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**Changing Interface Between Agriculture and Livestock:
A Study of Livelihood Options under Dry Land
Farming Systems in Gujarat**

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Abstract

Traditionally, dry land farming system is characterized by diverse activities where crops, livestock and minor forests produce are intertwined in a manner that ensured sustainable livelihood to a large proportion of people even during sub-normal rainfall years. Livestock constituted a particularly important component of the livelihood system due to uncertain rainfall conditions and frequent crop failure. Introduction of irrigation into dry land farming system however, helped reducing weather related uncertainty in the region. In turn, this may bring in its fold, significant changes in land use, cropping pattern, activity-mix and labour absorption. In the process, livestock economy seems to have been reorganized in a manner that it got drifted away from dry land to irrigated crops and thereby gradually losing its traditional niche as a drought proofing mechanism.

The two important changes that seem to have taken place in some of the dry land regions are: (i) shifting of livestock from dry to irrigated farms and areas; and (ii) changing composition from grazing to stall fed species. It is likely that a substantially large proportion of households in such regions do not own any livestock and that, the proportion is particularly high among those who do not own any land or water for irrigation. Absence of livestock ownership might further reduce their stake in Common Property Land Resources (CPLRs) that earlier used to support a large proportion of livestock especially, owned by the landless. Losing livestock and thereby their stakes in CPLRs might imply that livestock does not, any more, work as security for such households that are more vulnerable to the uncertain agro-climatic conditions in dry land regions. Besides these, unplanned shift from dry to irrigated crops may also cause significant damages in terms of ground water depletion and land degradation resulting in non-sustainability of crop-economy in the long run. Restoring a diverse but modified farming system in the region might therefore prove more sustainable-economically as well as environmentally. Revival of livestock economy through a more rational use and distribution of water across different components of the farming system along with improve management of CPLRs might be very crucial in this context.

The present paper tries to empirically examine the changing profile of distribution and ownership of livestock across different regions of India and specifically for Gujarat. Besides, primary data collected from a household survey of conducted

in six villages in Saurashtra region in Gujarat. The analysis helps enhancing the understanding on the changing dynamics of dry land farming and its implications for promoting diversified and perhaps more sustainable livelihood.

JEL Classification : *O13, Q18, R12, R14*

Keywords : ***Livestock; Dry land agriculture; CPLR; Livelihood; Gujarat; India***

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I ventured into this relatively new area of research out of sheer compulsion of extending the earlier work on natural resources and sustainable livelihood with special reference to dry land region in India. More I tried to understand the interface between natural resources and livelihood, more I got convinced of the fact that we have missed out something seriously with respect to livestock economy, notwithstanding the phenomenal growth the sector has achieved over a period of time. Hence the search for answer to the questions: (i) 'who owns livestock, of what type, and why?' And (ii) who are the losers in this process?' Since there is no secondary data capturing changing pattern of livestock ownership among a given set of households over a period of time, I tried to explore the questions with the help of the existing information, supplementing that with primary data collected from dry land districts in Gujarat. Added to this is understanding and insights that I have gained by observing field realities in dry land regions of the country that, till recently, were centres of some of the prosperous livestock economies in the country. The paper thus is exploratory in nature. I hope that it opens up new directions for looking at livestock economy in the country. I would be very grateful for the comments and suggestions for further modification of the analysis.

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Changing Interface Between Agriculture and Livestock: A Study of Livelihood Options Under Dry Land Farming Systems in Gujarat

Amita Shah

1 Introduction

Traditionally, dry land farming system is characterized by diverse activities where crops, livestock and minor forests produce are intertwined in a manner that it ensures sustainable livelihood to a large proportion of people even during sub-normal rainfall years. Livestock was to constitute a particularly important component of the livelihood system to safeguard against frequent crop failure and uncertain rainfall conditions. Introduction of irrigation into dry land farming system however, helped reducing weather related uncertainty in the region. In turn, this seems to have brought in its fold, significant changes in land use, cropping pattern, activity-mix and labour absorption. In the process livestock economy may also have undergone changes, eventually drifting away from dry land crops, and thereby losing its traditional niche as a drought proofing mechanism¹. Increased tractorisation as well as market support particularly for dairy sector, may have further contributed to this process of restructuring of livestock sector². An important fall out of these changes could have been further decrease in common property land resources (CPLRs) that are already under pressure due to increased livestock population, unregulated use and encroachment. As a result of the two processes viz; increase in irrigation and decline of CPLRs, may have exerted significant impact on the pattern of livestock ownership in several parts of dry land regions in the country. The changes are

¹ A recent study by Birthal and Rao (2004, p.563) highlights the processes of intensification taking place in different agro-ecological regions in the country. These refer to intensification of cattle production in high rainfall regions; that of buffalo in intensively irrigated regions; and sheep intensification in low rainfall regions.

² For a comprehensive review of the trends in changing composition of livestock in India, see Sharma (2004).

most likely to exert negative impact on livelihood among the poor, besides reducing diversity in land use within dry land regions.

Apparently, two major changes have taken place in the distribution and composition of livestock in dry land regions. These are: (i) shifting of livestock from dry to irrigated areas and farms; and (ii) changing composition from grazing to stall-fed species. Micro evidence suggest that a substantially large proportion of households in such regions do not own any livestock and, that the proportion is particularly high among those who do not own any land or water for irrigation. Absence of livestock ownership might further reduce their stakes in CPLRs, which earlier, used to support a large proportion of livestock especially among the landless (Jodha, 1986). Losing livestock and thereby their stakes in CPLRs may imply that livestock does not, any more, work as security for such households that are more vulnerable to the uncertain agro-climatic conditions in dry land regions. A similar phenomenon may also apply to marginal landholding households of which many are becoming casual labourers.

This implies shrinking livelihood options and at the same time reducing diversity in resource use especially, of land and water. Besides these, unplanned shift from dry to irrigated crops, including irrigated fodder, may cause significant damages in terms of ground water depletion and land degradation resulting in non-sustainability of crop-economy in the long run. Restoring a diverse but modified dry land farming system in the region might therefore prove more sustainable- economically as well as environmentally. For, revival of livestock economy through a more rational use and distribution of water across different components of the farming system along with improved management of CPLRs may pave way for more diversified land use, supported by sustainable use of water, especially in the water scarce regions in the country. This, of course, is not to deny the importance of economic diversification through non-farm employment in redressing livelihood insecurity in a dry land region. Nevertheless till the difficult trajectory of shifting a large proportion of labour force to non-farm activities is achieved, enhancing natural resource-based livelihood options may prove to be crucial for reinstating people's (rather poor's) stakes in the resources, especially in CPLRs. Creating such stakes through appropriate institutional arrangements is an essential pre-condition for improving sustainable resource use as well as livelihood among rural communities (Chopra and Gulati, 2001).

Given this backdrop, the present paper tries to empirically examine the changing profile of distribution and ownership of livestock across regions and households. The analysis specially focuses on dry land regions with a case study of Saurashtra region in Gujarat. The specific objectives are to examine: (a) distribution of livestock population among different categories of households across states (districts) in India (Gujarat), and discern the changes over time; (b) factors influencing incidence of livestock ownership across different categories of households in a micro context of dry land region in Gujarat; and (c) implications for promoting livelihood security through a stronger interface between livestock and agriculture. The analysis is based on secondary as well as primary data collected from a household survey covering six villages in a dry land region in Gujarat (Shah, 2003).

The paper is divided in five sections including this introduction. The next section looks into the changing pattern of livestock population and their distribution across households among the major states in India. This is followed by an analysis of changing distribution of livestock across districts in Gujarat and the correlates thereof. Section 4 presents findings from the micro study of households in the survey villages. The last section provides a summary of the major findings and draws policy implications. Unfortunately the data system for livestock sector in India is far from adequate (Mishra, 1995)³. Nevertheless, given the data limitations the analysis is mainly exploratory in nature.

2 Changing Livestock Population and its Distribution across Regions and Households

To a large extent, the aggregate size of livestock population in India is determined by free availability of crop-residue/fodder from both private land as well as common pool resources (Chawla, et.al, 2002). Overtime, the availability especially from the above sources seems to have increased owing to increase in net sown area (NSA) as well as yield (see Table 1). Notwithstanding the increase, green and dry fodder have remained short in supply partly due to

³ Especially, the existing data do not provide information for ascertaining changes in incidence of livestock ownership among different categories of households. The recent survey by National Sample Survey Organisation (NSSO) in the 54th round is probably the first attempt to capture this phenomenon, though it does not help capturing the changes over a period of time at dis-aggregated (i.e. state/district) level.

simultaneous increase in total number of livestock over time, and partly due to change in cropping pattern. Estimates suggest that the shortage has aggravated further in the past two decades (Pandey, 1995). Given the shrinkage of CPLRs (Jodha, 1997), this would imply increasing dependence on crop-residue for rearing of livestock. Ownership of land and the size thereof thus assume critical importance in this context.

Besides these, demand for draught animals is also an important determinant especially, for the bovine population (Vaidyanathan, 1988). This aspect however, has lost its relative importance due to increased mechanization as well as emergence of markets for sharing/ hiring of such animals especially, bullock. According to recent estimates, the share of work animals in farm power supply has drastically reduced from 71 per cent in 1961 to less than 23 per cent in 1991 (Chawla, et.al; 2002). Together these two sets of factors have exerted significant impact on the size and composition of livestock in India as shown in Table 1. The important observations are: (i) increased population of almost all major species except bullock which registered a decline since the post eighties; and (ii) a corresponding change in the composition of bovine population shifting from cattle to buffalo. These changes in size as well as composition of livestock have been influenced by simultaneous changes in agro-climatic conditions, technology as well as market development, and demographic profile especially since the eighties (Vaidyanathan, 1988).

It may be noted that the increase in livestock population is slower than that in human population as reflected by a decline in the number of livestock per household as well as per person in rural areas. An important implication of such changes in demographic profile is that: unless accompanied by simultaneous improvement in quality and productivity of livestock, its contribution, to people's livelihood even in absolute terms may have declined over time. This has led to a situation of overstocking of livestock (per unit of land) and yet, declining livelihood support especially, among the land-poor households in rural areas. Unfortunately, the achievement in terms of improving productivity of livestock has been not only moderate, but also uneven across species, regions, and households.

While the recent estimates show that contribution of livestock sector to the gross domestic product has increased from 4.8 per cent in 1980-81 to over 6 per cent in 1998-99, they do not throw light on the sector's contribution towards livelihood

of the resource poor viz; landless and semi-landless for whom economic diversification from farm labour is crucial. Apparently, the sector is a major source of supplementary income to over 70 per cent of rural and quite a few urban households, providing employment to 18.4 million people (Chawla, et.al; 2002). How many of them belong to the landless and semi-landless is difficult to discern. It may however be noted that the number of workers engaged in livestock as usual principal activity has declined not only in terms of percentage share in the total (main) workers in rural areas but also in terms of absolute magnitude (Government of India, 1997; Government of India, 2002).

The NSSO, in the 54th round, provides estimates of the proportion of rural households possessing livestock during the reference period 1998-99. According to this, 56 per cent of the households reported ownership of at least one livestock (Table 2). The proportion varies significantly from 29 per cent in Tamil Nadu to 81 per cent in Himachal Pradesh and Jammu and Kashmir. An important observation emerging from the estimates is that only 42 per cent of the rural labour owned any livestock vis-à-vis 66 per cent among others (see Table 3). It may be noted that the average estimate of 56 per cent households possessing livestock is lower than the estimated proportion (i.e. 70 per cent) of rural households deriving subsidiary income from livestock as noted earlier. This may suggest involvement of some of the households not owning livestock especially landless and semi-landless in rearing and/or processing of the produce of livestock owned by those with better land as well as livestock base⁴. Unfortunately, there is no comparable data set to discern the changes in these variables over time. We will get back to this in the next section.

2.1 Livestock Ownership among Landed and Landless Groups: Some Tentative Findings

Given the data-limitations, an attempt has been made in subsequent analysis to gauge the changes in the pattern of livestock ownership among landless and landed households. This has been examined by using household level information from the 38th and 50th rounds of NSSO. The idea is to identify households that did not have a single member reporting livestock related

⁴ In this context, evidence from our micro-study in Gujarat (Shah, 2005) suggests that the about 6-7 per cent of the rural households not owning any livestock had reported livestock as main or subsidiary activity. This indicates relatively smaller gap between the proportion households possessing livestock and those getting subsidiary employment in the sector.

occupations as main or subsidiary activity. Such households were treated as not owning any livestock. These are of course, subject to gross underestimation of proportion of households owning livestock since (a) livestock is often not reported even as subsidiary activity particularly among women; and (b) many of the relatively better off households owning livestock may not engage any of their family members in the activity. Given these limitations we have used the data set mainly to trace the change in the proportion of households (being treated as 'having livestock') over a period of time.

Table 4 provides estimates based on this exercise, separately for landless and landed households. It is observed that although there is a substantial decline (i.e. 28%) in the proportion of households considered as having livestock, the percentage change is more or less same among landless (27%) and landed (26%) households. There is, however significant inter-state variations in the pattern. It is observed that the percentage decline in households having livestock is higher among landless vis-à-vis landed households in 8 out of the 17 major states for which data are presented in Table 4. Apparently, most of these states had high incidence of rural poverty at least till mid-nineties. These states are: Assam, Bihar, Orissa, Rajasthan, Andhra Pradesh, Madhya Pradesh, Tamil Nadu, and Jammu and Kashmir. Contrary to this, there are cases like Haryana, Punjab and Himachal Pradesh where proportion of households with livestock have increased (at higher rates) among landless. This may be due to the increased agricultural prosperity where those in the economically better off community do not engage themselves in livestock rearing, irrespective of their ownership- the point made earlier. Apparently the cases of Gujarat and Maharashtra may depict somewhat similar phenomena where overall economic (industrial) prosperity has pulled the landed out of this subsistence sector at a higher rate as compared to the poor or the landless.

Together the observations in Table 4 suggest that economic prosperity (growth) leads to a positive shift of the landed moving out of livestock with landless as gainers in a relative sense. Against this, in the poorer states, where opportunities for upward mobility even among the landed is fairly limited, the landless tend to get further marginalized.

The above observations support a somewhat similar pattern with respect to ownership of livestock among predominantly dryland states in India as shown in Table 2. The states having lower or marginally higher than the average

proportion of households possessing livestock are found to include many of the dryland regions such as in Andhra Pradesh, Karnataka, Maharashtra, Tamil Nadu and to an extent Bihar and Orissa. The major exception however, is Gujarat. In fact, these are the major regions where CPLRs (including community forests) have undergone severe degradation and are facing frequent droughts. Shrinkage of livelihood options in terms of livestock may also imply increased instability and impoverishment and/or distress migration of large number of people from these regions. Both these may result into neglect and/or sub-optimal use of land both private as well as CPLRs in these regions (Bilsborrow, 1992). However, before we move on to understanding the dynamics of livestock economy especially, in a dryland region such as Gujarat, it would be useful to examine the changes in the distribution of livestock across different categories of households and changes therein over time. The subsequent analysis focuses on this.

2.2 Changes in the Distribution of Livestock Across Households with Different Landholding Size: India and Gujarat

Table 5 provides information about the size of livestock owned by 100 households in each landholding size-class for 1982 and 1992. It is observed that livestock population has declined by about 15 per cent among all the households taken together. The decline however, is significantly higher i.e. about 59 per cent among landless households⁵.

What is however important is that the livestock population in the first group of landholding size (i.e. up to 0.2 hectare) has declined at a lower rate, though it has increased in the next size class (i.e. 0.21 – 1.0 hectare). From then, the percentage of decline in livestock population starts rising, reaching a peak at 51.3 per cent among the largest landholding size class (with >10 hectares of land). The pattern therefore depicts a 'U'-shaped curve with respect to percentage decline in the number of livestock across landholding size-classes. The evidence suggests sustained importance of livestock among marginal and small farmers as compared to landless and medium-large farmers.

⁵ Of course, the share of landless to the total households has also declined from about 26 to 21 per cent during the reference period (see Appendix I). Nevertheless the decline in livestock population even after adjusting for its declining share (weight) in all households is still substantially higher than the average.

The above findings however, may be seen in the light of the fact that the average size of livestock held by medium and large farmers is significantly higher than that among landless as well as marginal and small farmers (with holdings up to 1 hectare). This is significant since the former constitutes nearly 30 per cent of the total households and yet, operating about 85 per cent of the area as compared to 50 per cent of the marginal and small farmers operating only 15 per cent of the area⁶. Small farmers accounting for 24 per cent of the households and 43 per cent of the area operated thus appear to be the only gainers in this process. Households in the rest of the categories have lost out as shown by the reduced size of livestock from an average of 337 to 252 for all households during the reference period.

The pattern in Gujarat shows a sharper decline as compared to the aggregate picture for all India (see Table 5). Whereas size of livestock possessed by households has declined significantly, i.e. by 23.1 per cent, the sharpest decline (80.8%) is observed among the landless households. A further break-up of the changing livestock population for Gujarat is presented in Table 6. Among different species of livestock the steepest decline is observed in the case of cows (48%), followed by bullocks (45%) and then by sheep and goat (40%). The average size of buffaloes possessed by all rural households has increased by 5.9 per cent. It may be noted that the increase in the average size of buffaloes has been observed among all the landholding size classes; the landless, once again, have lost out thus, registering a negative growth (Table 6).

It may be noted here that the above scenario should not be treated as an indication of absolute decline in the number of livestock population. In fact the actual population has increased over time. However, since the total number of households has increased at a faster rate than that of livestock (see Table 1), the average size of livestock may show a decline in the case of most of the landholding classes. What is however reflected by the estimates presented in Tables 5 & 6 is a relative shift in livestock held by households across different size-class rather than overall change in the total size of livestock at aggregate level.

3 Variations in Livestock Population Among Districts in Gujarat: Examining the Impact of Dryness

The following analysis examines distribution of livestock population and changes therein across districts in Gujarat. The basic idea is to see whether the pattern

⁶ It is therefore likely that with an average size of livestock of 0.28, 1.67 and 2.89 among landless, marginal and small farmers, a substantially large proportion of households in these three categories may not own any livestock at all. And that, the phenomenon may have been further accentuated with a substantial decline in the average size of livestock among landless and the marginal farmers

varies across districts that are predominantly dryland vis-à-vis the other districts in the state. Table 7 presents information about growth in livestock population along with the relative share across districts for 1971, 1981 and 1991. It is observed that districts in Saurashtra region, with predominantly dryland condition, have experienced a decline in livestock population as reflected by negative growth rates especially in the post eighties period. Between 1982 and 1992, the growth in total livestock for the state as a whole was 6.3 per cent whereas that for Saurashtra was (-) 3.7 per cent. Of course, a part of this negative growth in Saurashtra could be attributed to relatively higher growth experienced by the region during the previous decade, the decline during 1982-1992 is likely to be observed due to frequent droughts since the mid-eighties. The trend, especially in Saurashtra region, seems to have continued even during 1997. During 1982-92, the region has also experienced a decline in its relative share in the total livestock population from 41.1 per cent to 37.5 per cent. It is important to note that the decline has been observed among all the districts in Saurashtra.

We tried to examine major factors associated with the change in relative share of each district in total livestock population during 1982 and 1992. Table 8 presents results of the correlation exercise. Following observations deserve special attention:

- (i) Whereas average rainfall is positively correlated with changing share in livestock population, the relationship is negative with respect to variations in rainfall. The pattern is somewhat different in the case of milch animals where average rainfall per se is not found to have any significant correlation but variation in rainfall does exert a negative impact on changes in the share of such livestock. Conversely change in the extent of irrigation has positive impact on the relative share of milch animals across districts.
- (ii) The proportion of wasteland (i.e. barren and uncultivated land) is found to have a negative association with the total livestock though, it does not have any significant influence on the changing share of milch animals.
- (iii) Apparently, agricultural labour productivity is found to have negative correlation with the share of both - livestock and milch animals. This is somewhat surprising. A possible reason for this could be the higher labour productivity, associated with dry land districts of Saurashtra, which is mainly due to (a) the predominance of high-valued commercial crops

like groundnut and cotton; and (b) higher incidence of out-migration from the region⁷.

- (iv) Changes in the share of livestock and milch animals are found to be positively associated with density of livestock across districts.
- (v) We also tried to examine the correlation with the number of tractors within a district. It is found that the number of tractors have positive associations with the share of livestock as well as milch animals in a district. This, once again, suggests higher level of agricultural prosperity having positive links with livestock population.

Together the above results reinstate the observation made earlier that there has been a shift of livestock from relatively drier to agriculturally more prosperous regions with better rainfall as well as irrigation facilities. It is likely that this kind of divergence is also taking place among households within dry land regions. This phenomenon has been examined in the subsequent section.

4 Determinants of Ownership of Livestock among Rural Households: Results from a Primary Survey

This section tries to examine the extent of livestock ownership among households and identify the major determinants thereof. The analysis draws upon primary data collected from a census of households from six villages in three districts of Saurashtra region during 2001. The districts are Amreli, Jamnagar, and Surendranagar. The villages represented different levels of degradation of land – both public as well as private, which may have significant impact on ownership of livestock besides, the size of landholdings⁸.

It is observed (in Table 9) that of the total 1227 households, 65 per cent owned at least one livestock during the reference year. The proportion was 77 among landed and 42 per cent among landless households. If we look at the ownership of milch animals, the proportion is found to be fairly small. About 52 per cent of households reported ownership of such livestock; 68 per cent among landed, and 22 per cent among landless. Ownership of sheep and goat however is found to be limited only to 15.6 per cent of the households (see Table 9(a) & (b)).

⁷ For details see, Shah, 2005.

⁸ For details on the basic features of households covered by the primary survey see Appendix II.

What explains ownership of different types of livestock among the rural households? This question has been examined with the help of a logit model using the following equation.

$LIVESTOCK = f (PCLAND, IRRI; RLPROD; HING, DEGRAD; WLAND; LFM; NFE; HEDU; CASTE; CCROP)$

Where, LIVESTOCK denotes ownership of livestock taking a value 1 and 0 respectively in the event of ownership of livestock or otherwise. The independent variables are:

- PCLAND - Per capita land-holding (Acre)
- IRRI - Extent of Irrigation (%)
- RLPRODI - Productivity of the Main Crop (Index with respect to the average of the top five values)
- HINC - Household Income (Range)
- DEGRAD - Degradation of CPLRs and other Community Land (% to total area)
- WLAND - Extent of Degraded Private Land (% to total owned land)
- LFM - No. of Male Labour Force (No)
- NFE - No. of Workers engaged in activity other than agriculture and livestock (No)
- HEDU - Highest level of education attained by any member of the household (Years)
- CASTE - Caste taking a higher value for upper caste agriculturalists (Dummy)
- CROP - Cultivation of commercial crop rather than a subsistent fodder crop (Dummy)

The logit model has been estimated separately for total livestock (LIVESTOCK), milch animals (MILCH); and sheep and goat (SHEEP). The results of the logit model have been presented in Table 10. The important observations emerging from Table 10 are as follows:

(a) Milch Animals: The variables having significant and positive impact on ownership of livestock are: irrigation and crop productivity; household income, size of the male labour force and non-farm employment; and caste. Incidentally caste has the largest positive impact on the incidence of livestock ownership.

Size of landholding is not found to be a significant variable. Alternatively, we tried out ownership of land as a dummy variable, which turned out to be fairly significant thus supporting the results presented in Table 9.

(b) Sheep and Goat: The results pertaining to ownership of sheep and goat however, are quite different as compared to that for milch animals. The factors influencing ownership of sheep and goat are: per capita land, household income, education of the head of the household, caste and level of degradation of community as well as private land. All these variables, except the two related to land degradation, exert negative impact on ownership of sheep and goat. The results thus, reinstate the close interface of the ownership of sheep and goat with resource poor regions and households, often belonging to lower social strata (caste) and having low human capital (education). The analysis also reinforces close link with degradation of land.

(c) Total Livestock: The incidence of livestock ownership is found to be significantly influenced by all the variables except for household income, degradation of private land, and commercial crops and wasteland. The impact of all the significant variables observed to be positive, except for the variable related to education that has a negative sign.

Overall, the evidence lend support to the basic postulation that incidence of livestock ownership especially is largely governed by access to irrigation on the one hand and the size of male labour force on the other. Importantly, size of the land owned, *per se*, does not have significant impact on the ownership of such livestock. Households with higher social status were also found to be positively associated with ownership of milch animals. Against this, ownership of sheep and goat is found to be associated with land degradation and size of landholding (small) besides household income (low) as well as lower social status represented by caste. These findings, along with the analysis of macro level data in the earlier sections, lead to some important policy implications discussed in the following Section.

5 Summary of Findings and Policy Implications

In the foregoing analysis we tried to examine the changing profile of livestock across regions and households. Constrained by the data availability, we tried to

collate evidence from different sources so as to gauge the pattern of ownership of livestock and the changes thereof over time. In that sense, the analysis is mainly exploratory in nature. The major findings emerging from the analysis have been summarized as follows:

(a) While total population as well as density of livestock has increased over time, the number per rural household as well as per person has declined, especially during 1981 and 1991. To an extent, this could be due to severe droughts and the resultant loss of livestock during the mid-eighties. The pattern however seems to have continued in some of the dry land states such as Gujarat where livestock population in most of the districts had declined during 1992-97.

(b) Similar phenomenon has been reflected in the incidence of livestock ownership across major states in India. By 1998, for which such estimates are available, 56 per cent of rural households owned at least one livestock. This proportion was lower or marginally higher than the all-India average in most of the states with predominantly dryland characteristics. Incidence of livestock ownership was fairly low among rural labour households; only 42 per cent of these households owned any livestock.

(c) Distribution of livestock has changed across households with different landholding size classes, including the landless. The decline is particularly sharp among landless as compared to households having land. This of course, does not capture changes in the incidence of livestock ownership among households.

(d) Rainfall, along with extent of irrigation and agricultural labour productivity (or cultivation of commercial crops) were the major correlates of the changing share of livestock across districts in Gujarat- all having positive impact.

(e) The evidence from the micro study in a dryland region in Saurashtra indicated that whereas 65 per cent of the rural households owned at least one livestock, those possessing cow or buffalo constituted only 52 per cent of the households. Access to irrigation and size of male labour force were among the major factors influencing ownership of such livestock. Against these, size of landholding and level of land degradation were among the major factors influencing ownership of sheep and goat; the former having a negative impact whereas the latter exerted positive impact on the ownership of sheep and goat. Only 15 per cent of households in the study villages owned sheep and goat; to a

large extent ownership of milch animals and that of sheep and goat was found to be mutually exclusive.

Together the above findings lead to certain important implications for diversity as well as sustainability of livelihood base among rural households especially, in dryland regions. These have been discussed below:

First of all, limited extent of livestock-ownership, especially among landless households suggests absence of their stakes in natural resources. This is not only socially inequitable but also economically less sustainable (at least till the transition in terms of a major shift towards non-farm employment is achieved) as it restricts their coping mechanism under uncertain weather conditions or droughts. The fact that only a small proportion of the rural households own sheep and goat and ownership of milch animals is concentrated among the better endowed districts as well as households in terms of rainfall and/or irrigation, indicate limited range of diversity in terms of livestock species, land-use and agriculture-livestock interface. It may be noted that increasing dependence on irrigation for livestock economy has led to unsustainable use of ground water as evidenced by studies in Mehsana district in Gujarat (Singh, et.al; 2004)⁹. This may aggravate inequality and loss of diversity emanating from the changing composition of bovine population shifting from cattle to buffalos¹⁰.

Reversing this process therefore, would call for simultaneous changes in land-use pattern supported by allocation of water across regions and households on the one hand, and institutional mechanism on the other. Ideally, a beginning should be made by focusing on regeneration of wasteland, and at the same time, cultivation of fodder on marginal land both – CPLRs as well as privately owned crop-lands. This in turn, would necessitate changes not only in the investment priorities but also in allocation of water for different crops including fodder. Both these are difficult tasks, requiring strong fiscal as well as institutional support.

⁹ For instance, it has been noted that Gujarat uses 1900-4600 litres of water to produce one litre of milk. This is significantly higher than the water use of 2,749 litres at All India level (See Singh, et.al; 2004, p. 3497).

¹⁰ Observations from a village in dryland districts in Saurashtra revealed that some of the poor farmers had to resort to manual ploughing as they could not afford to own/hire bullocks/tractors. Also, ploughing by tractor alone could be damaging to soil-productivity especially, in dry conditions.

One of the crucial policy interventions in this context is promoting land-use and crops that have higher efficiency in terms of water use. This itself may help enhancing diversity in land-use, which essentially can support livestock of different kinds especially, cattle, sheep and goat. The idea is not to increase the population of such livestock *per se*. Rather, the aim should be to improve the quality, and at the same time, their distribution among the landless and marginal landholding households. But achieving this should go along re-organisation of land-holdings. Consolidation of holdings and group-ownership of a part of the community wasteland are the two important aspects of an effective policy intervention in this regards. This is essential because distribution of livestock, in the absence of a proper entitlement to land (and to an extent water) has failed to work in the past, as amply suggested by the experiences of Integrated Rural Development Programme (IRDP).

Similarly, the circulatory causation of land degradation and higher population of sheep and goat, in turn, leading to further degradation of land needs to be checked through proper institutional support. While regulated grazing is a key to resolve this issue, an important pre-cursor to resolving the management of CPLRs is removal of encroachment. While this is an extremely difficult proposition, creating a fodder pool by mobilising contribution from those with land and irrigation might be another policy alternative that need to be properly examined. Access to at least limited water for regeneration of CPLRs need to be explored properly.

Finally, it might be useful to explore implications of transfer of water and fodder from water-rich to water-scarce regions, and transfer of livestock and labour in the other direction. A proper assessment of the relative costs-benefits of each of these options might help identifying the future direction for policy support in terms of promoting agriculture-livestock interface, especially in dry land (rather drought prone) regions in India. This kind of analysis ideally, should take into consideration the value of land-use diversity, livelihood security, inter-household equity, and social cost of migration. Future policies for promoting agriculture especially, in drought-prone regions thus, needs to revive an integrated approach for promoting a sustainable farming system, based on diverse land-use as well as livelihood systems.

Table 1: Changing Profile of Livestock and Operational Environment in India

Livestock and the Associated Factors	1970-71	1980-81	1990-91	2001
I. Livestock Population ('000)				
Cattle	1,78,380	1,92,453	2,04,584	1,74,974
Buffaloes	57,428	69,783	84,206	84,027
Sheep/Goats	1,07,510	1,44,020	1,66,062	1,57,566
Other	10,061	13,339	16,008	35,880
Total Livestock	3,53,379	4,19,588 (1.8)	4,70,860 (1.2)	4,52,447 (0.8)
II. Human Population (000)				
Population	54,8159	68,3329	84,302	102,8610
Growth Rate (Annual)		(2.4)	(2.5)	(2.1)
III. Associated Factors				
Net Sown Area ('000 Ha)	1,40,784	1,40,270 (-3.6)	1,42,234 (1.4)	1,42,598
Gross Cropped Area ('000 Ha)	1,65,791	1,73,324 (4.5)	1,85,477 (7.0)	1,92,619
Yield of Major Crops (Q/Ha)				
Paddy	11.2	13.4	17.4	19.1
Bajri	6.2	4.6	6.6	7.2
No. of Tractors	1,483	5,185	12,218	-
No. of Rural HHS ('000)	79,610	90,866 (14.1)	1,07,940 (18.8)	-
No. of Landless HHs ('000) Rural	N.A.	23,680	25,425	-
Livestock Density (per sq.km) No.	107.5	127.6	143.2	137.6
Livestock per Rural Households No.	4.4	4.6	4.4	NA
Livestock per capita (Rural) No.	0.8	0.8	0.7	0.4

Note: Figures in parentheses indicate annual percentage change over the previous period.

- Sources: I. Livestock Census (for the year 1972, 1982, 1992, and 1997), Government of India
 II. Population Census of India
 III. Agriculture, Centre for Monitoring Indian Economy, (CMIE), Mumbai, 2000

Table 2: Ownership of Livestock and Access as well as Use of CPLRs Among Major States in India, 1998

States	% of HHs Processing Livestock	CPR-Land Per HHs	% of HHs Processing Livestock and Reporting Grazing
Andhra Pradesh	36	0.17	38
Assam	62	0.05	38
Bihar	52	0.08	30
Gujarat	59	0.72	42
Haryana	74	0.05	20
Himachal Pradesh	81	0.33	43
Jammu and Kashmir	81	0.14	31
Karnataka	56	0.25	44
Kerala	32	0.12	09
Madhya Pradesh	68	0.74	62
Maharashtra	46	0.30	24
Orissa	58	0.28	60
Punjab	55	0.02	02
Rajsthan	84	2.04	32
Tamil Nadu	29	0.16	30
Uttar Pradesh	72	0.14	30
West Bengal	54	0.03	31
All India	56	0.31	35

Source: NSSO 54th Round January 1998-June 1998, Common Property Resources in India, Report No. 452

Table 3: Use of CPRs for Livestock Rearing by Category of Households

	% of Households		Av. Quantity of Fodder Collected (Kgs.)
	Possessing Livestock	Reporting Collection of Fodder	
Rural Labour	42	13 (25)*	294
Other with Land Possessed (ha)			
<0.20	25	08	200
0.20 – 0.50	66	17	305
0.50 – 1.00	80	18	338
>1.00	88	11	251
Others: All	66	12	261
All	56	13 [23]** (25)*	275

** % of HHs reporting grazing on CPRs (T 37)

* value of fodder collection to the total value of material collected.

Source: As in Table 2. Compiled from T 37.

Table 4: Proportion of Households Reporting any Worker Involved in Livestock as Main or Subsidiary Activity: 1983 and 1993-94

States	Landless	Landed	Overall
	% Change Among Households		
Andhra Pradesh	-5.56	-4.60	-6.88
Assam	-95.45	-66.67	-73.68
Bihar	-96.72	-79.80	-81.44
Gujarat	-14.44	-15.22	-17.96
Haryana	85.19	54.04	57.45
Himachal Pradesh	122.22	-15.13	-15.14
Jammu & Kashmir	-33.33	0.25	-1.02
Karnataka	0.00	-19.09	-20.09
Kerala	-34.85	-45.98	-44.18
Madhya Pradesh	-40.82	-21.15	-25.00
Maharashtra	-11.94	-36.84	-6.76
Orissa	-54.55	9.37	0.00
Punjab	4.95	-33.22	-40.21
Rajasthan	-4.55	-1.80	-0.48
Tamil Nadu	-52.78	-8.76	-19.80
Uttar Pradesh	-30.33	-37.57	-38.17
West Bengal	-52.22	-54.24	-55.42
All India	-27.06	-26.32	-28.09

Source: NSSO 38th and 50th Rounds, Government of India, New Delhi

I – Refers to 1983 based on 38th Round;

II – Refers to 1993-94 based on 50th Round

Table 5: Livestock* Per 100 Households Across Landholding Size: India- 1982 and 1992

Landholding Size (Ha)	No.		
	1982	1992	% Change
I. Landless	68 (35)	28 (17)	-58.8 (-51.4)
II. Upto 0.2	222 (85)	167 (77)	-24.7
III. 0.21 – 1.0	265 (178)	289 (204)	9.0
IV 1.01 – 4.0	563 (382)	416 (293)	-26.1
V 4.01 – 10.0	863 (591)	494 (328)	-42.7
VI > 10.0	1523 (922)	741 (366)	-51.3
All	337 (205)	252 (179)	-14.8 (-12.7)

* Include total cattle, buffalo, sheep and goats

Figures in parentheses exclude sheep and goats

Source: NSSO 37th and 48th Rounds, Reports on Land and Livestock Holding Survey, Government of India

**Table 6 (a): Livestock per 100 Households across Landholding Size:
Gujarat-1982 and 1992**

Landholding Size (Ha)	No.		
	1982	1992	% Change
I. Landless	229	44	-80.8
II. Upto 0.2	450	532	18.2
III. 0.21 – 1.0	220	223	1.4
IV 1.01 – 4.0	376	297	-21.0
V 4.01 – 10.0	509	260	-48.9
VI > 10.0	883	330	-62.6
All	264	203	-23.1

Source: As in Table 5.

**Table 6(b): No. of Major Livestock Species per 100 Households Across
Landholding Size in Gujarat: 1982 and 1992**

	Bullock			Cow			Buffalo			Sheep & Goat		
	1982	1992	% change	1982	1992	% change	1982	1992	% change	1982	1992	% change
Nil	28	02	-92.9	24	5	-79.2	17	14	-17.6	160	23	-85.6
Upto 0.20	21	21	0.0	36	46	26.4	22	75	240.9	371	391	5.4
0.21-1.0	70	60	-14.3	51	38	-25.5	61	94	54.0	38	31	-19.0
1.01-4.0	142	79	-44.6	86	53	-38.6	76	121	59.2	72	44	-39.9
4.0-10.0	231	72	-68.8	142	34	-76.1	106	119	12.3	30	35	18.6
>10	435	53	-87.8	271	24	-91.1	112	198	76.9	34	55	60.2
All	95	52	-45.3	64	33	-48.4	51	54	5.9	107	64	-40.2

Source: As in Table 5.

Table 7 (a): Growth and Relative Share of Livestock among Districts of Gujarat

District/Region	1972 % Share	1982		1992		1997	
		% Change	% Share	% Change	% Share	% Change	% Share
Gujarat	100.00	22.1	100.00	6.3	100.00	1.7	100.00
Jamnagar	5.4	17.1	5.2	-4.2	4.6	-0.9	4.5
Rajkot	6.8	22.0	6.8	-2.6	6.2	-5.5	5.8
Surendranagar	4.2	-17.0	4.3	-8.2	3.7	-1.9	3.6
Bhavnagar	6.4	38.0	7.2	-9.7	6.1	-3.1	5.9
Amreli	4.1	22.0	4.1	-2.5	3.7	1.9	3.7
Junagadh	6.3	16.2	6.0	-0.3	5.6	6.0	5.9
Kachchh	7.3	57.1	9.3	-15.1	7.5	13.0	8.3
Saurashtra	40.4	25.1	42.9	-7.0	37.5	1.9	37.6
Banaskantha	9.3	18.1	9.0	1.9	8.6	-12.9	7.4
Sabarkantha	6.7	10.0	6.0	17.6	6.7	6.1	7.0
Mahesana	6.8	24.0	6.8	0.7	6.5	1.4	6.5
Gandhinagar	0.6	28.3	0.6	1.8	0.6	235.0	1.9
Ahmedabad	4.1	16.1	3.9	17.8	4.3	-30.8	2.9
Kheda	5.9	22.0	5.8	12.9	6.2	3.7	6.3
Panchmahals	9.7	16.1	9.2	23.5	10.7	17.4	12.4
Vadodara	4.6	25.4	4.8	30.8	5.8	-4.8	5.5
Bharuch	3.0	22.0	3.0	26.9	3.6	0.8	3.5
Surat	4.2	12.0	3.9	15.4	4.2	10.3	4.5
Valsad	4.2	8.0	3.7	34.9	4.7	15.5	3.9
Dangs	0.6	1.4	0.5	51.3	0.7	-3.5	0.6
Rest of Gujarat	59.6	17.2	57.1	16.3	62.5	1.5	62.4

Note: % Change over the previous time period.

Source: Directorate of Economics and Statistics, Statistical Abstract of Gujarat (Various Issues), Gandhinagar

Table 7 (b): Relative Share of Different Categories of Livestock Across Districts in Gujarat Percentage Share

	Cattle				Buffalo				Sheep & Goat			
	1972	1982	1992	1997	1972	1982	1992	1997	1972	1982	1992	1997
Gujarat	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Jamnagar	5.3	5.3	4.9	4.7	3.0	2.8	2.7	2.8	7.1	6.7	6.0	6.0
Rajkot	6.9	7.1	6.5	6.2	3.8	4.0	3.9	3.9	8.8	8.5	8.1	7.2
Surendranagar	3.7	4.2	4.1	4.0	2.1	2.3	2.1	2.6	6.3	5.9	4.5	4.0
Bhavnagar	5.5	6.2	5.0	4.9	5.1	5.6	4.9	4.5	8.6	10.2	8.7	8.3
Amreli	4.8	4.7	4.3	4.0	2.9	3.2	2.9	2.9	4.0	4.0	3.9	4.5
Junagadh	8.1	7.7	7.1	7.6	6.4	5.9	5.9	6.0	3.9	3.6	3.5	3.8
Kachchh	4.7	6.0	5.1	5.6	1.8	2.6	2.4	2.6	14.2	19.1	14.6	16.6
Saurashtra	39.1	41.2	36.9	36.9	25.2	26.4	24.8	25.3	52.8	57.9	49.3	50.4
Banaskantha	7.0	7.9	6.5	5.6	7.0	8.1	8.6	8.6	13.6	11.2	10.7	8.0
Sabarkantha	6.6	6.0	6.4	6.6	8.6	8.4	8.8	9.4	5.6	4.5	5.6	5.3
Mahesana	4.6	5.0	4.4	4.2	13.7	12.9	12.0	11.6	4.4	3.7	3.5	3.8
Gandhinagar	0.4	0.4	0.3	1.2	1.4	1.4	1.2	3.5	0.2	0.2	0.3	1.0
Ahmedabad	4.3	3.9	3.8	2.8	5.9	5.6	5.7	3.9	2.5	2.0	2.9	1.9
Kheda	3.8	3.9	4.4	4.5	15.2	13.1	12.4	11.4	2.0	2.0	2.6	2.9
Panchmahals	12.5	12.2	13.8	15.7	8.3	8.2	8.7	9.8	7.3	7.2	9.9	12.0
Vadodara	5.3	5.3	6.5	6.6	5.6	5.6	6.0	5.4	3.2	3.4	4.9	4.5
Bharuch	3.7	3.5	4.2	4.0	2.7	2.9	3.0	2.9	2.3	2.4	3.4	3.5
Surat	5.7	4.9	5.4	5.4	3.5	4.3	4.8	5.2	2.8	2.6	2.6	2.9
Valsad	6.0	5.1	6.4	5.5	2.8	2.8	3.6	2.8	2.9	2.6	3.6	3.4
Dangs	1.0	0.8	1.1	1.0	0.1	0.2	0.3	0.3	0.3	0.3	0.6	0.6
Rest of Gujarat	60.9	58.8	63.1	63.1	74.8	73.6	75.2	74.7	47.2	42.1	50.7	49.6

Source: Directorate of Economics and Statistics, Statistical Abstract of Gujarat (Various Issues), Gandhinagar

Table 8: Correlation Co-efficients for Change in the Relative Share of Livestock and Milch Animals Across Districts in Gujarat: 1982-1992

Variables	Correlation Co-efficients with change in the Relative Share of	
	Total livestock	Milch animals
% Change in Agri. Labour Productivity 91-81	-	-
Increase in % of GIA to GCA 91-81	-	.498*
% of Barren & Unculti. Land 91-98	-.592**	-
% Change in No. of Tractors 92-82	-	-
Average Rainfall 81-97	.533*	-
Variation in Rainfall 81-97 (CV)	-.705**	-.482*
Livestock Density 1992	.593**	.477*
Milch Animal Density 1992	-	.568*
Agri. Lab. Productivity 1991	-.691**	-.590**
% Change in the Share Milch Animals 82-92	.709**	1.00
% change in the Share of Total Livestock 82-92	1.00	.709**

Note: * 1% level of significance
 ** 5% level of significance
 *** 10% level of significance
 - No significant correlation

Table 9: Households having Different Types of Livestock among Sample Villages

Landholding Size (Ha)	% HHs Possessing Livestock		
	Livestock	Milch animals	Sheep & goat
1. Landless	42.4	21.6	22.5
2. Landed	76.7	67.8	11.9
2.1 Upto 1	62.7	46.6	22.9
2.2 1.01 – 2	69.8	59.0	13.1
2.3 2.01 – 3	73.8	62.7	13.5
2.4 >3	86.9	82.6	7.0
All	65.0	52.1	15.6

Source: Primary Survey (Shah, 2003)

Table 10: Odds Ratios Predicting Ownership of Livestock among Households in Sample Villages

Variables	Milch Animals		Sheep & Goat		Total Livestock	
	β -value	Level of Sig.	β -value	Level of Sig.	β -value	Level of Sig.
PCLAND	.019	.732	-.323	.024	-.024	.654
IRRI	.612	.000	-.122	.396	.597	.000
RELPRODN	.472	.000	.168	.229	.498	.000
HINC	.235	.002	-.363	.000	.050	.498
DEGRATOT	.005	.119	.017	.000	.008	.006
WLAND	.034	.864	.518	.075	.077	.688
LFM	.424	.002	.129	.408	.527	.000
NFE	.792	.000	.697	.002	.612	.001
HEDU	-.031	.139	-.045	.067	-.038	.048
CASTE	1.075	.000	-.542	.000	.317	.000
CCROP	.041	.754	-.169	.317	-.108	.405
CONSTANT	-5.903	.000	-.397	.304	-3.485	.000

References

- Bilsborrow (1992), *Rural Poverty, Migration and Environment in Developing Countries*, Working Paper Series 1017, The World Bank, Washington DC.
- Birthal, P.S. and Rao, P. (2004), 'Intensification of Livestock Production in India: Patterns, Trends, and Determinants,' *Indian Journal Agricultural Economics*, 59 (3), pp. 555-566.
- Chawla, N.K., Kurup, M.P.G. and Sharma, Vijay Paul (2003), *State of the Indian Livestock Farmers and Indian Livestock Sector: A Status Paper* (draft) Indian Institute of Management, Ahmedabad.
- Chopra, Kanchan and Gulati, S.C. (2001), *Migration, Common Property Resources and Environmental Degradation: Interlinkages in India's Arid and Semi-arid Regions*, Sage Publications India Pvt. Ltd., New Delhi.
- Government of India (2002), Basic Animal Husbandry Statistics, Ministry of Agriculture, Department of Animal Husbandry and Dairying, New Delhi.
- Government of India (1997), Basic Animal Husbandry Statistics, Ministry of Agriculture, Department of Animal Husbandry and Dairying, New Delhi.
- Jodha, N.S. (1997), 'Common Property Resources and Rural Poor in Dry Regions of India', *Economic and Political Weekly*, 31 (27), pp. 1169-81.
- Mishra, S.N. (1995), 'India's Livestock Economy: A Perspective on Research', *Indian Journal of Agricultural Economics*, 50 (3), July-September.
- Pandey, U.K. (1995), 'The Livestock Economy of India: A Profile', *Indian Journal of Agricultural Economics*, 50 (3), July-September.
- Shah, Amita (2005), Land Degradation and Migration in a Dry Land Region in India: SANDEE Working Paper No. 10, Kathmandu.
- Sharma, V.P. and Kohler-Rollefson lise (undated), *Scoping Study on Pastoralism in India*, Centre for Management in Agriculture, Indian Institute of Management, Ahmedabad.
- Sharam, V.P. (2004), 'Livestock Economy of India: Current Status, Emerging Issues and Long Term Perspectives,' *Indian Journal Agricultural Economics*, 59 (3), pp. 512-555.

Subrahmanyam, S and Nageshwar, Rao, R. (1995), Bovine Sector in Agriculturally Prosperous and Backward Region: A Comparison, *Indian Journal of Agricultural Economics*, 50 (3), July-September.

Singh, O.P.; Sharama, A.; Singh, R.; and Shah, T. (2004), `Virtual Water Trade in Dairy Economy: Irrigation Water Productivity in Gujarat', *Economic and Political Weekly*, 34 (31), pp.3492-3497.

Vaidyanathan, A. (1988), *Bovine Economy in India*, Oxford & IBH Publishing Co. Ltd., New Delhi.

Appendix I: Distribution of Rural Households and Area Operated by Landholding Size Classes (1982 and 1992)

Landholding size-class	1982		1992	
	% of hhs	Area operated		
Landless and semi-landless*	26.06	-	21.18	-
Upto 0.2	16.50	0.74	20.28	1.18
0.21 – 1.00	24.65	10.84	27.97	14.32
1.01 – 4.0	25.04	40.29	23.91	42.79
4.01 – 10	6.33	29.94	4.93	26.46
>10.0	1.47	18.22	1.06	15.24
All	100	100	100	100

* Operating <0.002 hectares of land

Appendix II: Asset Base Among Sample Villages

	Villages	Asset Base								
		% of landless hhs	Average landholding size	Per capita landholding* (acres)	Average household size (acres)	% of area irrigated	% of hhs covered with irrigation*	Average size of milch animal (no.)	% of hhs without livestock	% of landed hhs growing commercial crops
Moderate	Dudhai	17.1	9.1	2.0	5.3	31.7	46.2	2.1	25.4	34.5
	Dudhiya	22.6	7.6	1.3	5.8	40.6	46.3	1.4	17.7	100.0
High	Veraval	36.2	11.8	2.4	4.7	20.7	42.3	0.8	49.7	82.7
	Vaghaniya	42.1	8.8	1.6	6.1	2.9	5.7	0.5	51.8	87.9
Very High	Sushiya	44.2	6.2	1.2	5.4	7.4	15.5	2.1	34.5	55.5
	Liliya	55.2	8.1	2.3	5.2	2.3	14.1	0.9	53.0	83.3
	All	34.0	8.4	1.6	5.4	23.1	38.3	1.5	35.0	67.2

* For those having land