–	–

The soil and water conservation measures taken in the watershed program have increased crop yields. The year of study witnessed severe drought in the study area with a steep decline in the rainfall. The watershed village is not exposed to drought so much as the control village. The yields of all the crops, barring paddy and minor millets, are significantly higher in the watershed villages than in the control village. For instance, yield of pulses is 292 kg in the watershed village as compared to 135 kg in the control village (Table 4.3). Yields of maize and cotton are higher by 32.4% and 21.3%, respectively in the watershed village as compared to the control village.

4.5 Per capita income and composition

Levels of per capita income as well as the contribution of different sectors to income differ significantly between the two villages. Per capita income is higher in the watershed village by 61% as compared to the control village (Rs 5570 in the watershed village and Rs 3469 in the control village) (Table 4.4). This increase in income is due to crop and livestock sectors. Non-farm income is similar in both the villages. The share of crop income increased from 18% in the control village to 40% in the watershed village and that of non-farm income declined from 70% to 46% (Fig. 4.2). It is not proper to attribute all the difference in the income to the watershed program as the per capita availability of land is higher

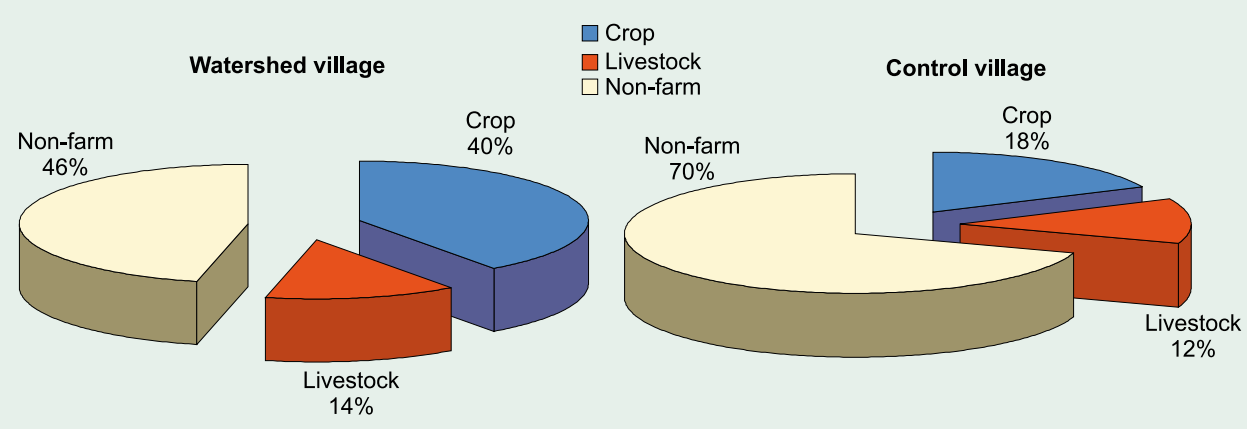

Figure 4.2. Share of different sources in total income.

Table 4.4. Per capita annual income, incidence of poverty and Gini coefficient in the two villages.

Source	Watershed village	Control village
Per capita annual income (Rs)	5570	3469
Crop income (Rs)	2227 (1485)[1]	624
Livestock income (Rs)	760	423
Non-farm income (Rs)	2583	2421
Head count poverty (%)	57.7	79.2
Poverty gap (%)	45.2	55.0
Squared poverty gap ((%)	24.9	38.1
Gini coefficient of income	0.48	0.45

1. Figure in parenthesis is the standardized crop income.

in the watershed village as compared to the control village. In order to obtain a more appropriate estimate of the contribution of the watershed program on per capita income, agricultural income is corrected for the difference in per capita availability of land. Even after this correction, improvement in per capita income is found to be 39.2%. However, the increase may be less in the years of normal rainfall. Income from livestock sector also improved significantly as a result of the watershed program. Per capita income from the livestock sector improved by 79.7% and its share in total income increased from 12.2% in the control village to 15.7% in the watershed village.

4.6 Size and composition of livestock

The watershed village differs significantly from the control village in the size, composition and productivity of livestock. Firstly, bovine activity is higher in the watershed village indicating that improvement in soil and moisture conditions leads to development of the livestock sector. This is because of the improvement in the availability of green fodder after implementing the soil and moisture conservation measures undertaken as a part of the program. The proportion of households maintaining bovines increased from 60% in the control village to 68.3% in the watershed village (Table 4.5). Secondly, there is a shift from small ruminants to bovine activity. Studies show that small ruminant activity is confined to resource-poor areas (Hanumantha Rao 1994). The shift from small ruminant to bovine activity in the watershed village indicates improvement in the resource base of the village due to the watershed program. The proportion of households maintaining small ruminants declined from 30.9% to 26.3% and this shift came because of the shift of small farmers from small ruminants to bovine sector. It is to be noted that though small ruminant production is more in resource-poor areas, it is not high among resource-poor farmers. While 38.9% of the medium and large farmers maintain small ruminants, only 24.3% of the marginal and small farmers maintain them. This is because of the need of fallow land for rearing small ruminants. Large farmers own a large extent of fallow land and this land facilitates them to maintain small ruminants. Thirdly, bovines are maintained for carrying on agricultural activities and also for milk production. Based on the types of animals maintained, the livestock holdings can be classified into three broad categories, viz, milch animal holdings, work animal holdings and mixed holdings. The production system changes from work to milk with improvement in the agricultural sector. In the initial stages when mechanization is not developed, mixed system will also be developed. The proportion of milch holdings increased from 22.2% to 39.0% and the proportion of work holdings declined from 47.2% to 22.0%. The share of mixed holdings also increased from 30.6% to 39.0%. As a result of these shifts, the proportion of bovine holdings producing milk increased steeply from 52.8% to 78.0%. Fourthly, the improvement

Table 4.5. Livestock characteristics of the two villages.

Item	Watershed village	Control village
Percentage of households maintaining bovines		
Bovine	68.3	60.0
Non-bovine	31.7	40.0
Percentage of holdings maintaining small ruminants		
Small and marginal (≤2 ha)	16.7	24.3
Medium and large (>2 ha)	37.0	38.9
All	26.3	30.9
Percentage of households by production system		
Pure milch	39.0	22.2
Pure work	22.0	47.2
Mixed	39.0	30.6
Total	100.0	100.0
Average number of bovines per holding		
Pure milch	2.1	2.3
Pure work	1.7	1.9
Mixed	4.3	4.1
Overall	2.0	1.6

in the bovine sector comes through productivity improvement and not through increase in the size of the herd. However, a shift towards mixed system increases the size of the bovine holding. The average size of the bovine holding is 1.6 in the control village and 2.0 in the watershed village. This higher size is only due to a slightly higher herd size in the mixed holdings and a higher proportion of mixed holdings in the watershed village as compared to the control village. Though the size of the total herd is higher in the watershed village as compared to the control village, the number of milch animals per holding is lower (1.37 in the watershed village as compared to 1.44 in the control village).

4.7 Maintenance of work animals

Dryland agriculture requires draft animal power as tractors are not suitable for intercultivation, an essential operation for dry crops. When agriculture depends mainly on animal power and fodder is scarce, milk production becomes secondary. As fodder availability improves, milk production becomes equally important and farmers manage the work animal needs with hire services of work animals. Studies show that small and marginal farmers have a higher density of work animals because of the indivisibility problem (Vaidyanadhan 1978). It is also found that the proportion of small farmers maintaining work animals is also low (Subrahmanyam and Nageswara Rao 1995). The data for the watershed and control villages indicate that the density of work animals is higher among small farmers as compared to large farmers. But with improvement in fodder availability in the watershed village, small farmers reduced their draft animal power and shifted to milk production. The density of draft animals is 99.6 per 100 ha on small and marginal farms and 40.3 per 100 ha on medium and large holdings in the control village. The density on small farms declined significantly to 49.7 per 100 ha whereas it remained constant around 40.3 per 100 ha on the medium and large farms in the watershed village (Table 4.6). The density of draft animals in all holdings declined from 61.5 in the control village to 43.5 per 100 ha of net area sown in the watershed village. It is also significant to note that the proportion of small farmers maintaining work animals also declined steeply from 28.16% in

Table 4.6. Maintenance rate and density of draft animals.

Farmers category	Percentage of farmers maintaining draft animals		Draft animals per 100 ha	
	Watershed village	Control village	Watershed village	Control village
Small	16.1	28.6	49.7	99.6
Large	29.6	20.4	41.3	40.3
All	46.4	50.0	43.5	61.5

the control village to 16.1% in the watershed village. The results indicate that as the potential for milk production increased under the watershed program, marginal and small farmers substituted animal power with mechanical power. Another significant result is that though the density of work animals remained the same, the maintenance rate is higher in the watershed village than in the control village. Small farmers are able to manage with hired animal power but the large farmers have to maintain own animal power, though it may be possible to reduce the number.

4.8 Milk production

The improvement in the green fodder availability in the watershed village improved milk production and this improvement came through spread of the activity and improvement in milk yield. There is no increase in the number of milch animals per household. In fact, the number of milch animals per household declined from 1.44 to 1.37. But the value of milk output per household increased by 14.7% from Rs 7630 to Rs 8750 and the proportion of households producing milk increased from 52.8 to 78.0% (Table 4.7). This increase in production per household, despite decline in the number of animals per household, is contributed by the improvement in yield per animal by 24.7% from 550 liters to 686 liters. Further, the entire improvement in the yield took place in the milk system. The mixed system has not gained in milk production because its priority is for animal power for agricultural operations and milk production is secondary. Thus, a shift in the production system from mixed to milk is an indication of improvement in income from dairying. The improvement in milk yield in the milch system may be either due to higher levels of feeding or due to higher quality of milch animals. The results on feed availability discussed later reveal that the feeding of green fodder is higher in the watershed village than in the control village.

Table 4.7. Quantity and value of annual milk production.

Production system	Number of animals		Milk yield (L)		Milk output value (Rs)	
	Watershed village	Control village	Watershed village	Control village	Watershed village	Control village
Milch	1.58	1.75	809	513	10982	7950
Mixed	1.20	1.22	556	596	6670	7280
All	1.37	1.44	686	550	8750	7630

The average value of the milch and work animals in the two villages reveals that the quality of animals has not increased in the watershed village. In fact, the value is higher for all the categories of animals in the control village as compared to the watershed village. However, the gap in the value of milch animals is only 4.4% (Table 4.8).

Table 4.8. Average value of milch animals.

Animal type	Watershed village (Rs)	Control village (Rs)	Value gap (%)
Draft animal	4640	5716	23.2
Cow	3000	3133	4.4
She-buffalo	5096	5320	4.4

Manure is one of the benefits of bovine maintenance. It is already mentioned that a higher proportion of households maintain bovines and the herd size is also larger in the watershed village than in the control. This change is expected to increase the availability and use of manure. But the results indicate that the use of manure in the watershed village (0.35 t ha^{-1}) is only half of the quantity used in the control village (0.69 t ha^{-1}). It is possible that the increase in the dairy activity may reduce the collection of dung as milch animals are generally maintained at home and dung may be diverted for other uses like fuel, for cleaning the house, etc.

4.9 Fodder availability and feeding levels

Crop residues, an important component in the livestock feed, are available from food grain crops and groundnut. The yield of crop residues is expected to increase with increase in the crop yield and shift in cropping pattern. Cropping pattern is more favorable to livestock feed in the watershed village as compared to the control village. The share of food grains is higher in the watershed village than in the control village and this is due to a larger extent of area under maize. The availability of crop residues per ha of cultivated land as well as per adult bovine unit in the watershed village is twice that of the control village both due to shift in cropping pattern towards food grains and higher crop yields (Fig. 4.3).

Because of the higher levels of fodder availability in the watershed village as compared to the control village, feeding levels are also found to be high. While the proportion of farmers feeding concentrates and green fodder is almost the same in both the villages, the quantities fed per animal differ significantly.

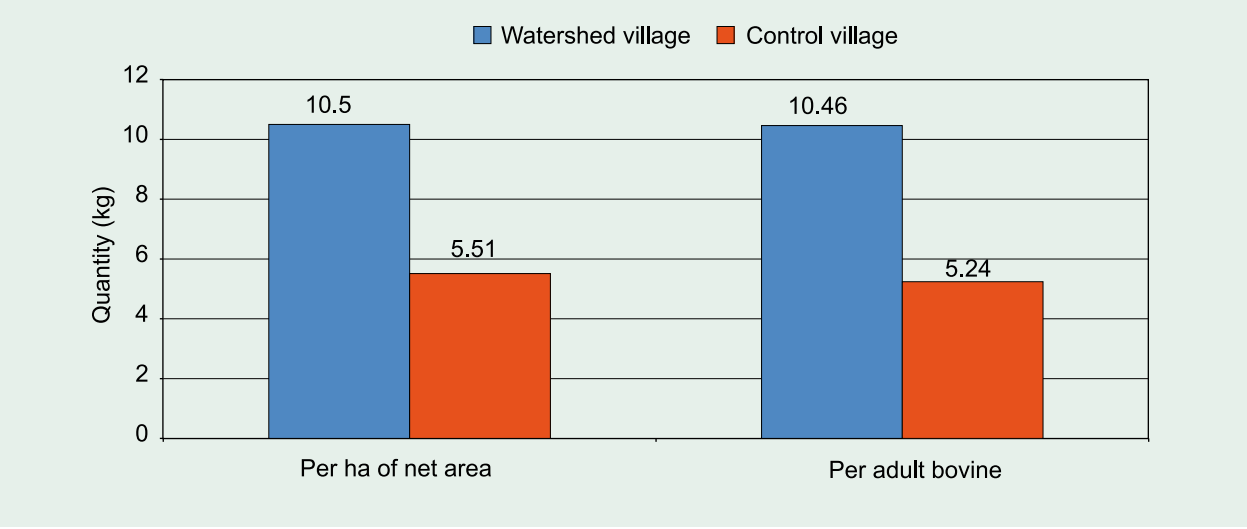

Figure 4.3. Availability of crop residues in the two villages.

About 14.6% holdings in the watershed village and 11.1% holdings in the control village feed green fodder. About 19% holdings feed concentrates in both the villages.

There is a steep increase in the quantity of greens fed and decline in the quantity of concentrates. With significant improvement in the availability of green fodder in the watershed village, farmers substitute concentrates for green fodder. The level of feeding dry matter is higher by 75% in the watershed village than in the control village (Fig. 4.4). The improvement in the feeding of dry fodder is only 35%. Thus, feeding levels improved through mostly green fodder and a little bit of dry fodder. These two types of feeds more than compensated the decline in the feeding of concentrates. It should be noted that farmers always try to manage with home-grown feeds rather than purchased feeds. The watershed program is expected to reduce the demand for concentrates because of the higher availability of green fodder. As the quality of animals improves, the demand for concentrates will again increase.

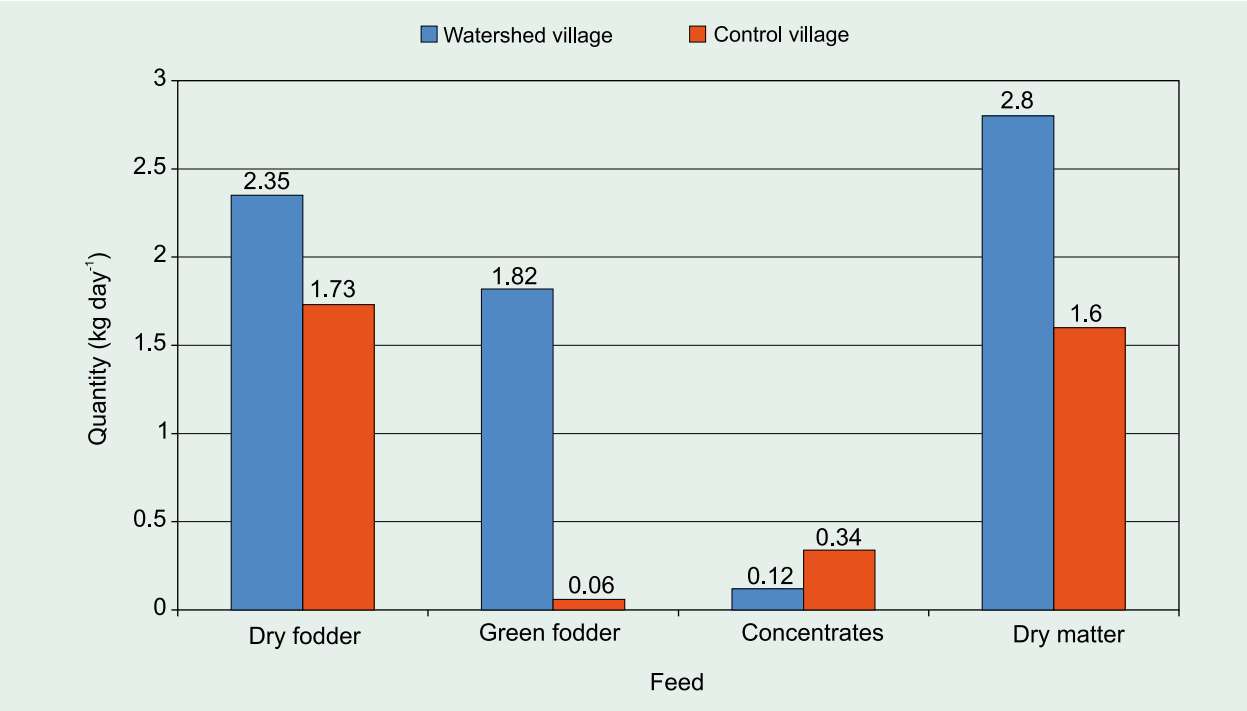

Figure 4.4. Quantity of feeds fed per adult unit.

4.10 Summary

As compared to the control village, watershed village has a lower proportion of SCs and STs and higher levels of education, more land resources but lower irrigation ratio. Dry fodder availability is more because of the higher share of food grains as compared to the control area. The village is more developed agriculturally than the control village because of higher crop yields and higher per capita income.

The bovine sector is more advanced in the watershed village than in the control village. The proportion of households maintaining bovines is higher and there is a shift from small ruminants to bovine

activity. The bovine production system is shifted from work to milk. Though the number of animals per household has not increased, productivity improvement has led to increase in milk production. Marginal and small farmers substituted animal power with mechanical power. The value of milk output per household increased by 14.7%, the number of households producing milk increased from 52.8 to 78.0%. The entire improvement in the yield took place in the milk system. The increase in milk production is due to better feeding rather than higher quality of animals. The improvement in the dairy activity appears to have reduced collection of dung as milch animals are generally maintained at home and dung may be diverted for other uses like making dung cakes for fuel or for cleaning the house.

Feeding levels are higher in the watershed village as compared to the control village. While the proportion of farmers feeding concentrates and green fodder is almost the same in both the villages, the quantities fed per animal are higher in the watershed village as compared to the control village. There is a steep increase in the quantity of greens fed and decline in the quantity of concentrate feeding. With significant improvement in the availability of green fodder in the watershed village, farmers substitute concentrates for green fodder.

5. Livestock Development in Dryland Agriculture

5.1 Introduction

Agricultural development has to focus on dryland areas because of the low productivity and high poverty in these areas. A large extent of land in these areas is kept idle. Because of this availability of land, livestock sector has a great potential. However, interventions are needed in input and output markets to realize this potential. Development cannot be left to the market forces as in the irrigated areas because both input and output markets are backward. An understanding of the type of land and livestock resources available across farm size is essential to identify the needed interventions. This section focuses on land use, crop productivity, size and composition of livestock and milk production across farm size.

5.2 Agriculture, rural income and poverty

Distribution of land is highly inequitable in dryland areas. Agriculture is highly uncertain because of poor irrigation facilities coupled with low rainfall. Average size of the land per household is high at 18.78 ha, but only 9.4% of it has irrigation facilities. The distribution of land is so unequal that 50% of the households own less than 16% of the total land and top 25% own 63.9%. Though distribution of land is highly skewed, irrigation is more favorable to small holdings than to the large holdings. Irrigation ratio is very high at 45.6% on marginal holdings and very low at 2% on very large holdings (Table 5.1).

Table 5.1. Distribution of households and area by farm size.

	Holdings		Area		Irrigated area
Farm size (ha)	Number	Share (%)	Extent (ha)	Share (%)	(%)
Landless	43	10.2	–	–	–
Up to 1.00	55	13.1	34.76	2.7	45.6
1.01 to 2.00	118	28.1	169.39	13.1	20.1
2.01 to 4.00	98	23.3	263.40	20.4	10.7
4.01 to 10.00	81	19.3	458.83	35.5	5.1
Above 10.00	25	6.0	366.73	28.4	2.0
All	420	100.0	1293.10	100.0	9.4

It is argued that a significant extent of land in dryland areas is fallow. The estimates based on agricultural census indicate that fallow land accounts for more than one-third of the geographical area in Andhra Pradesh. The proportion will be still higher if it is expressed as a proportion of operated area. The results of our study indicate that the extent of fallow land is exaggerated. Only 12.8% of the operational land is fallow. The relation between farm size and the extent of fallow land is of inverted U shape. The proportion of fallow land is highest among the marginal farmers at 22.1% and it falls to the lowest level of 9.8% among small farmers (Table 5.2). The proportion increases with increase in the operated area. It is found that marginal farmers in dryland areas neglect cultivation of own land because of the high opportunity cost of labor in wage employment and large farmers neglect agriculture because of the high opportunity cost in non-farm activities (Subrahmanyam et al. 2003).

Studies on poverty indicate that dryland areas suffer from high incidence and among the occupational groups, landless labor households are subjected to the highest incidence. However, there is no clear

Table 5.2. Distribution of households with fallow land.

Farm size (ha)	Holdings with fallow land (%)	Fallow area (%)
Up to 1.00	29.1	22.1
1.01 to 2.00	22.9	9.8
2.01 to 4.00	33.7	12.0
4.01 to 10.00	44.4	13.2
Above 10.00	48.0	13.5
All	29.5	12.8

understanding of the situations of different occupational groups in dryland areas. We have computed the incidence of poverty based on per capita income for occupational groups in dryland agriculture. Our results indicate that marginal farmers are more vulnerable to poverty than landless labor. This is because participation in wage labor market provides higher income than cultivation of own land in dryland areas. The situation is opposite in the irrigated areas. Income derived from one ha of land is quite low and dairy sector is less developed in these areas. As a result, poverty is higher at 40% among marginal farmers as compared to 34.9% among the landless (Table 5.3). A part of this gap may be due to the drought in the year, but it cannot explain the entire gap. When drought occurs even the agricultural laborers are likely to be affected adversely. The gap in per capita income between the landless and the marginal farmers is much more glaring than the gap in the incidence of poverty.

Table 5.3. Per capita income and poverty.

Farm size (ha)	Per capita income (Rs)	Incidence of poverty[1] (%)
Landless	5670	34.9
Up to 1.00	5519	40.0
1.01 to 2.00	6331	35.6
2.01 to 4.00	7548	30.6
4.01 to 10.00	11084	11.1
Above 10.00	27341	0.0
All	8869	28.1

1. Poverty line is Rs 4350 per capita per annum.

Many studies have shown inverse relation between farm size and crop yield per hectare. It may be true for irrigated areas, but not in dryland agriculture. In the irrigated areas with certain agricultural income, marginal and small farmers use inputs especially labor more intensively and derive higher levels of income. In dryland areas, small and marginal farmers use lower input quantities to minimize the adverse effect of crop damage. As a result these areas exhibit positive association between farm size and productivity. Except in the case of maize and cotton, all other crops indicate positive association between farm size and productivity (Table 5.4). The value of output per ha is very low for coarse cereals and pulses. Non-farm wage employment provides higher income than participation in own agricultural work and hence marginal and small farmers prefer non-farm wage employment to work on own farm.

5.3 Size, composition and productivity of livestock

Agriculture as well as livestock sectors play a moderate role in dryland areas with a small contribution of 40.0% and 12.4% to household income, respectively. A significant proportion of income is derived

Table 5.4. Yield (kg ha^{-1}) of principal crops.

Farm size (ha)	Paddy	Maize	Other millets	Pulses	Oilseeds	Cotton
Up to 1.00	3528	938	357	170	426	988
1.01 to 2.00	3417	928	466	180	526	854
2.01 to 4.00	3957	800	529	296	734	585
4.01 to 10.00	3921	898	787	378	579	780
Above 10.00	5395	827	1055	603	612	741
All	4224	875	679	378	617	728

from wage employment and non-farm activities. Further, income from livestock sector increases both in absolute and relative terms with increase in the size of landholding (Table 5.5). Farmers operating 4 to 10 ha derive the highest proportion of income (17.4%) from the livestock sector. Thus, dairy income is increasing with farm size. In such a situation, livestock sector is not suitable for improving the livelihood of the poor.

Table 5.5. Distribution of income (%) by source.

Farm size (ha)	Livestock income	Crop income	Non-farm income	Total income
Landless	2.1	0.0	97.9	100.0
Up to1.00	10.6	9.4	80.0	100.0
1.01 to 2.00	11.0	18.7	70.3	100.0
2.01 to 4.00	12.8	41.4	45.8	100.0
4.01 to 10.00	17.4	54.7	27.9	100.0
Above 10.00	12.5	69.1	18.4	100.0
All	12.4	40.0	47.6	100.0

There is a general feeling that small ruminant sector is very important in dryland areas. But this activity is taken up by only two communities in Andhra Pradesh namely, Yadava and Kurma. These two communities are socially and educationally backward. Further, land base is important for maintaining non-migratory small ruminants units. Tree lopping and grazing are the sources of feed for small ruminants. In the absence of migration, a farmer must have enough land to maintain small ruminants. In the study area only 10.3% of rural households maintain small ruminants, while 60.2% maintain bovines. Further, most of these farmers maintain small ruminants along with bovines (Table 5.6). Thus, small ruminant sector is less developed than the bovine sector despite steeper increase in price of mutton as compared to milk. Crossbreeding technology might have helped in improving

Table 5.6. Percentage of households maintaining bovines and ruminants.

Farm size (ha)	Only bovine	Only small ruminants[1]	Both bovine and small ruminants	No bovine
Landless	20.9	7.0	2.3	69.8
Up to1.00	29.1	5.5	3.6	61.8
1.01 to 2.00	47.5	4.2	8.5	39.8
2.01 to 4.00	60.2	2.0	9.2	28.6
4.01 to 10.00	71.6	1.2	11.1	16.0
Above 10.00	92.0	0.0	4.0	4.0
All	52.6	3.3	7.6	36.4

1. A household must posses at least five animals to be designated as a small ruminant holding.

the milk yield and profitability of dairying. Such a technological change has not taken place in the small ruminant sector. The importance of small ruminants for marginal and small farmers will further decline with development of irrigation because of the scarcity of land for their free movement. Bovine production is more strongly related to farm size than small ruminant production. While the proportion of households maintaining small ruminants increased marginally from 9.3% among the landless to 12.7% among marginal farmers and to 12.3% among large farmers, the corresponding increase in the rate of bovine maintenance is from 23.2% to 56% and to 82.7%, respectively (Table 5.6).

It is important to examine whether dairy production is neutral or biased to farm size. This has to be examined by considering the proportion of households participating in milk production and the productivity of animals maintained by different farm size groups. The proportion of households participating in milk production increases with increase in farm size. Further, as farm size increases, there is a shift from pure to mixed system. While only 20.9% of the landless participate in milk production, more than 70% of the large farmer holdings produce milk. The proportion of milk producers under mixed system increases from 3.6% among marginal farmers to more than 60.0% among large farmers (Table 5.7).

Table 5.7. Percentage of households by production system.

Farm size (ha)	Milk	Work	Mixed	Other bovine[1]	Non-bovine	Total
Landless	18.6	2.3	2.3	–	76.7	100.0
Up to 1.00	23.6	3.6	3.6	2.3	67.3	100.0
1.01 to 2.00	33.9	8.5	13.6	–	44.1	100.0
2.01 to 4.00	19.4	20.4	29.6	–	30.6	100.0
4.01 to 10.00	8.6	9.9	63.0	1.2	17.3	100.0
Above 10.00	8.0	24.0	64.0	–	4.0	100.0
All	21.2	11.2	27.4	0.5	39.8	100.0

1. Households maintaining young stock and non-productive animals.

The value of milk produced per household decreases with landholding size initially and then increases. While the landless produce Rs 9133 worth of milk, the small farmers produce only Rs 8593 worth of milk. The value of milk produced by the large farmers increases steeply to Rs 14392 (Table 5.8). This pattern can be explained as follows. As farm size increases, the need to maintain work animal increases and milk production is relegated to the second place. With further increase in the size of the farm, there will be a regular farm servant to take care of the bovines and milk production will be intensified due to economies of scale in bovine maintenance.

Table 5.8. Value (Rs) of milk produced per household.

Farm size (ha)	Milk system	Mixed system	Overall
Landless	9133	–	9133
Up to1.00	9388	1200	8804
1.01 to 2.00	7632	11852	8593
2.01 to 4.00	12451	8123	9791
4.01 to 10.00	19329	13701	14392
Above 10.00	9000	14324	13969
All	10158	12121	11183

Let us now consider the productivity of milch animals across farm size groups. There is a difference between cows and buffaloes. In the case of cows, high-yielding animals are maintained more by medium and large farmers as compared to marginal and small. For instance, 45.2% of the cows maintained by medium and large farmers produce more than 3 liters a day, while the corresponding proportion for the small and marginal farmers is only 2.6% (Fig. 5.1). On the other hand, 56.4% of the cows maintained by small and marginal farmers produce only 1 to 2 liters per day, while the corresponding proportion for the medium and large farmers is only 24.6%. Thus the distribution of high-yielding cows is biased towards large holdings.

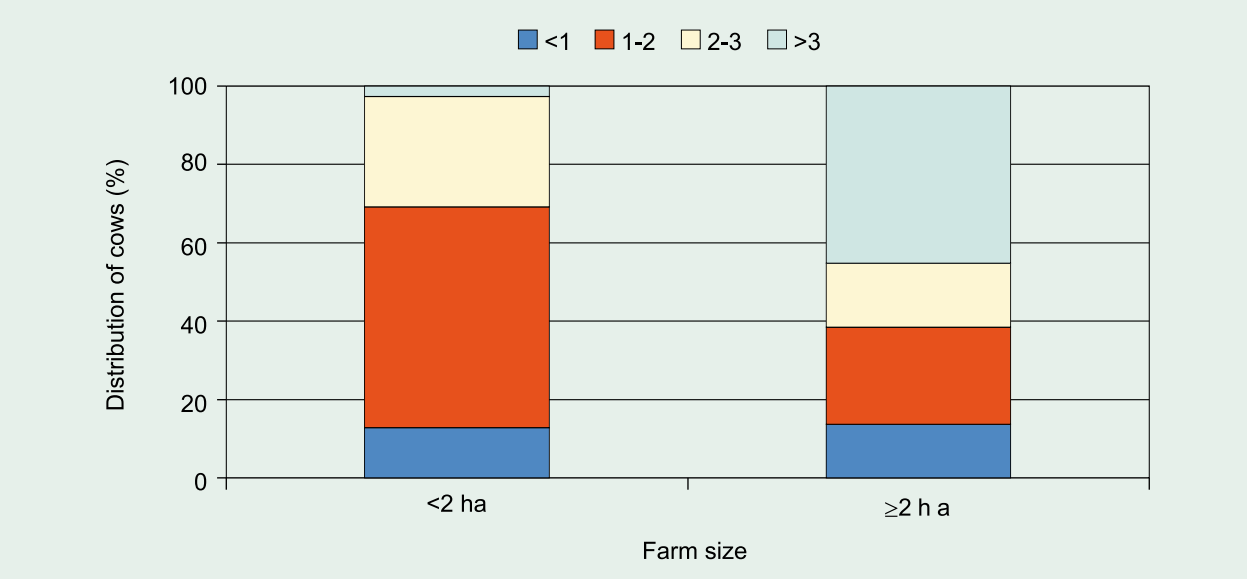

Figure 5.1. Distribution of cows by level of milk yield (L).

The distribution of buffaloes is different from that of cows. Both very small and large holdings maintain low productive animals whereas medium farmers (2–4 ha) maintain high productive animals. Thus the relation between farm size and quality of buffalo is of inverted U shape (Table 5.9).

Table 5.9. Distribution of buffaloes by level of milk yield.

Farm size (ha)	<1 L	1-2 L	2 –3 L	>3 L
Landless and marginal	0	40.0	48.6	11.4
1.01 to 2.00	0.0	42.3	39.4	18.3
2.01 to 4.00	1.3	26.0	46.8	26.0
4.01 to 10.00	0.9	53.9	28.7	16.5
Above 10.00	0.0	44.7	44.7	10.6
All	0.6	42.6	39.1	17.7

Factors influencing milk yield and milk production is studied through linear regression. Feed available per animal, size of landholding and education of the head of the household are used as explanatory variables. In addition to these quantitative variables, dummy variables for the existence of work animal and caste are also introduced as explanatory variables. The equation for all the six villages taken together gives good fit for the data and all the variables except work animal dummy are statistically

Table 5.10. Regression results explaining milk yield in the size study villages.

Variable	Malleboin-pally	Mentapally	Thirumala-puram	Kacharam	Nanda-varam	Devana-konda	All villages
Constant	1288.019	3235.085	1553.062	4837.326	2402.223	3800.576	3726.592
Work animal dummy	1427.454 (0.968)	694.069 (0.469)	326.462 (0.267)	–232.596 (–0.230)	–315.425 (–0.485)	1181.403 (0.952)	–
Fodder per animal	–0.577 (–0.678)	2.603 (1.917)	1.672 (1.765)	2.014 (3.057)	0.031 (0.104)	0.527 (0.338)	0.819 (2.555)
Operated land	209.278 (0.733)	–159.23 (–1.319)	17.200 (0.384)	–33.754 (–0.321)	17.058 (0.622)	–89.70 (–0.982)	–52.808 (–2.141)
Caste dummy	–272.912 (–0.085)	–1961.85 (–1.363)	–1712.835 (–1.333)	–867.68 (–0.811)	266.41 (0.285)	–2683.951 (–1.719)	–1012.071 (–1.723)
Education of head	58.092 (0.493)	–68.990 (–0.442)	135.143 (1.030)	89.488 (0.915)	72.879 (1.190)	267.934 (2.352)	132.994 (2.756)
R squared	0.0857	0.450	0.319	0.219	0.128	0.417	0.114
F	0.356	1.471	2.062	2.690	0.795	2.439	5.553
Probability of F	0.872	0.289	0.109	0.032	0.563	0.077	0.000
N	25	15	28	54	33	23	178

significant (Table 5.10). Education of the head has a positive impact on milk yield. Regarding the impact of caste on milk yield, it is found that yield per animal is lower in the households belonging to forward castes as compared to backward castes, SCs and STs. Size of holding has a negative coefficient indicating inverse relation between farm size and milk yield. It is already noted that the high-yielding buffaloes are more predominant in the medium holdings than large holdings. When equations are estimated separately for each village, only two equations (for Kacharam and Devanakonda villages) have a good fit. The coefficients of all the variables have the same sign as in the equation estimated for the entire sample. However, some of them are not statistically significant. These results indicate that no generalization is possible regarding the factors influencing milk yield.

The equation estimated for milk production per household gives good fit for the entire sample and also for four villages. Size of landholding has a positive impact on milk production because of the increase in the number of milch animals with increase in the size of landholding. The coefficient of fodder available per animal is not statistically significant. Education has a positive impact on milk production. As in the case of milk yield, given other factors milk production is lower among forward castes as compared to other castes (Table 5.11).

Let us consider the maintenance of animal draft power in dryland agriculture. As the crops grown in these areas need intercultivation to be performed by animal power, a large proportion of cultivators are expected to maintain animal draft power. But due to the use of tractor for initial land preparation, there is reduction in the rate of maintenance of work animals. Our results show that only 43.7% of farmers maintain work animals. In the case of marginal farmers the proportion is as low as 7.3%

Table 5.11. Regression results explaining milk production in the six study villages.

Variable	Malleboin-pally	Menta-pally	Thirumala-puram	Kacharam	Nanda-varam	Devana-konda	All villages
Constant	10.198	10.426	5.648	11.294	4.075	2.993	9.963
Work animal dummy	1.032 (0.138)	–3.428 (–0.546)	0.443 (0.199)	–0.606 (–0.135)	–0.464 (–0.303)	5.403 (1.892)	
Fodder per animal	–0.006 (–1.305)	0.001 (0.244)	–0.002 (–1.036)	–0.003 (–0.962)	0.001 (1.589)	–0.001 (–0.393)	–0.001 (–0.889)
Operated land	0.706 (0.488)	–0.351 (–0.684)	0.376 (4.623)	0.905 (1.947)	0.029 (0.454)	0.090 (0.430)	0.032 (0.347)
Caste dummy	–9.133 (–0.564)	–5.913 (–0.967)	–5.575 (–2.390)	–4.766 (–1.009)	–1.727 (–0.783)	–5.150 (–1.433)	–5.019 (–2.290)
Education of head	0.510 (0.856)	–0.037 (–0.056)	0.111 (0.466)	0.670 (1.551)	0.294 (2.035)	0.724 (2.760)	0.541 (3.002)
R squared	0.137	0.123	0.717	0.241	0.379	0.474	0.111
F	0.602	0.253	11.151	3.054	3.292	3.069	5.412
Probability of F	0.699	0.927	0.000	0.018	0.019	0.037	0.000
N	25	15	28	54	33	23	178

(Fig. 5.2). Though the proportion of farmers maintaining draft animals increases systematically with farm size, density of work animals increases only up to 4 ha and declines thereafter. The argument that density of work animals is inversely related to farm size does not hold in the present stage of development of mechanization.

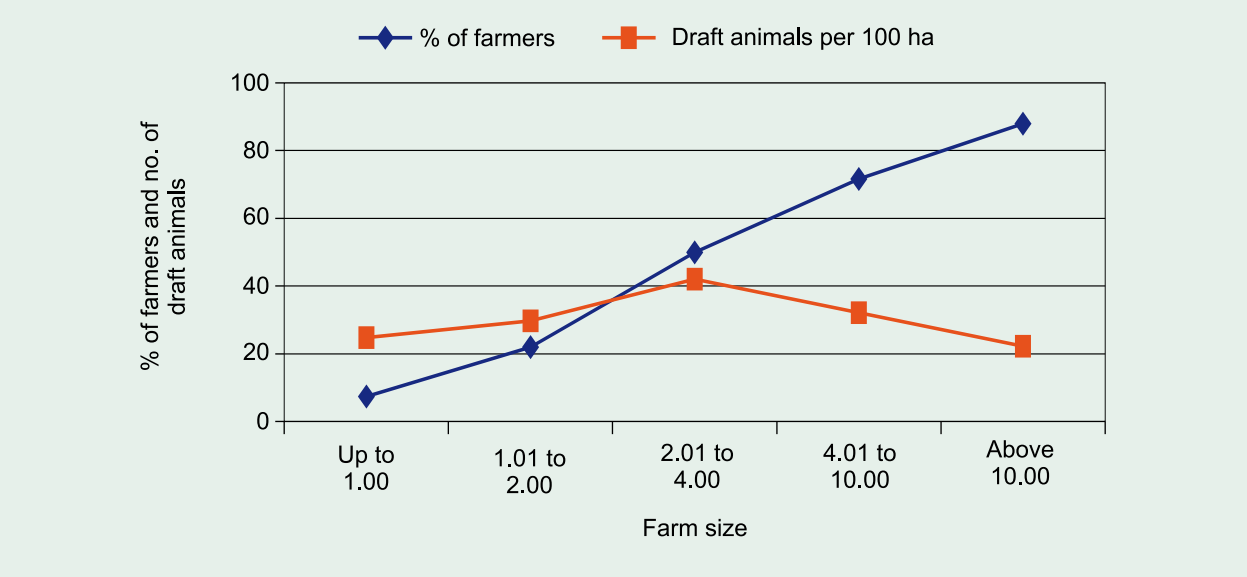

Figure 5.2. Maintenance rate (percentage of farmers) and density of draft animals (no. per 100 ha).

Table 5.12. Regression results explaining the density of work animal.

Variable	Malleboin-pally	Mentapally	Thirumala-puram	Kacharam	Nanda-varam	Devana-konda
Constant	31.596	22.833	27.669	38.926	16.308	16.182
Operated area	0.177 (0.112)	–1.439 (–1.541)	–0.186 (–0.346)	–0.423 (–1.116)	–0.537 (–3.407)	–0.059 (–0.221)
Area (%) needing intercultivation	–0.167 (–1.042)	0.334 (2.032)	–0.169 (–0.823)	–0.064 (–1.009)	0.120 (1.392)	–0.074 (–0.789)
Share (%) of non-farm income	–0.135 (–1.034)	–0.123 (–1.175)	–0.025 (–0.175)	–0.378 (–6.896)	–0.175 (–3.025)	–0.058 (–0.753)
Value of milk produced	–0.139 (–0.379)	0.496 (0.606)	–0.232 (–0.239)	–0.128 (–0.930)	0.639 (1.824)	–0.082 (–0.214)
R squared	0.056	0.113	0.024	0.490	0.263	0.026
F	0.698	1.789	0.271	17.295	4.896	0.381
Probability of F	0.597	0.144	0.895	0.000	0.001	0.821
N	52	61	49	77	60	63

Regression equation is estimated using the household data to identify the factors influencing the density of work animals. Size of operational holding, percentage of area needing intercultivation, share of non-farm income in household income and value of milk produced are used as explanatory variables. Equations are estimated separately for each village. Out of the six equations estimated, only two (for Kacharam and Nandavaram villages) gave good fit for the data (Table 5.12). Though operated area has negative sign, as expected, the coefficient is statistically significant for only one village. The finding of earlier studies that the density of work animals is higher on the small holdings as compared to large because of the indivisibility problem has not come out clearly. The share of non-farm income in the total household income has negative association with the density of work animals and the coefficient is statistically significant in both the equations. This indicates that farmers participating in non-farm activities manage their draft power requirement by hiring tractor or bullock services. The relation between density of work animals and milk production in the household is not clear. The coefficient is positive for one village and negative for the other. Thus, the results indicate that the factors considered above have no strong association with the density of work animals.

Use of FYM varies with farm size (Table 5.13).

Table 5.13. Use of farmyard manure in agriculture.

Farm size (ha)	Total (t ha^{-1})	Own (%)
Up to 1.00	0.99	75.4
1.01 to 2.00	0.71	100.0
2.01 to 4.00	0.77	90.7
4.01 to 10.00	1.23	94.6
Above 10.00	0.80	100.0
All	0.93	94.9

5.4 Availability and utilization of feed and fodder

Bovines are fed through stall-feeding and grazing. Information on the availability of fodder through grazing is not available. The quantity fed through stall-feeding is 2.46 kg per adult unit per day. If an adult unit requires 4 kg day^{-1}, about 40% of the feed requirement is met from grazing. Dry fodder is the major component through stall-feeding and it accounts for 85.6% of the dry matter fed. The share of concentrates is only 8.1% of the total dry matter fed. Green fodder accounts for only 6.3% of the total feed (Table 5.14). The composition of feed indicates that feeding is of poor quality. There are no significant variations across farm size. However, the distribution according to the average quantity of dry matter fed indicates that about two-thirds of the farmers feed less than 2 kg per adult unit per day (Table 5.15). These farmers depend more on grazing. It is significant to find the dependence on grazing declines with increase in the size of the landholding. The proportion of farmers feeding dry matter of less than 2 kg a day is as high as 93% among the landless and 81.8% among marginal farmers (Table 5.16). The proportion falls to 45.7% and 40.0% among large and very large farmers.

Table 5.14. Holdings (%) feeding green fodder and concentrates.

Farm size (ha)	Green fodder	Concentrates
Landless	2.3	9.3
Up to 1.00	7.3	18.2
1.01 to 2.00	12.7	26.3
2.01 to 4.00	19.4	29.6
4.01 to 10.00	27.2	54.3
Above 10.00	36.0	72.0
All	16.7	32.4

Table 5.15. Quantity of feeds (kg ha^{-1}) fed per adult unit.

Farm size (ha)	Dry fodder	Green fodder	Concentrates	Dry matter
Landless	1.28	0.44	0.20	1.44
Up to 1.00	2.03	0.31	0.25	2.13
1.01 to 2.00	1.75	0.47	0.24	1.90
2.01 to 4.00	2.22	0.56	0.17	2.28
4.01 to 10.00	2.48	0.63	0.28	2.63
Above 10.00	2.52	0.92	0.23	2.65
All	2.34	0.61	0.23	2.36

Table 5.16. Percentage distribution of holdings by dry matter fed per day.

Farm size (ha)	<2 kg	2–4 kg	≥4 kg	Total
Landless	93.0	4.7	2.3	100.0
Up to 1.00	81.8	9.1	9.1	100.0
1.01 to 2.00	75.4	14.4	10.2	100.0
2.01 to 4.00	54.1	35.7	10.2	100.0
4.01 to 10.00	45.7	35.8	18.5	100.0
Above 10.00	40.0	16.0	44.0	100.0
All	65.2	21.9	12.9	100.0

The high dependence on grazing is due to low availability of crop residues. As the cropping pattern mainly consists of non-cereal crops and only one crop is grown in a year, availability of straw per ha of net area is low. With a high density of animals, straw available per animal is also low. The quantity of crop residues available per ha is 0.71 t and per animal is 2.01 kg day^{-1} (Table 5.17). Because of the variations in density of animals, the quantity available per adult unit varies from 1.1 kg day^{-1} in the holdings of marginal farmers to 2.6 kg day^{-1} in the holdings of large farmers. Feed scarcity is a major constraint for the poor to take up dairy activity and interventions have to focus on this aspect.

Table 5.17. Availability of crop residues.

Farm size (ha)	Per ha of net area (t)	Per adult bovine (kg day^{-1})
Up to 1.00	0.67	1.10
1.01 to 2.00	0.72	1.40
2.01 to 4.00	0.77	1.91
4.01 to 10.00	0.79	2.37
Above 10.00	0.56	2.64
All	0.71	2.01

5.5 Summary

Though 'landlessness' is low, the distribution of land is highly unequal in dryland areas. Irrigation ratio though low at the aggregate level is more favorable to small landholdings than large. The proportion of land kept fallow increases with farm size, but marginal farmers have the highest proportion of land under fallow. Even household income indicates that marginal farmers derive less income than the landless. Incidence of poverty is also higher among these households.

Livestock production is not a major source of income for the landless and small farmers. A major share of income is derived from wage employment. The value of milk produced per household in a year first declines and then increases with farm size. The distribution of buffaloes across farm size also indicates the superiority of medium size landholdings in milk production.

Medium farmers with 2–4 ha of farm size maintain a large proportion of high-yielding buffaloes. Regression results show that farm size has a negative impact and education of the head a positive impact on milk yield. It is significant to note that the milk yield is lower in the households belonging to forward castes as compared to others. Though milk yield has negative association with farm size, milk production has positive association, indicating that large farmers maintain more animals of slightly poor quality as compared to the small farmers. The negative association between density of work animals and farm size observed in earlier studies is getting weakened in recent times. Such negative association is found only in one village out of the six villages under study.

6. Indicators for Monitoring Impacts from Intervention

This section suggests a few indicators that can be easily measured for understanding the impact of interventions. While preparing these indicators it is kept in mind that no comprehensive and in-depth data collection will be involved in the process. Though a sample survey has to be conducted, each interview requires less than 15 to 20 minutes. This information can be collected at one time point every year. Further the results can also be checked with a Focus Group Discussion (FGD) in the village. FGDs are needed in each village and the groups have to be selected on the basis of farm size and community. The FGD is also intended to know the changes that have taken place in the common property resources. The rationale for selecting each indicator is presented below.

6.1 Decline of fallow land

The watershed program is likely to improve the soil moisture condition and lead to use of fallow land either for crop production or for growing fodder crops, which require less water. Sometimes it is also possible that the fallow lands may be used for growing fodder trees like *avisa*, *subabul*, etc. It is desirable to know whether any of these changes have taken place in the sample village. Information at household level as well as village level can be collected on this aspect.

6.2 Green fodder available from grazing

With improvement in soil moisture, days of grazing and the availability of green fodder for grazing will improve. Farmers will be in a position to tell the improvement in the situation in terms of days and quantity of fodder available for cutting and for grazing.

6.3 Fodder trees planted on bunds

In the watershed program, a number of contour bunds will be laid and bunds can be used for growing grasses or fodder trees. The extent of land under bunds and the increased availability of grasses or leaves from these bunds can be collected from FGD. This information need not be collected from sample households.

6.4 Changes in cropping pattern

If the watershed program is leading to development of bovine production, farmers are likely to keep in mind the need for fodder while deciding the cropping pattern. A qualitative question about the change in the cropping pattern and the reason for such change will provide information on this.

6.5 Cultivation of fodder crops

When the potential for milk production increases farmers allocate some land for cultivation of low water intensive fodder crops like pillipesara, fodder sorghum, etc. It is desirable to collect information about this to understand the impact of the interventions.

6.6 Treatment of straw with urea

The treatment of straw with urea improves the nutrient content. Farmers may adopt this technology when milk production is gaining prominence. Information may be collected about awareness, acceptance and adoption of this technology.

6.7 Increase in milk production

This indicator provides direct assessment of the impact of intervention in the livestock sector after the treatment of the watershed. The sample household may be asked about the average daily milk production and number of days of production in a year. This will help to understand the relation between socioeconomic features and improvement in milk production. Information about the increase in milk production at the village level can be obtained by contacting the milk collection centers and vendors.

6.8. Increase in consumption of milk

Farmers may increase milk production but may use it for home consumption. It is essential to collect information about the changes in the disposal of milk.

6.9. Hire market for services of work animals

It is likely that the farmers will reduce the work animals and increase milch animals as the potential for dairying increases. Information can be collected from the sample households about the size of work animals maintained earlier and now and the reasons for change. Information can also be collected from FGDs whether there is increase in the number of tractors and whether there is any development in the market for work animal services.

6.10 Breeding method adopted

Adoption of artificial insemination or natural service with selected bull is an indication of the preference for improvement in the quality of animal. Information on the shift from one type of breeding to another will throw light on the breed preferences.

6.11 Crossbred/graded in the total milch animals

A high proportion of crossbred/graded animals is an indication of shift towards intensive milk production. This information will be collected from sample households.

6.12 Motives in bovine maintenance

The main motive behind bovine maintenance varies from manure production to selling of calf, producing work animal, producing milk for home consumption and producing milk for market. Information on the main motive will be collected to understand the shifts in the priorities.

6.13 Landless labor in milk production

When the village economy is shifting towards milk production, landless laborers will also participate in milk production. Information on this is also an indication of the positive impact of interventions.

6.14 Institutional changes

Livestock development depends upon the existence of institutions like Milk Cooperative Society, social control of common property resources for grazing, etc. Existence or establishment of these institutions in the recent period is an indication of livestock development.

6.15 Changes in animal care

Feeding the animals with concentrates and adopting management practices like deworming, vaccination, etc to reduce mortality are also indicators of development of livestock sector. This information can be collected both at the household level and the village level.

A small check list of the above indicators can be used for each of the sample villages. Information can be processed quickly and changes can be understood. The analysis also helps to identify the gaps in the developments that are taking place in the livestock sector.

References

Deaton A. 2001. Prices and poverty in India. Princeton, New Jersey, USA: Research Program in Development Studies. 17 pp.

Government of Andhra Pradesh. 2004. Economic survey: 2003-2004. Hyderabad, India: Planning Department, AP Secretariat.

Government of India. 2003. Economic survey: 2002-2003. New Delhi, India: Ministry of Finance & Company Affairs, Economic Division.

Hanumantha Rao C H. 1994. Some inter-relationships between agriculture, technology and livestock economy. Pages 155–194 *in* Agriculture growth, rural poverty and environmental degradation in India. New Delhi, India: Oxford University Press.

Shiferaw BA, Wani SP and **Nageswara Rao GD.** 2003. Irrigation investments and groundwater depletion in India semi-arid villages: The effect of alternative water pricing regimes. Working Paper Series no.17. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 19 pp.

Subrahmanyam S and **Nageswara Rao R.** 1995. Bovine sector in agriculturally prosperous and backward regions: A comparative study. Indian Journal of Agricultural Economics 50(3):311–316.

Subrahmanyam S, Sudhakar Reddy S and **Karin Verstralen.** 2003. Labor and financial markets from employers' perspective: The case of Ranga Reddy District in Andhra Pradesh. Hyderabad, India: Centre for Economic and Social Studies.

Vaidyanadhan A. 1978. Aspects of India's bovine economy: Some preliminary results. Indian Journal of Agricultural Economics 33(1):1–29.

About ICRISAT®

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).

Contact Information

ICRISAT-Patancheru (Headquarters)
Patancheru 502 324
Andhra Pradesh, India
Tel +91 40 30713071
Fax +91 40 30713074
icrisat@cgiar.org

Liaison Office
CG Centers Block
NASC Complex
Dev Prakash Shastri Marg
New Delhi 110 012, India
Tel +91 11 32472306 to 08
Fax +91 11 25841294

ICRISAT-Nairobi (Regional hub ESA)
PO Box 39063, Nairobi, Kenya
Tel +254 20 7224550
Fax +254 20 7224001
icrisat-nairobi@cgiar.org

ICRISAT-Niamey (Regional hub WCA)
BP 12404
Niamey, Niger (Via Paris)
Tel +227 722529, 722725
Fax +227 734329
icrisatsc@cgiar.org

ICRISAT-Bamako
BP 320
Bamako, Mali
Tel +223 2223375
Fax +223 2228683
icrisat-w-mali@cgiar.org

ICRISAT-Bulawayo
Matopos Research Station
PO Box 776,
Bulawayo, Zimbabwe
Tel +263 83 8311 to 15
Fax +263 83 8253/8307
icrisatzw@cgiar.org

ICRISAT-Lilongwe
Chitedze Agricultural Research Station
PO Box 1096
Lilongwe, Malawi
Tel +265 1 707297/071/067/057
Fax +265 1 707298
icrisat-malawi@cgiar.org

ICRISAT-Maputo
c/o INIA, Av. das FPLM No 2698
Caixa Postal 1906
Maputo, Mozambique
Tel +258 21 461657
Fax +258 21 461581
icrisatmoz@panintra.com

Vist us at **www.icrisat.org**

266–2006