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Effect of Socio-Economic and Agro-ecological Factors on Structure and Ownership of Livestock: Evidence from Rajasthan

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I

INTRODUCTION

The importance of livestock in Indian agricultural economy is increasing with its contribution to agricultural gross domestic product rising to over 25 per cent in 2002-03 from 16 per cent in 1970-71 (Birthal and Taneja, 2006) an annual growth rate of 4.3 per cent, higher than the overall growth rate of 2.8 per cent in the agricultural sector as a whole. The robust growth in the livestock sector is likely to continue considering rapidly increasing demand for animal food products (Delgado *et al.*, 1999 and Parthasarathy Rao *et al.*, 2004). Robust growth in livestock production is important to sustain agricultural growth, and also to improve household nutritional security, generate employment and reduce poverty. Besides, the contribution of livestock towards draft power, energy for rural households and maintaining soil fertility is of great importance (Mishra and Sharma, 1990; Sharma, 2004).

The importance of livestock is much pronounced in arid and semi-arid environments as in Rajasthan, which are frequently prone to droughts (Rathore, 2004). Livestock production is vulnerable to such natural hazards, but not as much as crop production, it acts as a cushion against risks of crop failure. Livestock generate a continuous stream of income and help consumption smoothening, and being more liquid, they can be easily marketed during times of crises. In 2003 Rajasthan had 10.9 million cattle, 10.4 million buffalo and 26.8 million small ruminants and produced 80 lakh tonnes of milk, 0.63 lakh tonnes of meat and 0.15 lakh tonnes of wool, contributing 9.1, 1.5 and 30.7 per cent of state GDP (gross domestic product) respectively (Government of Rajasthan, 2003).

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The structure of livestock production in the state however has been undergoing a change, partly due to changes in the economic and ecological environments. The population of large ruminants in the state increased from 19.5 million in 1983 to 21.3 million in 2003 at a compound annual growth rate (CAGR) of 0.43 per cent, whereas the small ruminants reduced from 28.9 million to 26.8 million during the same period at an CAGR of –0.37 per cent per annum (Gupta *et al.*, 2006). Though the aggregate bovines registered an increase in population, it was mainly due to the increase in the population of buffalo, which could more than offset the decline in the cattle population. Within the cattle population, the crossbred cattle recorded a sharp CAGR of 13.18 per cent, whereas, that of local cattle was –1.29 per cent highlighting that the productive crossbred cattle are gradually replacing the local cattle. In this dynamic adjustment matrix, we have to undertake goal oriented policies and adopt appropriate technologies to generate various products and services from the livestock on a long-term perspective. For better targeting of the policies and livestock technologies, it is essential to understand the profile and ownership pattern of livestock. Both the land ownership and social caste are relevant to livestock ownership and production in India (Turner, 2004). The amount of land one holds affects his ability to support livestock by raising ample crop residues. Other than such private land, the common property resources (CPRs) like village pastures, tanks, local forests, etc. provide opportunity for grazing the livestock. The type of livestock reared depends on the farmers' capacity to invest and their access to resources (both private and common) and services for which caste is a major factor in Indian villages.

Livestock development policy, therefore should consider the interplay of various factors. This study examines the structure and ownership pattern of livestock across classes, caste and agro-ecologies and identifies the factors influencing it.

The paper is divided into four sections. The following section provides a brief description of the data and the method of analysis. Section III presents the results and discussions. The concluding observations and implications are given in Section IV.

II

DATA AND METHODOLOGY

The study uses primary data collected for a larger study "Crop-Livestock System Analysis for Sustainable Production for Rajasthan State" funded by the National Agricultural Technology Project of Indian Council of Agricultural Research. The data were collected using multistage random sampling from 5,818 households spread over nine districts in different ecologies of Rajasthan. These are Jodhpur from arid Western Zone, Hanumangarh from Irrigated North Western Plain, Jhunjhunu from Transitional Plain Zone of Inland Drainage, Jalore from Transitional Plain of Luni Basin, Jaipur from Semi-Arid Eastern Plain, Alwar from Flood Prone Eastern Plain, Bhilwara from sub-humid Southern Plain, Banswara from humid Southern Plain and Sawai Madhopur from humid South Eastern Plain. Further, one district from each

sub-zone was selected at random. One tehsil from each of the selected district was randomly selected and a cluster of 3-4 villages from each tehsil was selected for collection of information from farmers. All the farmers who were essentially keeping livestock in these selected cluster of villages were identified for data collection. They were personally interviewed using structured survey schedule during December 2002.

The total sample was post-classified into seven zones based on the rainfall and irrigation variations for easy comprehension. The classification and the districts included are High Rainfall High Irrigation (HRF-HIRR, Sawai Madhopur), High Rainfall Medium Irrigation (HRF-MIRR, Bhilwara), High Rainfall Low Irrigation (HRF-LIRR, Banswara), Medium Rainfall High Irrigation (MRF-HIRR, Alwar), Medium Rainfall Medium Irrigation (MRF-MIRR, Jaipur), Low Rainfall Medium Irrigation (LRF-MIRR, Hanumangarh, Jhunjhunu and Jalore) and Low Rainfall Low Irrigation (LRF-LIRR, Jodhpur).

Analytical Methods

Determinants of the Livestock Holding and Intensity

Considerable variation are noticed in the holding size and intensification of livestock across different agroclimatic regions as a response to the variation of rainfall, temperature, land availability, etc. Besides, a number of factors affecting the resource availability, technology responsiveness, social hierarchy could also be important determinants of livestock holding and intensification. As far as the rural household is concerned, the operational holding (OH) is the major determinant and indicator of asset possession (Batra, 1986 and Rajagopalan and Anuradha, 1987). The quantity and quality of land represented mostly by the size of operational holding and extent of irrigation reflects the cropping potential and hence availability of crop residues/stubbles as fodder. The family size is an indicator of potential household labour supply for livestock rearing. Literacy is many times projected as an indicator of progressiveness of the society and hence technology sensitiveness and as such is expected to influence livestock ownership parameters. The occupation of the farmers as well as their caste mostly determine the social status of the caste ridden rural households. In the analysis the above variables are used as determinants of both the household livestock holding as well as intensification. In our study the intensification is defined as the number of standard livestock unit (LU) per hectare of operational holding and represent stocking rate. Since the LU is a term which captures all the livestock we have given unequal weightages to different livestock groups[1] in calculating it. Intensification of livestock is a means to increase the returns to land (Birthal and Parthasarathy Rao, 2004).

In this context, we hypothesise that (i) the size of livestock holding increases with the increase in the size of operational holding, but livestock intensification declines with it, (ii) size of livestock holding and intensification increases with the increase in

the quality of land (percentage area irrigated), (iii) size of livestock holding and intensification increases with increase in the household labour supply, (iv) size of livestock holding increases with increase in the caste hierarchy, but intensification declines with it, and (v) agroclimatic variation profoundly influences the livestock holding and intensification.

The association between the socio-economic variables and livestock holding were captured by correlation analysis. The determinants of the livestock holding in the context of the socio-economic parameters and agroecological variation was assessed using multiple linear regression of the following form:

$$Y= a+ b_1 OH +b_2 PERIRR +b_3 FLYSIZE + d_1DUMOCPN + d_2 DUMLIT + d_3ST+ d_4SC+ d_5OTR + d_6 HRF\text{-}HIRR + d_7 HRF\text{-}MIRR + d_8 HRF\text{-}LIRR + d_9 MRF\text{-}HIRR + d_{10} LRF\text{-}MIRR + d_{11} LRF\text{-}LIRR + e \quad ....(1)$$

Where,

Y = Livestock possession in terms of livestock unit (LU)/ household and LU/ha,
OH = Size of operational holding (ha),
PERIRR = Percentage area irrigated (per cent),
FLYSIZE = Total family size (No.),
DUMOCPN = Dummy variable for main occupation of the head of the family (1 = for farming and 0 otherwise),
DUMLIT = Dummy variable for literacy of the head of the family (1 = literate and 0 otherwise).

ST, SC and OTR = Dummy variable for Scheduled Tribe, Scheduled Caste and Other Community respectively. The farmers broadly belonged to four caste groups, which included the Other Backward Caste also (OBC). The OBC were the largest community in terms of population and was taken as the base population. The Other Community includes the forward castes, which were not included in the earlier discussed caste groups.

HRF-HIRR, HRF-MIRR, HRF-LIRR MRF-HIRR, LRF-MIRR and LRF-LIRR = These are the agroclimatic zones dummies classified as described in the data section. The Medium Rainfall- Medium Irrigation zone (Jaipur) was taken as the base dummy.

Logit Model

The effect of the above described variables on the livestock holding varies considerably among different livestock groups classified species-wise and functionally. It is generally believed that relatively low land holders depend more on small ruminants than on other livestock groups for meeting their livelihood (Bhatia *et al.*, 2004 and Sharma, 2004). Also it is held that, the literacy of the farmers and

various social factors influence the adoption of the cross breeding technology. However, there is lack of empirical evidence in this regard and in this study we attempt to examine the factors affecting ownership of individual livestock groups also.

Here, we hypothesise that (i) the ownership of bovines are positively influenced by the size of operational holding and that of the small ruminants are negatively influenced by the size of operational holding, (ii) the size of operational holding influences the draft animals negatively, (iii) the literacy of the head of the family positively affects the ownership of crossbred cattle, (iv) the caste of the farmers has profound influence on the ownership of various livestock groups.

The ownership of a particular livestock group has been brought out by logit model.

Let P_i be the probability that a farmer owns a particular livestock.

$$P_i = \frac{1}{1+e^{-Zi}}$$

$$1\text{-}P_i = 1\text{-}\frac{1}{1+e^{-Zi}}$$

= the probability that a farmer does not own the particular livestock.

$$\text{The Odd's ratio} = \left(\frac{Pi}{1-Pi}\right) = e^{Zi}$$

Taking logarithm on both sides,

$$\text{Ln}\left(\frac{Pi}{1-Pi}\right) = Z_i = \alpha + \beta i X i + e_i$$

Where, α =intercept, β = Vector of response coefficients, e= Vector of random disturbance and X is the set of explanatory variables described in equation 1.The livestock included for the analysis are bovine, total cattle, local cattle (LC), crossbred cattle (CBC), buffalo, draft animals (DA), small ruminants (SR), goat, sheep, and camel. The logit analysis was separately done for all the above variables.

III

RESULTS AND DISCUSSION

Livestock Production System

The livestock production system in Rajasthan is mainly of mixed farming consisting of both crop and livestock. The livestock till the fields, feed on crop residues and fertilise the fields with their manure and provide milk and meat for household consumption, celebration and religious festivals and for meeting the cash

requirement. Livestock farming in Rajasthan is a way of life and is well integrated with the culture of people. The livestock farmers in the state have average operational holding of 3.72 ha (Appendix 1). However, considerable variation exists in the distribution of land. The small holders (<2 ha of OH) accounted for nearly half of the total livestock rearers. The proportion of small holders seemed to positively vary with the extent of rainfall and irrigation.

Of the total respondents, nearly two-fifth of the livestock farmers were in the low rainfall zone, one-third in the high rainfall zone and one-fourth in the medium rainfall zone. The distribution of farmers by caste revealed that nearly half of the livestock farmers belonged to OBC. The scheduled caste and tribe (SC/ST) accounted for nearly 15 per cent each and the rest were in Other Category. The population of OBC is highest in almost all the zones. The average literacy of the farmers was around 46 per cent, lower than that reported for the state as a whole (61 per cent). The distribution of the farmers classified by the land holding class (Table 1) reveals declining share of small holders (<2 ha of land) among the higher caste hierarchy (more than three-fourth of ST, 70 per cent of SC, 47 per cent of OBC and one-third of the Other Category were small holders).

TABLE 1. DISTRIBUTION OF CASTE AND OCCUPATION OF FARMERS ACROSS LAND CATEGORY (CLASS) OF FARMERS

		Caste (per cent)*					Occupation (per cent)**			
Category	Number of farmers	ST	SC	OBC	Others	Literacy per cent	Business	Farm labour	Farming	Service
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Landless	414	4.76	13.0	6.77	5.05	49	7.49	38.89	15.94	15.22
Marginal	1234	41.04	29.38	15.42	13.51	42	2.35	10.29	75.12	9.08
Small	1420	31.52	26.72	25.10	14.71	46	3.10	3.94	82.25	9.43
Semi-Medium	1516	17.92	21.50	28.69	29.50	48	1.64	1.91	82.52	12.60
Medium	708	4.65	5.76	15.15	15.72	49	1.41	0.85	82.06	15.40
Large	526	0.11	3.55	8.87	21.51	37	1.90	0.38	91.23	6.46
Overall	5818	100	100	100	100	46	2.56	6.55	76.90	11.05

Note: * Percentage to the corresponding overall; ** percentage to the corresponding number of farmers.

Livestock Distribution

On an average there were more than 375 livestock units (LU) per 100 farmers, and the number is highest in the Low Rainfall Low Irrigated zone (605 per 100 households) as the zone is not very favourable for cultivation (Table 2). The size of livestock in absolute number was also the highest in this zone (2161 per 100 households) as this zone possesses largest number of small ruminants (1858 per 100 households). The size of the livestock holding varies significantly among zones. It was the highest in the lower rainfall zones (within it, the Low Irrigation and Medium Irrigation in that order). The crop sector in the low rainfall zone in the state is fraught with higher risk of crop loss due to occurrence of drought and extreme moisture

TABLE 2. DISTRIBUTION OF OPERATIONAL HOLDING AND LIVESTOCK ACROSS AGROCLIMATIC TOPOLOGY

(per 100 households)

			Bovines					Small Ruminants						
Caste group (1)	Farmers (per cent) (2)	Average size of OH (ha) (3)	Total bovine (4)	Buffalo (5)	Cattle (6)	Milch animal (7)	Draft animal (8)	Total small ruminants (9)	Goat (10)	Sheep (11)	Camel (12)	Total livestock (13)	LU (14)	Lu/ha (15)
HRF-HIRR	10.16	1.95 (5.33)	370 (12.5)	305 (17.3)	65 (5.4)	110 (12.0)	17 (7.6)	267 (5.5)	266 (9.0)	0 (0)	0 (0)	337 (8.1)	351 (9.5)	1.79
HRF-MIRR	11.64	1.60 (5.02)	32 (1.2)	0 (0)	32 (3.1)	28 (6.0)	0 (0)	425 (10.1)	266 (10.3)	159 (9.7)	0 (0)	457 (6.7)	241 (7.5)	1.50
HRF-LIRR	13.70	1.28 (4.71)	452 (20.7)	235 (17.9)	218 (24.7)	98 (14.4)	121 (72.7)	182 (5.1)	176 (8.0)	6 (0.4)	10 (8.1)	638 (11.0)	457 (16.7)	3.57
MRF-HIRR	8.46	1.50 (3.41)	297 (8.4)	280 (13.2)	17 (1.2)	98 (8.9)	0 (0)	30 (0.5)	30 (0.9)	0 (0)	26 (13.0)	337 (3.6)	254 (5.7)	1.69
MRF-MIRR	15.86	2.84 (12.11)	414 (21.9)	266 (23.6)	148 (19.4)	109 (18.5)	15 (10.4)	289 (9.4)	251 (13.2)	38 (3.2)	1 (0.5)	704 (14.0)	387 (16.4)	1.36
LRF-MIRR	29.27	4.71 (37.02)	253 (24.7)	159 (26.0)	94 (22.7)	93 (29.3)	4 (5.6)	471 (28.1)	271 (26.4)	200 (30.9)	35 (61.3)	738 (27.1)	341 (26.6)	0.72
LRF-LIRR	10.91	11.05 (32.39)	292 (10.6)	32 (1.93)	260 (23.5)	94 (11)	8 (3.6)	1858 (41.3)	889 (32.2)	969 (55.7)	26 (17.1)	2161 (29.6)	605 (17.6)	0.55
Overall	5818	3.72	300	179	121	93	23	491	301	190	17	797	375	1.01

Figures in parentheses indicate percentages to total of corresponding column heads.

deficiency and farmers depend on the livestock for regular source of income. Though the average size of operational holding is higher in the lower rainfall zones (for instance it was 11.05 ha in the low rainfall low irrigation zone and 1.95 ha in high rainfall high irrigation zone), the quality of the land is poor in terms of productivity. In the Low Rainfall-Low Irrigation zone, less than one per cent land is irrigated and as such the carrying capacity is low and farmers depend mostly on the CPRs for grazing and fodder. The low rainfall zones together contributed nearly 70 per cent of total small ruminants (nearly 87 per cent of sheep and 59 per cent of goats) and nearly 35 per cent of bovines (28 per cent of buffalo and 46 per cent of cattle) and therefore any policy of enhancement of livelihood security in the arid regions has to essentially consider the livestock sector, particularly small ruminants. For these regions, the research priorities for bovines have to be oriented towards cattle, both for the milch and draft purposes. On the other hand, buffalo plays an important role in the high and medium rainfall zones. In the case of camel, nearly 78 per cent was distributed in the low rainfall zone, 14 per cent in the medium rainfall zone and 8 per cent in the high rainfall zones.

The intensification of livestock (LU/ha) was generally high in the higher rainfall zones and gradually declined in the medium rainfall and lower rainfall zones - from 1.79 LU/ha in high rainfall zone to 0.55 LU/ha in low rainfall low irrigation zone. This might be because of high fragmentation of operational holding due to mounting demand for agricultural land in the higher rainfall zones. Thus the size of the livestock holding was high in the low rainfall zone, but the intensification was high in high rainfall zone.

A look at the distribution of livestock across different classes (Table 3) reveals interesting insights. The land and livestock holdings are positively related and this is true for all the livestock groups (except draft animals). Further, the livestock is more equitably distributed than the land holdings. Nearly 53 per cent small holders (landless, marginal and small farmers together) accounted for only 13 per cent of land where as 9 per cent large farmers alone accounted for 43 per cent of land. But the large farmers accounted for only one-fifth of total livestock in absolute numbers and one-sixth in terms of LU compared to nearly 46 per cent (both in absolute number and LU) by the small holders. Thus the farmers might be compensating for their low income from land by undertaking livestock farming. The egalitarian role of livestock in rural income distribution is documented earlier also (Birthal and Singh, 1995; Shukla and Brahmanker, 1999).

One important observation is that though the small ruminants constituted the major livestock component of resource poor farmers, the large farmers control nearly one-fourth of total small ruminants comprising 17 per cent goat and 39 per cent sheep. This may be because the large farmers might have access to common lands more than the resource poor farmers and raise the animals in an extensive system. Such a situation is reported for Karnataka state also (Pasha, 1991 and Birthal *et al.*, 1999).

TABLE 3. DISTRIBUTION OF OPERATIONAL HOLDING AND LIVESTOCK ACROSS LAND CATEGORY OF FARMERS

(per 100 households)

Caste group (1)	Farmers (per cent) (2)	Average size of OH (ha) (3)	Bovines					Small Ruminants			Camel (12)	Total livestock (13)	LU (14)	Lu/ha (15)
			Total bovine (4)	Buffalo (5)	Cattle (6)	Milch animal (7)	Draft animal (8)	Total small ruminants (9)	Goat (10)	Sheep (11)				
Landless	7.12	0.00	146	89	57	49	4	781	325	456	0	927	281	-
		(0.0)	(3.5)	(3.5)	(3.4)	(3.7)	(1.3)	(11.3)	(7.68)	(17.1)	(0.5)	(8.27)	(5.3)	
Marginal	21.21	0.62	208	116	92	60	32	259	218	42	4	471	253	4.10
		(3.5)	(14.7)	(13.7)	(16.1)	(13.6)	(29.5)	(11.2)	(15.3)	(4.7)	(11.5)	(12.5)	(14.3)	
Small	24.41	1.43	289	184	105	86	32	347	261	86	2	638	334	2.32
		(9.4)	(23.5)	(25.1)	(21.3)	(22.5)	(34.5)	(17.3)	(21.2)	(11.1)	(5.9)	(19.5)	(21.7)	
Semi-medium	26.06	3.15	320	205	115	103	21	430	290	140	6	756	384	1.21
		(22.1)	(27.8)	(29.8)	(24.8)	(28.8)	(24.1)	(22.8)	(25.2)	(19.2)	(23.9)	(24.7)	(26.7)	
Medium	12.17	6.68	399	259	140	127	13	472	331	141	14	885	462	0.69
		(21.8)	(16.2)	(17.6)	(14.1)	(16.5)	(6.8)	(11.7)	(13.4)	(9.0)	(24.7)	(13.5)	(15.0)	
Large	9.04	17.79	474	202	272	153	10	1393	574	819	25	1892	704	0.40
		(43.2)	(14.3)	(10.2)	(20.3)	(14.8)	(3.8)	(25.7)	(17.2)	(39.0)	(33.6)	(21.4)	(17.0)	
Overall	100	3.72	300	179	121	93	23	491	301	190	7	797	375	1.01

Figures in parentheses indicate percentages to total of corresponding column heads.

The number of milch animals varies positively with the size of farm. This does not mean that the low landholders, particularly landless farmers are not participating in dairying, but they posses only 3.5 per cent of bovines compared to 11.3 per cent of small ruminants. Thus landless farmers participate more in the small ruminant farming than in bovine farming. Given the lower productivity of the local cattle, their not-so-small share in the milch animal is to be viewed with respect to its role as a source of producing draft animal. Traditionally the local cattle are considered as a source of production of draft animals (Vaidyanathan, 1988). The draft animals are mainly maintained by the low land-owners. About 90 per cent of the draft animals are reared by farmers with less than 4 ha of operational holding. The economies of size is favourable for owning a tractor in the case of large farmers and for draft animal by small farmers. The number of draft animals kept by the farmers decreases from around 30 in the case of marginal and small farmers to 10 in the case of large farmers indicating a declining use of the animal power for draft purpose by the bigger farm categories. In view of such enormous importance of draft animals for small holders and decline in the population of the draft animals, it is important to develop suitable animal breeding policy for draft purposes.

Rajasthan being the proud owner of most of the camels in India, it is interesting to examine its ownership pattern in terms of landholding. The large, medium and semi-medium farmers together accounted for more than 80 per cent of camels, more than one-third by the large farmers alone. At many places in Rajasthan, camels are not bred, but are purchased from the camel breeding zone and are used for transportation purpose. But, recent census data indicate decline of this livestock even in its breeding tracts, gradually being replaced by the motor vehicle for transportation, threatening its diversity and even existence. The traditional *Raika* community who were the keepers of this livestock are gradually getting disinterested in its rearing due to obvious economic compulsions (Rollenfson and Rathore, 2004).

Of the total livestock, buffalo accounted for nearly 10 per cent for both landless and large farmers and ranged between 25 to 30 per cent for all other categories. The share of cattle hovered around 15- 20 per cent except for the landless farmers. Goats constituted more than 30 per cent of livestock for all categories where as sheep accounted for nearly 10-15 per cent for all categories except the landless and large farmers where they constituted nearly half in the former and 43 per cent in the latter. Thus small ruminants turned out to be the major component of livestock systems.

The intensification of livestock shows a negative relationship with the land holding. The marginal farmers nearly exert 10 times more pressure on the land compared to the large farmers. It was 4.1 LU/ha in the case of marginal farmers and consecutively declined to 0.40 LU/ha in case of large farmers.

The equitable distribution of livestock in comparison with land is true in case of the caste-wise classification also (Table 4). Nearly one-third SC/ST farmers together accounted for 15 per cent of land, but owned nearly one-fourth of total LU. The livestock holding showed positive relation with the caste hierarchy. The backward

TABLE 4. DISTRIBUTION OF OPERATIONAL HOLDING AND LIVESTOCK ACROSS CASTE GROUP OF FARMERS

(per 100 households)

			Bovines					Small Ruminants						
Caste group	Farmers (per cent)	Average size of OH (ha)	Total bovine	Buffalo	Cattle	Milch animal	Draft animal	Total small ruminants	Goat	Sheep	Camel	Total livestock	LU	Lu/ha
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
ST	15.54	1.47	354	159	194	68	93	307	288	19	2	661	374	2.54
		(6.13)	(18.3)	(13.83)	(24.97)	(11.4)	(63.22)	(9.71)	(38.96)	(1.52)	(1.78)	(12.88)	(15.57)	
SC	15.50	2.24	156	76	80	57	8	493	340	153	6	652	243	1.08
		(9.32)	(8.1)	(6.62)	(10.26)	(9.5)	(5.66)	(15.56)	(17.50)	(12.50)	(5.60)	(12.66)	(10.03)	
BC	50.25	3.73	343	247	96	114	11	390	233	156	24	742	398	1.06
		(50.32)	(57.5)	(69.42)	(39.86)	(61.48)	(24.40)	(39.91)	(38.96)	(41.42)	(70.99)	(46.78)	(53.37)	
OTRS	18.70	6.81	258	97	161	88	8	914	461	453	20	1180	423	0.62
		(34.21)	(16.1)	(10.13)	(24.92)	(17.67)	(6.72)	(34.81)	(28.65)	(44.61)	(21.63)	(21.08)	(21.08)	
Overall	5818	3.72	300	179	121	93	23	491	301	190	17	797	375	1.01

Figures in parentheses indicate percentages to total of corresponding column heads.

communities accounted for nearly 50 per cent of land, 57 per cent of bovines (consisting of 69 per cent of buffaloes and 40 per cent cattle) and nearly 40 per cent of small ruminants thus owning nearly 53 per cent of total LU. In the drier zones, the higher caste farmers owned large flocks of small ruminants looked after by hired labour. The ST community possessed nearly 93 draft animal per 100 household accounting for 63 per cent of total draft animals and the livestock turned out to be the major draft power for ST communities than for other caste groups. The backward community accounted for nearly 58 per cent of bovines and 61 per cent of milch animals, thus accounting for bulk of milk production. The livestock intensification showed negative association with the caste hierarchy.

Association between the Socio-Economic Factors and Livestock Holding

The association between different socioeconomic characters and livestock ownership was captured by the correlation analysis (Table 5). The literacy of the farmers was positively associated with the number of buffalo, crossbred cattle and bovines where as negatively associated with local cattle, goat, sheep and small ruminants in general along with camel and draft animal. Family size and the size of operational holding had significant positive association with all the livestock variables (except that between the operational holding and number of draft animal, where the significant negative relation might perhaps be due to the mechanization of draft work in the large farms). The percentage area irrigated had positive relation only with the buffalo, cross bred-cattle (possibly because of higher availability of crop residues as fodder from irrigated areas) and draft animal (as it could be used for land preparation). Among the livestock themselves, the notable one is the positive association between the buffalo and CBC, positive association between sheep and goat, negative association between the small ruminants and bovines and negative association between cattle and buffalo depending on the similarity between the type of livestock in terms of feeding and management requirements.

Determinants of Livestock Holding per Household and the Intensification

The descriptive statistics of the variables included in the analysis is given in Appendix 2. The operational holding as hypothesised had positive effect on the number of livestock per household (Table 6). The marginal contribution of one hectare of operational holding was nearly 0.18 LU. However, the percentage of irrigation was not an important determinant. This could be possibly due to the fact that the farmers could generate higher income from the irrigated agriculture reducing their dependence on livestock. But the results differ across various livestock groups due to the all encompassing nature of the dependent variable standard livestock unit (LU) which captures all the livestock species into a single variable. The effect of irrigation on various livestock groups is discussed in latter part of the article. The

TABLE 5. CORRELATION COEFFICIENT BETWEEN IMPORTANT LIVESTOCK VARIABLES AND SOCIO-ECONOMIC VARIABLES

Variables (1)	LIT (2)	OCPN (3)	FLYSIZE (4)	OH (5)	PERIRR (6)	CASTE (7)	BUFL (8)	CATL (9)	LCATL (10)	CBCATL (11)	GOAT (12)	SHEEP (13)	CAMEL (14)	SRS (15)	BOVS (16)	DA (17)
LIT	1.00	-0.26*	-0.03#	-0.5*	0.07*	0.09*	0.12*	-0.07*	-0.09*	0.04*	-0.14*	-0.11*	-0.04*	-0.14*	0.04*	-0.07*
OCPN		1.00	0.03#	0.15*	0.15*	0.03#	0.09*	0.11*	0.11*	-0.01	0.05*	0.02	0.09*	0.03#	0.14*	0.09*
FLYSIZE			1.00	0.18	0.06	0.05	0.27*	0.22*	0.21*	0.06*	0.07*	0.07*	0.04*	0.08*	0.35*	0.08*
OH				1.00	-0.29	0.27	0.06*	0.31*	0.32*	0.02	0.20*	0.22*	0.20*	0.24*	0.25*	-0.07*
PERIRR					1.00	-0.23	0.30*	-0.03*	-0.05*	0.03#	-0.21*	-0.15*	-0.16*	-0.19*	0.21*	0.26*
CASTE						1.00	0.03#	-0.05	-0.07*	0.02*	0.05*	0.10*	0.09*	0.09*	-0.01*	-0.37*
BUFl							1.00	-0.01*	-0.01	0.04*	-0.15*	-0.11*	0.02	-0.14*	0.77*	0.17*
CATl								1.00	0.94*	0.31	0.10*	0.07*	0.09*	0.09*	0.63*	0.39*
LCATL									1.00	-0.02	0.10*	0.07*	0.10*	0.09*	0.60*	0.40*
CBCATL										1.00	-0.01	-0.01	0.01	-0.01	0.23*	0.05*
GOAT											1.00	0.51*	0.03#	0.76*	-0.06*	-0.02
SHEEP												1.00	0.09*	0.95*	-0.04*	-0.03*
CAMEL													1.00	0.08*	0.07*	-0.01
SRS														1.00	-0.05*	-0.03#
BOVS															1.00	0.38*
DA																1.00

* and # indicate significance at 1 and 5 per cent level.

LIT-Literacy, OCPN- Occupation (1 for agriculture, 0 for others), FLYSIZE- Family Size, OH-Operational holding , PERIRR-Percentage area irrigated, CASTE-Caste of the farmers (1-ST, 2-SC, 3-OBC and 4-Forward), BUFL-Number of buffaloes, CATL-Number of cattle, LCATL-Number of local cattle, CBCATL-Number of cross bred cattle, GOAT-Number of goats, SHEEP- Number of sheep, CAMEL-Number of camels, SRS-Number of small ruminants, BOVS-Number of bovines, DA-Number of draft animals.

family size, a proxy for potential household labour supply, as hypothesised, showed a marginal value of 0.19 LU and turned out to be the major determinant of livestock holding. The dummy variable for literacy lowered the livestock holding by 0.53 LU. All dummy variables for caste were negative and significant suggesting that ST, SC and Other Community had significantly less number of livestock compared to the OBC. Among the agroecological variables, all except the HRF-HIRR had significant values. All the other high and medium irrigation zones had negative sign where as the low irrigation zones had positive sign. This highlights the role of livestock in insuring the household income, especially in areas, which are poor in terms of cultivability.

TABLE 6. REGRESSION ESTIMATES OF THE DETERMINANTS OF LIVESTOCK HOLDING AND INTENSIFICATION

	Livestock Holding (LU)		Livestock Intensification (LU/ha)	
Variable	Coefficient	Standard error	Coefficient	Standard error
(1)	(2)	(3)	(4)	(5)
Constant	2.023***	0.211	2.292***	0.225
OH	0.179***	0.009	-0.0925***	0.008
PERIRR	0.0011	0.002	0.0043***	0.002
FLYSIZE	0.193***	0.012	0.0346***	0.010
DUMOCCPN	0.511***	0.121	-0.405***	0.109
DUMLIT	-0.530***	0.102	-0.501***	0.089
Caste Dummy				
ST	-0.906***	0.165	-.102	0.143
SC	-1.150***	0.140	-0.0241	0.124
OTR	-0.963***	0.147	-0.330**	0.127
Agro-climatic Zone Dummy				
HRFHIRR	0.055	0.192	0.662***	0.166
HRFMIRR	-0.653***	0.190	-0.191	0.168
HRFLIRR	1.524***	0.200	2.843***	0.173
MRFHIRR	-0.932***	0.200	0.473***	0.181
LRFMIRR	-0.368**	0.178	-0.260	0.178
LRFLIRR	1.232***	0.256	0.273	0.241
R^2	0.21		0.19	
N	5815		5402	

*** and ** indicates significance at 1 and 5 per cent levels.

Operational holding had significant negative effect on the livestock intensification because of high dependency of small holders on the livestock for livelihood. The small holders therefore used the land intensively than the large landholders. In the analysis, the utilisation of common pastureland was not considered. The percentage area irrigated, which was an insignificant determinant of the livestock units per household turned out to be a positive factor of livestock intensification probably because of the potential of the irrigated land to support more livestock. Here also the family size turned out to be the major variable determining the household livestock intensification. The dummy for literacy reduced the per hectare livestock holding by half a LU. However, the households with occupation other than the farming reared less number of livestock per unit OH (but allowed more productive animals, especially buffaloes). Though, the caste dummies were negative, it was significant only in the Other Community group. Among the zonal dummies, only three were

significantly different from the base (MRF-MIRR), and all the three had higher cropping intensity compared to other zones. Thus crop and livestock intensification go hand in hand.

Determinants of Livestock Ownership

The analysis for the ownership of individual livestock showed an interesting pattern. All the variables like operational holding size, percentage area irrigated, family size, occupational dummy and dummy for literacy had positive impact on the ownership of bovines (Table 7), possibly due to the reasons mentioned earlier. Dummy variable for caste had significant negative sign suggesting that the probability of these communities owning bovines is less as compared to backward community. Among agro-climatic variables, only the LRF-LIRR and HRF-MIRR has negative effect on the odds of bovine ownership where as all other zones indicated significant positive effect, reiterating the fact that the high rainfall or irrigation zones are more prone to have bovines.

The results obtained for total bovines are exactly true for all the variables for buffaloes, the difference being only in magnitude, not in sign. But the results were quite different between buffaloes and cattle and between the local cattle and crossbred cattle. The dummy for literacy status of the farmers which exhibited significant negative effect on the total livestock holding and intensification in the earlier linear regression analyses indicated positive sign in favour of farmers owning bovines. This is true in the case of buffaloes and crossbred cattle only (the magnitude of the coefficient was higher for crossbreds) and not for the local cattle (for local cattle the coefficient was negative). This leads to the important policy orientation towards the positive influence of literacy in the adoption of high producing milch animals and cross breeding technology. The marginal impact of OH, percentage irrigated area and family size are more for buffaloes than for cross bred cattle. The percentage of irrigated area had positive effect on the buffaloes and crossbred cattle, but negative effect on total cattle. Thus the development of irrigation facility improves not only the agricultural production, but also the population of better milch animals leading to higher milk production. The correlation analysis in the earlier section also indicated similar results. It is noteworthy that the OH and family size had positive effect on all the livestock group, as the former supports the fodder availability and the latter labour supply. The caste variables exhibited an interesting pattern in the ownership of the all categories of bovines. The SC, ST and other communities were significantly less probable to own bovines as compared to the OBC in Rajasthan. The results are the same in case of better milch animals like buffaloes and CBC and other way round in case of local cattle. The magnitude of the coefficient for ST, SC and Other Community shows a declining trend in that order in case of buffaloes.

TABLE 7. LOGIT REGRESSION ESTIMATES OF DETERMINANTS OF LIVESTOCK OWNERSHIP

	Bovines		Total Cattle		Local Cattle		Crossbred Cattle		Buffalo	
Variable	Coefficient	SE	Coefficient	SE	Coefficient		Coefficient	SE	Coefficient	SE
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Constant	-0.096	0.178	-0.786***	.0132	-0.916***	0.138	-3.599***	0.373	-0.674	0.152
OH	0.269***	0.022	0.088***	0.009	0.077***	0.009	0.059**	0.016	0.075***	0.008
PERIRR	0.006***	0.001	-0.002*	0.001	-0.002**	0.001	0.005	0.003	0.013***	0.001
FLYSIZE	0.075***	0.015	0.070***	0.009	0.066***	0.009	0.037**	0.016	0.040***	0.010
DUMOCPN	0.710***	0.113	0.405***	0.077	0.529***	0.080	-0.250	0.220	0.522***	0.088
DUMLIT	0.410***	0.098	-0.051	0.064	-0.143*	0.067	0.766***	0.212	0.188**	0.078
Caste Dummy										
ST	-1.457***	0.166	0.819***	0.103	0.819***	0.103	-0.638	0.477	-1.634***	0.132
SC	-0.879***	0.116	0.185**	0.088	0.185**	0.088	-0.889**	0.379	-1.210***	0.105
OTRS	-0.557***	0.132	0.147	0.091	0.147	0.091	-1.315***	0.409	-0.954***	0.112
Agro climatic Zone Dummy										
HRFHIRR	2.290***	0.307	-1.254***	0.121	-1.254***	0.121	1.714***	0.418	1.837***	0.181
HRFMIRR	2.312***	0.238	-1.092***	0.118	-1.092***	0.118	-7.737	10.158	-9.774***	3.685
HRFLIRR	-2.525***	0.146	0.797***	0.123	0.797***	0.123	-2.185***	0.573	0.780***	0.146
MRFHIRR	1.088***	0.213	-2.255***	0.168	-2.255***	0.168	-3.731***	1.012	1.923***	0.200
LRFMIRR	0.655***	0.156	-0.506***	0.103	-0.506***	0.103	-0.645**	0.293	0.423***	0.126
LRFLIRR	-1.438***	0.217	-0.121	0.159	-0.121	0.159	-7.955	9.911	-2.608***	0.236
-2 log- likelihood	3532.739		6726.728		6726.728		963.695		4699.779	
N	5818		5818		5818		5818		5818	

(Contd.)

TABLE 7. (CONCLD.)

Variable (1)	Draft animal		Small Ruminants		Goat		Sheep		Camel	
	Coefficient (12)	SE (13)	Coefficient (14)	SE (15)	Coefficient (16)	(17)	Coefficient (18)	SE (19)	Coefficient (20)	SE (21)
Constant	-3.830***	0.275	1.882***	0.145	1.880***	0.144	-3.244***	0.333	-6.743***	0.804
OH	0.028***	0.008	-0.032***	0.006	-0.032***	0.006	-0.008	0.007	0.057***	0.007
PERIRR	0.007***	0.002	-0.003***	0.001	-0.003***	0.001	-0.007***	0.002	-0.020***	0.003
FLYSIZE	0.051***	0.012	0.011	0.008	0.010	0.008	0.023**	0.015	0.040**	0.016
DUMOCCPN	0.616***	0148	-0.396***	0.079	-0.392***	0.078	0.158	0.169	2.374***	0.308
DUMLIT	-0.334***	0.114	-0.172***	0.064	-0.154**	0.063	-0893***	0.138	-0.393***	0.134
Caste dummy										
ST	1.243***	0.139	1.047***	0.107	1.015***	0.106	-1.114***	0.331	-2.027***	0.542
SC	0.443**	0.190	0.949***	0.093	0.932***	0.093	-0.309*	0170	-1.309***	0.241
OTRS	-0.336*	0.188	-0.086	0.090	-0.100	0.090	0.113	0155	-0.304*	0.185
Agro climatic Zone Dummy										
HRFHIRR	-0.166	0.193	-0.990***	0.124	-0.988***	0.124	-2.208**	1.030	2.290***	0.307
HRFMIRR	2.338***	0.165	-1.992***	0.131	-1.982***	0.131	-0.720	0.577	2.312***	0.238
HRFLIRR	-6.913*	3.742	-1.067***	0.123	-1.139***	0.123	0.985***	0.301	-2.525***	0.146
MRFHIRR	-3.662***	1.009	-3.437***	0.162	-3.438***	0.162	-5.038	4.432	1.088***	0.213
LRFMIRR	-0.926***	0.236	-1.396***	0.119	-1.400***	0.119	1.130***	0.297	0.655***	0.156
LRFLIRR	-0.005	0.317	-0312*	0.170	-0.308*	0.170	2.728***	0.333	-1.438***	0.217
-2 log-likelihood	2502.509		6853.448		6877.627		2284.121		3532.739	
N	5818		5818		5818		5818		5818	

***, ** and * indicate significance at 1, 5 and 10 per cent level.

The determinants of the draft animal ownership indicate positive effect of OH, irrigation, family size and occupation, but negative effect of the dummy variable for literacy. The negative sign for the dummy variable for the Other Community and positive sign for SC and ST has to do with the size of operational holding and the differential possession of tractors. The size of operational holding was least for ST (Table 4) and the highest for Other Community.

Though camels are also used for draft purpose, they were not considered in the earlier analysis as part of draft animals: but the analysis is done separately. The results indicated that camels are negatively related with the extent of irrigation and literacy, as they are mainly seen in the drier regions and reared by relatively illiterate farmers. All the caste variables had significant negative effect, as camels are mainly reared by the OBC.

Unlike the bovines, size of operational holding and percentage area irrigated had negative effect on the small ruminants, both in case of the goat and sheep. Similarly family size did not turn out to be significant for small ruminants as a whole, but was significant for sheep rearing which needs labour for grazing management. Further, sheep is reared in large flocks whereas the goat is reared in the smaller number along with other animals. Goat can combine with any other livestock species, as its feeding habit is different from all others (Singh, 2004) and hence there is least competition for feed. The lower rainfall region (particularly the LRF-LIRR) is probable to rear more sheep compared to the other zones as it has the ability to graze on the vegetation very closely on the ground surface. The HRF-MIRR region has higher number of the landless farmers and they also went for sheep rearing. Thus in the dry regions and for landless farmers, sheep is a boon which can come up depending on the sparse vegetation available. Therefore, the developmental efforts towards sheep production plays a significant role in mitigating rural poverty and improve household income in dry regions.

IV

CONCLUSION AND IMPLICATIONS

The structure of livestock differs in rural areas with respect to the composition and ownership, all varying to a great degree with regard to class, caste and agroecological variation. The present study brings about some important conclusions and implications. The regions with favourable cultivation environment are dominated by the smallholdings and the less favourable environment is dominated by the relatively large farmers and their livestock composition varies significantly. Hence there is a need to develop feed management strategy suitable for different agroecological conditions. Considering the dependence of the farmers on the pastures and other common property lands for the nutritional requirement of the livestock - especially the small ruminants - there is urgent need to ameliorate the deteriorating conditions of the pasture by developing suitable technology and its adoption in a

large scale. Though the draft animals are gradually being replaced by the tractors, the male local cattle still constitute an important source of the draft energy for the small and semi-medium farmers as well as for the ST farmers. Hence we need a suitable draft animal breeding policy and development strategy suitable for them. The data also indicated the spread of crossbred cattle at some zones and there is a need to augment the technology further in such areas. The literacy of the farmers is the most important variable determining the adoption of cross breeding technology. The crop and livestock intensification go hand in hand and irrigation development holds key to this. As the intensification of livestock is higher for the small farmers, there is a need to bring suitable support measures to them in the form of better accessibility to the credit, insurance, marketing and input supply facilities and investment in irrigation.

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NOTE

1.The following factors were used to convert the population of different livestock species to standard livestock unit (LU):

Adult female cattle= 1.00 LU
Adult male cattle = Adult female crossbred cattle = Adult male crossbred cattle = Adult female buffalo = Adult male buffalo= 1.2 LU
Young cattle = Young buffalo = 0.5 LU
Goat = Sheep = 0.2 LU
Camel = 2.5 LU.

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APPENDIX 1

DISTRIBUTION OF FARMER CATEGORIES ACROSS AGROCLIMATIC TOPOLOGY

Zones (1)	Landless (2)	Marginal (3)	Small (4)	Semi-medium (5)	Medium (6)	Large (7)	Total* (8)
HRF-HIRR	0.00	0.65	1.51	2.93	5.65	10.00	1.95
	(4.23)	(28.77)	(33.34)	(24.03)	(9.31)	(0.34)	(591)
HRF-MIRR	0.00	0.66	1.60	3.08	6.47	11.50	1.60
	(5.30)	(40.62)	(29.99)	(21.13)	(2.66)	(0.30)	(677)
HRF-LIRR	0.00	0.59	1.31	2.68	5.23	15.08	1.28
	(2.36)	(44.80)	(35.51)	(15.31)	(1.64)	(0.39)	(797)
MRF-HIRR	0.00	0.55	1.31	2.63	5.99	10.00	1.50
	(16.25)	(26.22)	(27.85)	(23.78)	(5.49)	(0.41)	(492)
MRF-MIRR	0.00	0.57	1.43	3.14	6.82	16.30	2.84
	(14.52)	(11.60)	(27.92)	(29.47)	(13.01)	(3.47)	(923)
LRF-MIRR	0.00	0.63	1.44	3.24	6.74	14.73	4.71
	(6.93)	(9.40)	(16.62)	(32.59)	(21.55)	(12.92)	(1703)
LRF-LIRR	0.00	0.71	1.52	3.82	7.26	20.70	11.05
	(0.32)	(5.67)	(9.30)	(25.99)	(17.01)	(41.74)	(635)
OVERALL	0.00	0.62	1.43	3.15	6.68	17.76	3.72
	(7.12)	(21.21)	(24.41)	(26.06)	(12.17)	(9.04)	(5818)

Figure in parentheses indicate the percentage of farmers to corresponding total.
*Parentheses in this column indicates total number of farmers.

APPENDIX 2

MEAN AND STANDARD DEVIATION OF IMPORTANT VARIABLES

Indicators (1)	Mean (2)	Std. Deviation (3)
Literacy (Dummy)	0.45	0.50
Occupation (Dummy)	0.77	0.42
Family Size (No)	6.53	3.93
Operational holding (ha)	3.72	5.97
Percentage irrigated area (%)	54.90	47.66
Caste (dummy)	2.72	0.94
Buffalo (Number)	1.79	2.26
Cattle T(Number)	1.21	1.88
Local Cattle (Number)	1.12	1.80
Cross bred cattle (Number)	0.005	0.62
Goat (Number)	3.01	5.74
Sheep (Number)	1.90	11.64
Camel (Number)	0.007	0.31
Small Ruminants (Number)	4.91	15.37
Bovines (Number)	3.00	2.92
Draft animals (Number)	0.23	0.64