

# Sustainable Livestock Production in Semi-Arid Watersheds

*Watershed development programmes while exhibiting significant impacts in terms of increased crop production and productivity, appear to have accentuated the inter-household inequities, by ignoring or sometimes negatively affecting landless and livestock, especially small-ruminant, owning households. Enhancing the production potential of a watershed for sustainable livestock production, would contribute to livelihood- and equity-enhancing impacts of the programmes. Appropriate policy and investment decisions are crucial to making this plausible.*

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## I Introduction

Watershed Development Programmes (WDPs) were conceived as tools for correcting the regional imbalances in agricultural development created by green revolution, through investments in soil and water conservation (SWC) and natural resource management (NRM) in rainfed areas. The WDPs have evolved from being purely technically oriented SWC programmes to more integrated and participatory programmes aiming at NRM with organisation of beneficiaries (watershed plus) and more recently targeting livelihood improvement (watershed plus plus). Though the rationale for WDPs has been to promote inter-regional equity, the impact of watershed investments on inter-household equity has turned out to be mixed. Though the overall impact of WDPs has been positive and significant [Rao 2000], increase in physical and economic access to groundwater [Chandrakanth et al 2004], landless and marginal households hardly benefited from watershed development, while the better off households located in downstream areas and with access to irrigation have benefited most [Farrington et al 1999]. The availability of irrigation is central to increased cropping intensity, crop productivity, hence labour absorption and reduced migration [Shah 2001]. With the focus of most watershed development projects on increased crop productivity, the inequities embedded in the distribution of agricultural land were only reinforced. Recent evidence points out that in many watersheds inequities increased, since for non-land owning and -well owning households access to drinking water, grazing lands and other natural resources decreased [Kerr 2002; Batchelor et al 2003].

It is increasingly being recognised that to increase the equity of watershed development, more attention has to be paid to livestock production, which is a major livelihood activity in most rainfed areas. In addition to providing income through animal and dairy sales, it has an important function for crop production by providing manure and draught power. Especially in the ecologically fragile areas of semi-arid watersheds, livestock makes an important contribution to the survival of the economically weaker sections [India Task Force 1987], small ruminants in particular playing an important role in ensuring rural livelihoods against drought [Pasha 2000].

Water and fodder are the most critical constraints for livestock development in semi-arid areas. Although in some cases WDPs have tried to improve biomass production on commons, in most

cases livestock production has insufficiently been accounted for, missing out on important opportunities to improve the livelihood of the watershed poor. Watershed development appears to have even negatively affected livestock production: due to grazing restrictions on common lands, households dependent on small ruminants have in some cases been forced to migrate with their livestock and/or to sell it off. For large ruminant owners the effects were not so adverse: as these species usually depend more on crop residues and stall-feeding.

This paper will elaborate how the equity and sustainability impacts of watershed interventions can be improved by targeting investments to incorporate livestock production concerns and by increasing the livestock production potential in semi-arid watersheds.

## II Livestock Production in Semi-Arid Watersheds

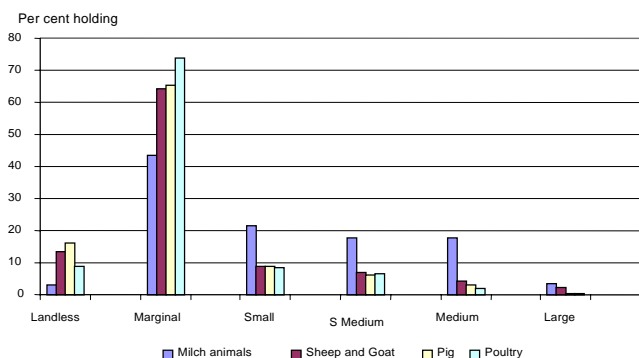
The predominant farming system in most semi-arid watersheds is the 'mixed crop-livestock farming system' under rainfed conditions, supported with limited irrigation from existing tanks, open wells or borewells tapping the groundwater. Traditionally, livestock production played an important role in the rural economy of India's semi-arid zones [Walker and Ryan 1990]. On an average, 15 per cent of household income was derived from livestock production. For poor households, like landless shepherds and women, the importance of livestock production is much larger: 2/3 of the rural poor have livestock for income and drought insurance. Whereas landless and marginal landowners would mainly depend on goat and sheep, large ruminants were mostly held by landowners, as the costs of maintenance were high due to fodder scarcity [Walker and Ryan 1990]. The share of household

**Table 1: Annual Household Cash Income by Source**  
(In percentage)

Category	Dairying	Crops	Others
Landless	53.08	0.00	46.92
Marginal	30.14	46.55	23.30
Small	29.17	53.75	16.58
Semi-medium	26.25	58.98	14.76
Medium	25.33	62.77	11.91
Large	19.02	71.48	9.50
All	27.28	55.36	17.36

Figures relate to All Households in the districts studied  
Source: NCAER, 1999

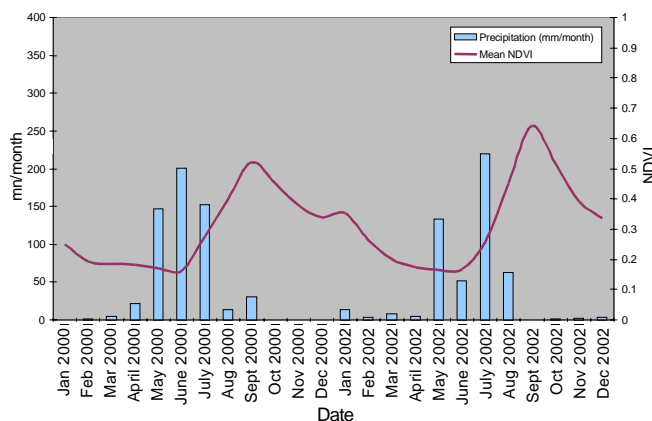
**Figure 1: Distribution of Livestock Species, Land Holding Categorywise: 1992**



Note: Per cent holding exhibited is the per cent to total population, holding category and specieswise.

Source: Land and Livestock Holding Survey: NSS 48th Round: NSSO Report No 408: 1997.

**Figure 2: Precipitation versus Biomass, Ladki Nadi January 2001-December 2002**



income from dairy production in different land holding categories (Table 1) reveals the critical dependence of landless and small landholders on livestock for their cash incomes.

Livestock holding is more equitably distributed than landholding: marginal and small holders together owned over 67 per cent of all milking animals in 1992. Distribution of small ruminant, pig and desi poultry follow more or less the same pattern as in the case of bovine: 86.6 per cent of sheep and goat, over 90 per cent of pig and desi poultry are owned by the marginal/small holders and the landless, with marginal holders alone accounting for nearly three-fourth of the desi poultry (Figure 1).

A desk study of livestock-environment interactions (LEI) in watersheds by Mangurkar et al (2001) highlighted some important issues. They found support for the hypothesis that WDPs tend to change the livestock composition (numbers, proportion of different breeds and species in their total population) depending on the restrictions on access to feed/fodder resources and,

quantitative and qualitative change in the types and availability of fodder. Based on the documented success stories of the WDPs with livestock component, the study concluded that WDPs with integrated livestock component strongly strengthen the crop-livestock integrated mixed farming system, with a positive impact on the environment. The study supported the premise that introduction of practices such as stall feeding, prohibited access to grazing resources and declining traditional arrangements in WDPs do influence the promotion of natural regeneration, but tend to adversely affect the livelihoods of the resource-poor livestock owners. Lack of appropriate policies and approaches, adequate poverty focus and convergence of related sectors in NRM programmes are limiting the promotion and effective utilisation of positive LEI.

As a follow up to the Mangurkar study, the International Water Management Institute undertook together with five NGO partners (Sampark, Samuha, Sevamandir, WASSAN and WOTR) and with the support of CALPI/SDC and LEAD-FAO, a study (hereafter referred to as the LEAD study) to identify, research and document livestock-environment-livelihood interactions in five watersheds in semi-arid India. The partners expressed a need to better understand the factors determining the livestock production potential in semi-arid watersheds and options for enhancing this potential. The LEAD study, therefore, focused on not only the interlinkages between livestock production, resource endowment and market conditions, but also on the management of resources and policy environment: since sustainable livestock production depends strongly on community organisation and their capacity to manage the common resources. This paper will present some preliminary results of the study, and elaborate how watershed interventions can support sustainable livestock production in semi-arid watersheds.

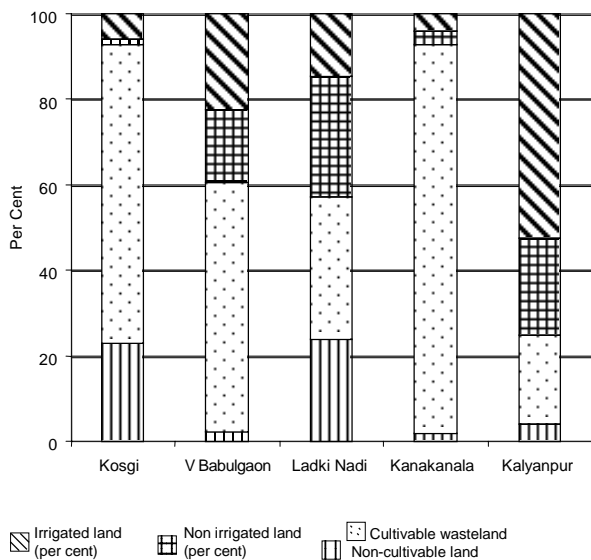
### III Data and Methods

The five watersheds chosen for the LEAD-India study provide a representative sample of the broad diversity of Indian semi arid areas and offer adequate opportunities for a special focus on studying the livestock-livelihood dependence of poor and landless women and men. Criteria for site selection were relative resource scarcity and economic integration, resource scarcity being estimated by average rainfall and economic integration by location and market access. Some general characteristics of the selected watersheds are presented in Table 2. In all five sites, investments were made by non-governmental and governmental organisations in SWC, reforestation, horticulture development and rainwater harvesting. Apart from Kosgi watershed, where investments mainly focused on horticulture development, tank maintenance and groundwater recharge, in most sites some investments were made to increase biomass availability through

**Table 2: Some General Characteristics of Study Sites**

Name of Watershed	Village Babulgaon	Kanakanala	Kalyanpur	Kosgi	Ladki Nadi
District	Ahmednagar	Koppal	Udaipur	Mahabubnagar	Jhabua
State	Maharashtra	Karnataka	Rajasthan	AP	MP
Scale of watershed	4,875 ha	14,518 ha	4,664 ha	3,587 ha	5,338 ha
Market integration	Good access	Remote	Remote	Good access	Remote
Average annual rainfall	430 mm	499 mm	584 mm	739 mm	1,024 mm
Livestock intensity (ACU/ha)	1.30	0.91	1.74	0.72	1.12
SWC: proportion of treated area	24 per cent	43 per cent	44 per cent	56 per cent	90 per cent
SWC: average expenditure/ha (Rs)	6,800	2,600	5,500	3,600	3,300

**Figure 3: Land Use Pattern in the Five Study Watersheds**



reforestation, pasture development and plantation of road sides, nala beds and bunds.

Hydrological and land use analysis employing GIS/RS techniques has been used to explore the biophysical characteristics in relation to livestock management practices. For the socio-economic and institutional assessments, primary information regarding livestock and livelihood patterns, resource management and institutions was collected at the village/hamlet level in all the watersheds through focused PRAs and key informant interviews. These qualitative data were ranked by the partner organisations, using the methodological framework provided by Quantified Participatory Analysis (QPA) [James 2003]. Household level data was collected from a sample of 200 households in each watershed through questionnaire surveys. The results presented here mainly draw on the watershed and village level data and results.

#### IV

### Preliminary Results on Livestock – Environment – Livelihood Interactions in Watersheds

#### *Water and biomass for livestock*

WDPs geared toward improving agricultural productivity on rainfed lands have tended to rely on a range of SWC techniques including structural and vegetative barriers, field bunds, and

check dams, as well as erosion control through gully plugs, etc. Widespread adoption of WDPs has altered the water balance generally in favour of the uplands but also in the form of increased groundwater recharge that is most evident in water table increases in the valley portions of the watersheds [IWMI 2003]. Several studies by IWMI and partners have shown how the intensification of land use resulting from WDPs has increased the availability and utilisation of runoff water and soil moisture in the upstream reaches, which in the semi-arid agro-ecosystems described in this paper has tended to result in diminished runoff flows to downstream users (whether tanks, irrigation reservoirs, etc). A secondary dimension of increased water availability in upper watersheds is the relative availability for agricultural lands vs soil moisture and runoff conservation for pasture and forest lands, i.e., water availability for biomass production. This latter element has crucial implications for livestock dependent populations. While large ruminants, particularly milch buffaloes, remain dependent on irrigated fodder or crop residues, the small ruminants and to a lesser extent non-lactating or non-draft cattle remain heavily dependent on biomass produced on the common lands. This raises an important policy and management challenge vis-a-vis the relative investment (financial, government, NGO, or community management) in WDPs on private vs common or public lands.

When livestock owners do not take part in the planning and implementation of watershed development, the direct benefits of increased biomass availability and access to common lands are not recognised as such. In 4 of the 5 LEAD watersheds however, livestock owning households did take part in watershed planning and implementation, placing biomass enhancement and pastureland productivity on the agenda of watershed interventions. Although grazing restrictions were imposed, clear agreements were reached on how the fodder produced would be shared. By investing in roadside plantations, fodder cultivation and drought support the pressure on available resources was further reduced.

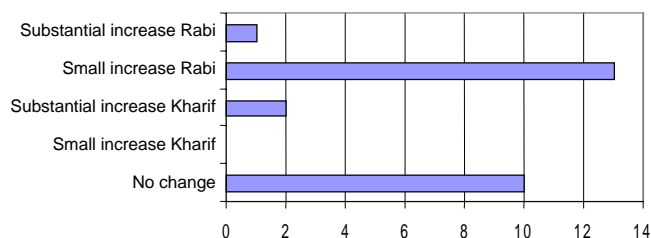
Table 3 compares the different climatic and water resource characteristics of the five watersheds studied by IWMI and partners. Of the five, aridity (difference between water inflow and outflow through natural loss) is highest in Kananakala and is much lower in Kosgi and Ladki Nadi, where rainfall is higher. In all five watersheds rainfall is confined to 2-3 months a year. Only in Ladki Nadi and Kosgi are water resources sufficiently stored. This not only has a direct effect on the availability of water for livestock drinking, but water storage increases the availability of supplemental irrigation for crop production through the year. This enhances the crop residue availability for livestock feeding, besides the effects on biomass growth on tank and nala

**Table 3: Some Biophysical Features of the Study Watersheds**

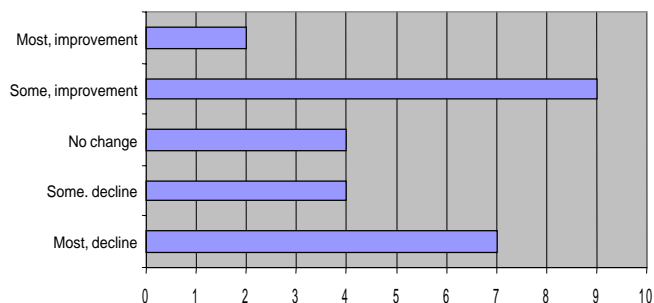
Name of watershed	Village Babulgaon	Kananakala	Kalyanpur	Kosgi	Ladki Nadi
Average annual rainfall (P)	430 mm	499 mm	584 mm	739 mm	1,024 mm
Average annual PET	1,350 mm	1,591 mm	1,485 mm	1,462 mm	1,449 mm
Aridity index (P/PET)	0.32	0.31	0.39	0.5	0.71
<i>Terrain</i>					
Average slope per cent	7	7	17	2	7
Surface stoniness per cent	16	32	31	4	13
<i>Drainage and Storage</i>					
Drainage density (km/km <sup>2</sup> )	2.7	2.4	3.3	1.6	3.4
Main irrigation source	All	Open well and borewell	Open well	Borewells and tank	Tank
# tanks	13	3	4	11	14
Tank storage in watershed (mm)	16	9	43	133	58

*Note:* PET=Potential Evapotranspiration.

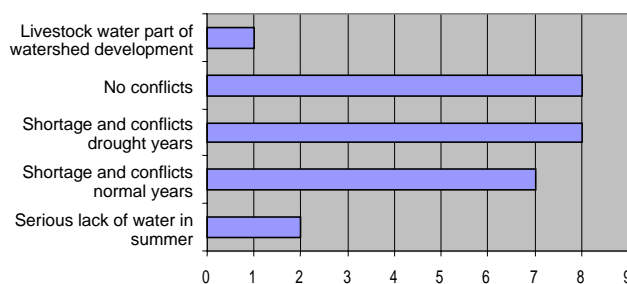
**Figure 4: Change in Cultivated Area**



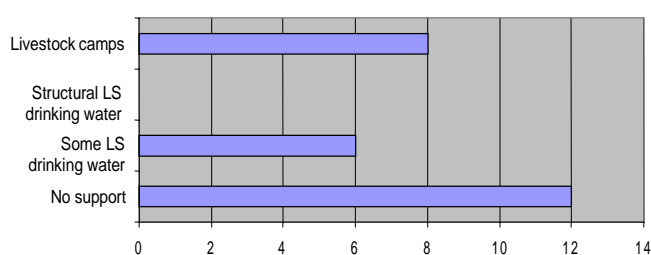
**Figure 5: Crop Residue Availability**



**Figure 6: Livestock Drinking Water**



**Figure 7: Drought Support Livestock**



bunds throughout the year. The variations in biomass availability through the year and the strong correlation of the same with rainfall and irrigation is illustrated in Figure 2, for Ladki Nadi in 2001-02.

Plotting the biomass produced in the watersheds (from RS analysis) with the precipitation, shows that biomass in Kanananala is structurally less while the other four watersheds do not differ much in the peak biomass availability. In Ladki Nadi, V Babulgaon and Kosgi watersheds an increase in biomass availability from irrigation can be seen. However, these inferences have to be read with a caveat as 2001/02 was a drought year.

The land use pattern, which influences the amount of biomass produced, in the five study watersheds is presented in Figure 3.

Kosgi, which is the smallest amongst the watersheds being studied, has the lowest proportion of cultivable wasteland and the highest cultivable area (94 per cent) that is actually cultivated. With the highest rate of irrigation, and groundwater depletion, a question about the sustainability of the resources utilisation arises. With most of the lands in Kosgi and Kanananala being cultivated and relatively lower amounts of common land available for grazing, there is higher pressure of grazing livestock on the available lands. With irrigation, the trend is to grow cash crops, which have limited/no fodder value precipitating the fodder shortages. Even though the percentage of cultivable wasteland and fallow land is high in the other three watersheds, there is seasonal variation and based on climate. For instance, this year Ladki Nadi received good rains. As a result, more than half the fallow land has been cultivated. Most of the wastelands in these watersheds are affected by erosion and grazing pressure.

The comparison of resource endowments between the watersheds provides an impression of the differences in their livestock potential. However, the potential does not depend on resource endowment alone; the socio-economic conditions and, the external and local management of resources play a crucial role in determining the same. This is the case in Village Babulgaon watershed, where good livestock production support facilities allow marginal farmers to maintain intensive production systems. The socio-economic characteristics of livestock production will be elaborated in the following sections.

## Livestock Production Systems in Watersheds

### Livestock Holdings and Intensity

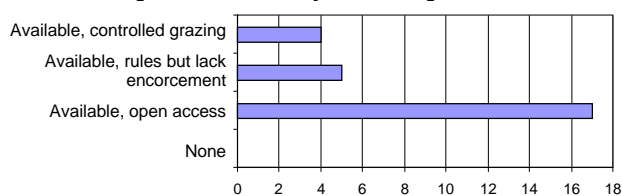
The livestock holding households range from around 30 per cent in Kosgi to 85 per cent in Kanananala. Poorer villages with less access to irrigation do have more livestock. In Kosgi, trends over the last 10 years indicate that livestock holdings have been greatly reduced, mainly because of increased migration and mechanisation. A shift from cows to buffaloes and from sheep to goat has taken place. Fodder scarcity increased, as hardly any common lands remained (only the tank bunds) and crop residues are used for compost. In VBabulgaon, large ruminants are mostly cross bred cows, mainly for dairy production and consequently, there is widespread stall-feeding. Bullocks are also many, mainly for draught power, but the numbers are decreasing due to mechanisation. There are twice as many goat as sheep, because of social preferences. In Kanananala, goats and sheep are most popular, with few buffaloes. Large ruminants are reared for draught (hardly any

**Table 4: Livestock Intensity in Study Watersheds**

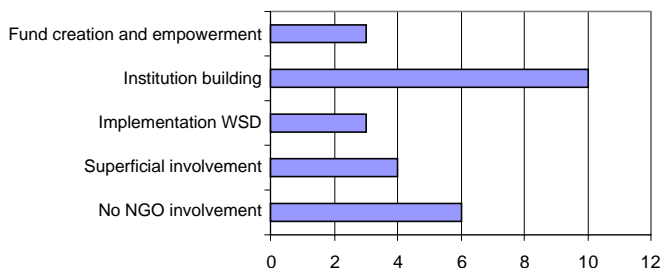
Village	Rainfall	ACU/ha	LR/ha	SR/ha	LR/hh	SR/hh
Babulgaon	430	0.99	0.81	0.18	2.63	2.98
Kanananala	499	1.39	0.71	0.68	3.20	10.85
Kalyanpur	584	1.54	1.27	0.26	4.16	4.76
Kosgi	739	0.71	0.58	0.13	2.70	3.14
Ladki nadi	1,024	1.56	1.29	0.27	2.90	3.91

*Note:* ACU= Adult Cattle Unit, LR= Large Ruminants, SR=Small Ruminants, ha= hectares of watershed area, hh= household  
1 cow of 250 kg=1 bullock =1 ACU; 1 buffalo= 1 ACU; 1 calf= 0.6 ACU;  
1 sheep=1 goat=0.2 ACU

**Figure 8: Availability of Grazing Land**



**Figure 9: NGO Involvement in Local Institution Building**



mechanisation) and manure, small ruminants for liquidity and insurance. Dairying is a limited activity, but increasing in villages close to the town. Kalyanpur has an average livestock holding of 5-6 animals per family. Each family owns a pair of bullocks since mechanisation is low. Goats are also popular since the meat fetches a good price. Over the last decade there has been a great decline in livestock holdings, mainly because of drought and diseases. The differences between livestock population among villages in Ladki Nadi are large. Livestock population has reduced due to the fodder and drinking water shortages because of recurring droughts.

Table 5 provides the livestock intensity in the five watersheds being studied. It appears that the livestock intensity (ACU/ha) is positively correlated with rainfall, except in case of Kosgi watershed. This is probably due to the higher extent of cultivated land in the watershed and non-availability of commons for grazing. The highest livestock holdings, both small and large ruminants per household, is encountered in Kalyanpur and Kananakala, the watersheds with the lowest bio-physical potential, corroborating that in highly fragile environments, livestock becomes the major source of livelihood.

Though there are huge differences in livestock intensities among villages in the watersheds, there is no definite trend in livestock holding patterns or density among villages located in various reaches of the watershed. Similar is the case with treated or untreated villages/areas in the watersheds. Statistical analysis revealed that there is no significant correlation between population and livestock intensity. There is however a significant inverse correlation between availability of arable land per household and livestock intensity.

### Feeding Systems

Generally in semi-arid watersheds India, free grazing and stall feeding are not mutually exclusive, but coexist with the relative importance varying depending on the cropping intensity; proximity to forests, wastelands, and fallow lands and access to markets for milk and fodder [Puskur 2002]. In all the watersheds studied, crop residues are an important source of fodder and their importance has increased. While small ruminants are all free

grazed, there is partial stall feeding for large ruminants, especially for lactating and draught animals.

The farming community balances the fodder demand-supply gaps by following a discriminatory feeding regime within their herds, the high yielding animals receive larger quantities and better quality feed stuffs; older and unproductive animals receive the poorest quality and subsistence rations; work animals are raised on dry fodder only, with concentrate supplements during the working season [Kurup 2003]. Home grown/bought crop residues and grazing on CPRs, are the universal treatments for all animals. There are regional and seasonal variations in the availability of the different feed and fodder and farmers' feeding practices take into account these variations in supply.

### Market Access

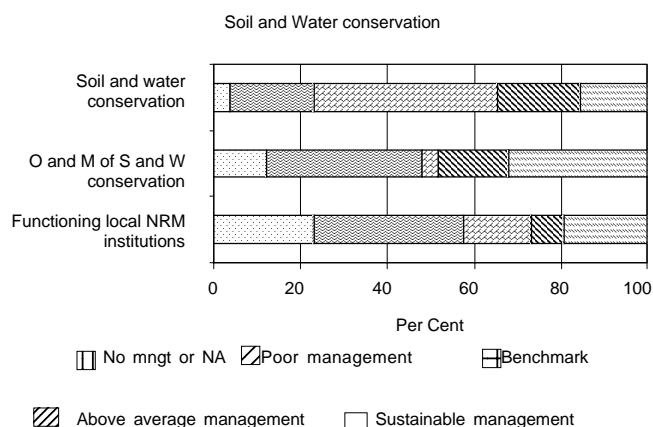
Out of the five watersheds being studied, dairy production is taking place to a higher extent in Kosgi and VBabulgaon (both of which have access to chilling plants and milk route) and to a very small extent in Kananakala and Ladki Nadi, two villages each, which are closer to towns. This indicates that market integration is an important factor in developing dairy as an enterprise. While commercial livestock production, especially dairying, seems to be stimulated by market access and infrastructure, it has to be noted that the livestock intensity in general is influenced by the resource endowment. The market access appears to induce a change in species composition of large ruminants and also the milch animal breeds. In Kosgi there is a clear shift to buffaloes primarily to improve dairy production for the market and in V.Babulgaon; about 78 per cent of the cows are crossbreeds. In Kananakala and Kalyanpur in most villages there is no improvement in large ruminant breeds, whereas in Kosgi and Ladki Nadi some households have improved breeds and in VBabulgaon most households have improved breeds.

In Kosgi, the SHG membership seems to be positively correlated with livestock ownership: especially goats and buffaloes. SHGs are especially responsible for the increase in dairy production. In Kananakala, though development of SHGs has improved access to credit, it is not very clear whether this has helped livestock production.

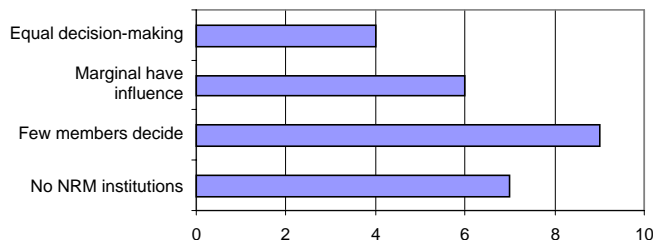
### Trends in Crop and Livestock Production in Watersheds

Watershed treatments generally increase crop output and therefore output of crop residues. With watershed projects a shift in cropping pattern has also taken place, from low to high value crops or from mono to mixed and inter-cropping. An increase in the extent of irrigated area and the well command area, and also an increase in ground water table, ranging from 3 to 38 m in different watersheds have been noticed. Beneficial impact of watershed programme on moisture availability has been observed [Ninan 1997]. In the study watersheds, 100 per cent of the sample villages reported an increase in productivity of both irrigated and rainfed crops. Seventy-seven per cent of the study villages reported increase in the cropping intensity and 50 per cent reported a small increase in the rabi cultivated area (Figure 4). WDPs through improvement in soil moisture content, generally tend to bring about an overall increase in

**Figure 10: Management and Functioning of Institutions for NRM**



**Figure 11: Participation Local NRM Institutions**



biomass cover of the land, many of them edible to the species normally depending on grazing.

The cropping pattern in all the watershed villages has changed over the last decade or two. Only about 24 per cent of the sample villages report no change, while in 48 per cent there is a shift towards more dryland cash crops and in 24 per cent a shift towards wetland cash crops.

It is felt that there has been a general decline in the quality and quantity of crop residues for fodder, especially so during drought years. While 35 per cent of the villages report improvement in the availability of crop residues for some households, 27 per cent report a decline in availability for most households in the village (Figure 5). As a result, the households have responded by decreasing their livestock holdings, but would like to acquire livestock again when the situation becomes comfortable. There is a large import of fodder from outside the watershed during drought periods.

The water harvesting structures though not planned explicitly with a focus on livestock, have served the livestock drinking water purposes. In several places they eased the constraint of water on livestock production. While 31 per cent of the villages report shortages of livestock drinking water and conflicts with crop production during drought years, 27 per cent report the same being true even in normal years (Figure 6). It has been observed in many areas that due to lack of water, and in some areas due to consumption of dirty water by livestock, there is high incidence of livestock diseases. It has also been pointed out that in many places farmers consider construction of farm ponds as failure since they may not be able to use such water for various reasons [Ramanna 1991] and for livestock consumption.

While drought support to livestock is provided in 54 per cent of the study villages in the form of either livestock camps or provision of drinking water, no support is available in the rest (Figure 7).

### Management of Biomass, Land and Water Resources in the Watershed

In semi-arid areas, livestock production depends crucially on common property resources, like forests, common lands and village tanks. Coordination of resource use is needed to ensure that they are used in a sustainable way. Over the last decades

the management of these resources has been partly decentralised to local communities and user groups. In the study sites, in most villages with access to forestland, some form of joint forestry management (JFM) exists. The impact of this on availability of fodder and, the usufruct rights often remain unclear. In all the study watersheds this poses a serious constraint to sustainable resource management since it obstructs investments in biomass generation.

In most villages where watershed development takes place, attention is paid to soil erosion caused by overgrazing on common lands. The grazing restrictions that are usually imposed to reduce the pressure on the land do not necessarily have to affect marginal, small ruminant holders negatively: in the study sites innovative ways of equitable common and pasture land management were found. In Kalyanpur watershed, fodder from common pasturelands is collectively harvested and equally shared. In fact in all sites, even small ruminant holders seemed to prefer controlled grazing to open access, since the availability of fodder is increased. However, only in 16 per cent of the villages does controlled grazing takes place (Figure 8): establishing arrangements for controlled grazing to improve fodder availability on common lands could be an important instrument to increase the productivity of livestock in semi-arid watersheds.

WDPs invest part of the funds in local institution building and empowerment, to ensure that the enhanced resource base continues to be managed in a sustainable way after project completion. Studies have shown that NGOs tend to invest more in local capacity building than GOs [Farrington et al 1999; Kerr et al 2000]. This was seen in the LEAD study sites too (Figure 9): in all NGO villages, local institutions for NRM like watershed committees and forest committees were established. In non-NGO villages, few NRM organisations seem to function in an effective way: In 90 per cent of the villages the role of the panchayat raj institutions (PRI) in NRM was said to be non-effective.

Livestock-related institutions like dairy cooperatives and producers/breeders organisations, where exist, do not play any significant role. Only in some cases, JFM organisations and water users associations were functioning for the management of forestlands and village tanks.

Clearly, the establishment of an organisation for resource management alone does not ensure that resources are managed in a sustainable way. When asked about their own perceptions, villagers responded in more than 50 per cent of the cases that local NRM was poor. Only in 20-25 per cent of the villages are land, water and biomass resources apparently managed in a sustainable way, leaving substantial room for improvement if the positive impact of watershed interventions is to be maintained (Figure 10).

Finally, for the management of biomass, land and water resources to be sustainable it is not only important to have established institutions, clear rules and a sound system of monitoring and control, it is crucial that the institutions for NRM function in a participatory and equitable way. If marginal households have no access to community decision-making or if the local rules and regulations affect certain households in a negative way, improvements in natural resource availability are likely to reduce equity and threaten the sustainability of resource use in the long run [Farrington et al 1999].

Although in four of the 26 villages local NRM institutions were said to function in an equitable way, in most villages few members still seem to take most decisions (Figure 11). If watershed interventions are to be equity- and livelihood-enhancing, ensuring full participation, including livestock owners, is an important first step. After all, enhancement of livestock production and sustainable resource management cannot be imposed top-down: it is the community which has to reach an agreement on how to make best use of the scarce resources that are there.

## V Policy Recommendations

Mangurkar et al (2001) found that lack of appropriate policies has constrained both the benefits and equity of livestock outcomes of WDPs as well as their contribution to poverty alleviation. The ongoing study reported in this paper indicates that additional equitable benefits may be achieved through:

- Inclusion of the crucial dimensions of livelihood dependence of poor on the livestock sector and the value of livestock assets in poverty reduction (especially small ruminants) in the watershed development strategy of the government.
- Consideration of the access of poor and the backward regions/villages to the infrastructure on livestock health services, marketing, breed improvement in the state policy.
- Emphasis on developing common property resources, productivity enhancement activities including diversification of crop patterns, fodder production in such a way that they pave way for high value crop-livestock integrated mixed farming as an income generation activity in the rainfed areas.
- Increased effort for controlled grazing and community management of common and revenue lands with clear usufruct rights regarding investments in biomass (roadside plantations, nala bunds, revenue land, forests).
- Assessment and inclusion of livestock fodder needs in social forestry projects.
- Assessment of livestock drinking water needs and incorporating livestock watering ponds/points into the design.
- Inclusion of livestock holders using the tanks for drinking water for their livestock in water users's associations and making clear provision for drinking water for animals while deciding on the command area to be irrigated in an year from the tanks.
- Resource scarcity in semi-arid watersheds may introduce tradeoff between livestock and crop development, between upstream and downstream users, or between free grazing and stall-fed livestock. Adequate consideration must be given to the sustainability of land and water use practices in order to ensure inter-generational equity.
- Strengthening of PRI to play more effective role in NRM.
- Delineation of clear methodologies for action planning, good

field examples of practice, resource material and appropriate administrative procedures – planning, monitoring, etc. [EW](#)

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