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Temporary Sheep Migration in Response to Climatic Risk in Semi-arid Rajasthan: Structure, Determinants and Economics

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Abstract: The study investigates the structure of sheep migration, socio-economic determinants of sheep migration as well as the cost and return of migrant and non-migrant sheep flocks in semi-arid zone of Rajasthan. The share of temporary sheep migration in the total migrant population is increasing, with declining rainfall, roughly at the rate of 1% per cm decline in rainfall. While the temporary migration was to the tune of 22%, the average size of migratory and non-migratory flocks was 79 and 48, respectively. Logit analysis indicated that the flock size, caste and technology adoption index were significant in determining the migration decision. The net return per sheep was higher for the non-migrant flock (Rs. 468) compared to the migrant flock (Rs. 430). The paper concludes that although the non-migrant flocks have yielded more, migration could be considered an essential mechanism to save large animal flocks from fodder scarcity.

Key words: Sheep, migration, structure, determinants, Rajasthan, semi-arid.

Sheep migration is a common feature in many parts of Rajasthan, and is a coping mechanism to adjust with fodder scarcity (Rathore, 2004; Narain and Kar, 2005). The occupation also serves as an intermediate stage between sedentary life and nomadism, incorporating different scales of seasonal movement (Bharara, 1989).

As per Livestock Census, 2003, Rajasthan possesses nearly 10.8 million cattle, 10.4 million buffaloes, 10.1 million sheep and 16.8 million goats (Govt. of India, 2003). The state accounts for 16.4% of the total sheep population in India, second only to Andhra Pradesh. Sheep depend mainly on common property resources (CPRs) like permanent pasture and other grazing lands for green fodder, but grazing pressure on these lands is increasing due to increasing livestock population and declining area under CPR (Singh *et al.*, 2005). Crop residues from the harvested fields also provide the feed and fodder, but aberrant rainfall often results in shrinkage of fodder supply, as was experienced during the drought of 2002 (Narain and Kar, 2005).

Adjustment to fodder deficits usually includes early sale of stock for slaughtering and migration, the last one being widely adopted by the farmers (Umamaheswari *et al.*, 2001; Rathore, 2004; Narain and Kar, 2005; Sah and Shah, 2005). Sheep migration may be temporary and permanent. Depending on severity of drought, temporary migration starts by the end of winter/start of summer and the migrants return by the onset of monsoon. Permanent migration, on the other hand, is a long-term adjustment and a trait of nomadic life. Given the same level of rainfall, households adopt migration differently, depending on their socio- economic conditions and resource endowment. The adjustment process results in structural changes in sheep migration over the years. This paper attempts to study: (1) the structure of sheep migration in semi-arid Rajasthan and to quantify the impact of rainfall on temporary migration; (2) the socio-economic determinants of the temporary sheep migration; and (3) the relative cost and return from migrant and non-migrant sheep flocks.

Materials and Methods

Data

The study used both primary and secondary data of Government of Rajasthan on rainfall and livestock census. Socio-economic determinants at field level were analyzed using primary data collected during March 2005 from randomly selected 107 sheep farmers of 20 villages in Malpura and Toda Rai Singh Tehsils of Tonk District, Rajasthan. Data were collected by personal interview using a structured survey schedule.

Analytical method and model specification

Structural changes in sheep migration: Mostly tabular analysis was used for the study. The effect

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of rainfall on migration was determined through simple linear regression, based on the null hypothesis of non-affectedness of rainfall on migration. The standard model for such studies is:

$$M_t = \alpha + \beta\ RF_t + \mu \quad \text{....(1)}$$

where, M_t indicates the number of temporary migration in the year t; RF_t represents rainfall in the t^{th} year; μ is the random error with usual stochastic properties. However, this model has a problem of non-adjustment of the sheep population for the natural changes in the population. Livestock Census shows a decline of sheep population in Rajasthan between 1997 and 2003. To account for this, it would have been desirable to get data on the share of migrant sheep population in the total sheep population of the state, but was not available. Therefore, the model was modified, in which the share of temporary sheep migration as a percentage of total migrant sheep population was taken as a dependent variable and rainfall as an independent variable:

$$M_{st} = \alpha + \beta\ RF_t + \mu \quad \text{.....(2)}$$

where, M_{st} is the share of temporary migration in total migration; RF_t and other parameters are as indicated earlier.

Logit model: The purpose of the analysis was to find out the factors affecting decision of the rearers to migrate and therefore, the dependent variable was a dichotomous one. Hence we used Logit model, which could overcome many deficiencies arising from employment of other estimation techniques like Ordinary Least Square Regression and Linear Probability Model (Lee and Stewart, 1983; Capps and Crammer, 1985).

The Logit model is specified as:

$$f\ (Zi) = \frac{e^{Zi}}{1+e^{Zi}} \text{ for } -\infty < Zi < \infty \text{ and } Zi = Xi' \quad \text{.....(3)}$$

where, f (Zi) is the logistic density function for Logit model; Xi' is the matrix of dependent variable.

The probability of an individual farmer opting for migration, P (M), was defined as:

$$P\ (M) = \frac{1}{1+e^{-Zi}} \quad \text{.....(4)}$$

The probability of an individual not migrating was determined as:

$$1-P\ (M) = 1-\frac{1}{1+e^{-Zi}} \quad \text{.....(5)}$$

The Odd's ratio of probability of migration to non-migration was calculated as:

$$[P\ (M)\ /\ \{1\text{-}P\ (M)\}] = e^{Zi} \quad \text{.....(6)}$$

Taking logarithm on both sides,

$$Ln\ [P\ (M)\ /\ \{1\text{-}P\ (M)\}] = Zi = Xi\beta + E \quad \text{.....(7)}$$

where, Xi= Vector of explanatory variable, â = Vector of response coefficients, E= Vector of random disturbance.

Model specification

The specific Logit model estimated to predict the odds of a farmer migrating was:

$$Ln\ [P(M)\ /\ \{1\text{-}P\ (M)\}] = \alpha+\beta_1X_1 + \beta_2X_2+ \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \mu \quad \text{.....(8)}$$

where, α = constant, X_1= age of the farmer (years), X_2= dummy variable for literacy of the head of the family (1 for literate, 0 for illiterate), X_3= family size (no), X_4= caste of the farmer (no.), X_5= operational holding (ha), X_6= technology adoption index (TAI) (no.), X_7= flock size (no.), μ is the random error term with usual stochastic properties and βi s are the coefficients to be estimated.

The TAI, which is defined here as the ratio of the total score of the rearers to the maximum obtainable score (20) was found out based on information on the adoption of 10 improved sheep management practices on a discrete response choice set of 'usually', 'sometimes' and 'never', each with a score of 2, 1 and 0, respectively. The 10 improved management practices used for construction of the TAI were scientific selection of breeding rams, exchange of breeding rams, fodder enrichment, supplementation with concentrate mixture, artificial insemination, treatment of anoestrous sheep, vaccination, dipping/drenching of sheep, grading of the sheared wool before marketing and washing the animals before shearing. TAI is an indication of the progressiveness of the farmer and hypothesized to have positive influence on the decision to migrate. Literacy of the sheep rearers helped in gathering information on availability of fodder and feed, which was expected to influence the migration decision. Family size was considered as a proxy for the potential household labor supply (Khirsagar *et al.*, 2003), and hence, positive sign was expected for the same. Caste of the farmer was included in the analysis to examine the caste bias of migration. Scheduled tribe, scheduled caste, backward community and other castes (forward community) were given a score of 4, 3, 2 and 1, respectively. Higher operational holding acted

as a productive asset, and reduced the probability of migration. Higher the flock sizes, the rearers were expected to migrate as higher demand for fodder could not be met from local resources.

Results and Discussion

Structure and trend of sheep migration in semi-arid Rajasthan

The analysis of data on migration pattern of livestock at the state level for the period 1996-97 to 2002-03, revealed that the magnitude of migration was increasing, though with some variation (Fig. 1). During 1996-97, around 20 lakh sheep migrated was, accounting for 14% of the total sheep population in Rajasthan (based on 1997 Census), but it increased to nearly 26 lakh in 2002-03, accounting for 26% (based on 2003 census).

Over the 7-year period, structural differences occurred in the composition of sheep migration. On an average nearly 18 lakh sheep migrated during the period, of which the permanent migration accounted for nearly 51% and was less variable as compared to temporary migration (coefficient of variation was 48% in the case of permanent migration and 75% in case of temporary migration). Except some minor variation, temporary migration showed a steady increase. In 1996-97, nearly 23% of the total migration was temporary, but it increased gradually to reach 77% by 2002-03 as a response to the feed and fodder scarcity arising out of inadequate rainfall. The state received a mean rainfall of 76 cm in 1996-97, 51 cm in 1999-00 and 27 cm in 2002-03, which influenced the temporary migration (Table 1). Here the null hypothesis was non-affectedness of the rainfall on temporary migration. The reduction in temporary migration was nearly 0.31 lakh for every one cm increase in rainfall and the rainfall variable alone could explain nearly 53% of the total variation in temporary migration. However, since these estimates suffer from non-exclusion of the effect of natural population change from the dependent variable, we ran another regression as described by equation 2. The results indicated that the marginal decline in the share of temporary migration was to the extent of 1% for every cm increase in rainfall.

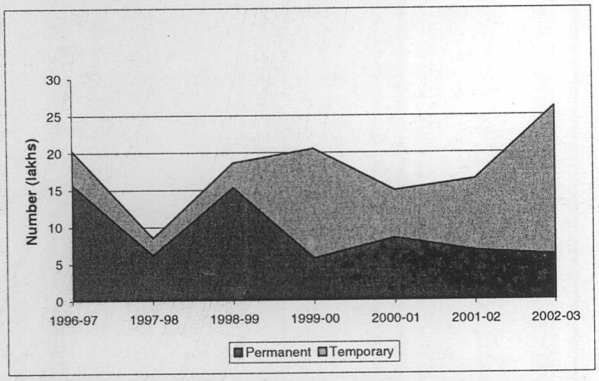

Fig. 1. Structural changes in sheep migration in Rajasthan. Data source: Government of Rajasthan (2003).

Socio-economic background of sheep rearers

Out of 107 sheep rearers, small, medium and large category farmers accounted for 27, 39 and 34%, respectively (Table 2). The average number of sheep per flock for these categories was 24, 43 and 91, respectively, with an overall average flock size of 54. The animals of reproductive age (adult) group constituted nearly 65% of the total flock. The adult animals were mainly ewes with 1-3 rams per flock. One healthy ram is sufficient enough to maintain a flock of nearly 30 ewes. Even though the operational holding size was slightly higher (5 ha), it was poor in terms of cultivation due to poor irrigation facility.

Joint family system was most dominant among sheep rearers (53%). The average family size was 9.54, varying from 6.9 in case of small flock rearers to 12.7 in case of large flock rearers. Literacy was poor (37%), female literacy being <10%. The overall livestock possession, expressed in the form of Adult Cattle Unit (ACU), was 19.3, ranging from 9.7 in case of the small sheep rearers to 31.2 in case of large sheep rearers.

Table 1. Estimates of the effect of rainfall on migration

Variable	Model 1		Model 2	
	Coefficient	Standard error	Coefficient	Standard error
Constant	25.29**	6.24	104.12**	24.84
Rainfall	-0.31*	0.11	-1.08*	0.44
Adj R^2	0.53		0.45	

** and * indicate significant at 1 and 5% level.
Data source: Government of Rajasthan (2004).

Table 2. Socio-economic status of sheep rearers in semi-arid zone of Rajasthan

Particulars	Small (<31)	Medium (31-60)	Large (>60)	Overall
No of rearers	29.00	42.00	36.00	107.00
Average age of the farmer (years)	44.40	42.80	46.50	44.50
Size of operational holding (OH) (ha)	2.58	4.980	6.97	5.00
Percentage of rearers based on OH				
Landless	6.90	2.40	5.60	4.70
Marginal	17.20	14.30	0.00	10.30
Small	24.10	21.40	19.40	21.50
Semi-medium	31.20	26.20	22.20	26.20
Medium	17.20	19.00	27.80	21.50
Large	3.40	16.70	25.00	15.80
Family details (no.)				
Males	3.33	4.48	6.42	4.81
Females	3.57	4.19	6.27	4.73
Total	6.90	8.67	12.69	9.54
Type of family (per cent to the total)				
Joint	37.90	47.60	72.20	53.30
Nuclear	62.10	52.40	2.80	46.70
Literacy status of the farmer (%)				
Literate	20.70	54.80	30.60	37.40
Illiterate	79.30	45.20	69.40	62.60
Livestock status (mean no.)				
Sheep	24.00	43.40	91.40	54.30
Goat	6.70	4.80	8.90	6.70
Cattle	1.40	2.30	3.80	2.60
Buffalo	1.60	2.80	5.50	3.40
Total livestock	33.70	53.30	109.50	66.90
Adult Cattle Unit (ACU)+	9.70	15.70	31.20	19.30

+ACU is calculated as cattle-1, buffalo-0.75, goat-5, sheep-5.
Data source: Field survey.

Migration and its socio-economic determinants

The rate of temporary migration was 22% (Table 3). This included 7% in the small category, 17% in the medium category and 39% in the large category. Generally, farmers migrate by the end of winter and return by the onset of monsoon. The place of migration varied from neighboring districts to other states (mostly Uttar Pradesh in case of sheep rearers of Tonk district of Rajasthan).

Logit analysis was undertaken to identify the socio-economic determinants of migration. The mean of the variables included in the analysis is given in Table 4. The migrant rearers had larger family size, operational holding and flock size and were younger to the non-migrants. The TAI was higher for the migrant farmers (0.51) than the non-migrant farmers (0.36).

The TAI had a significant positive sign indicating that technology adoption positively influenced the migrating behavior (Table 5). The dummy for the caste of the farmer was also positive, indicating that the lower caste people were more prone to migration than the higher caste people. As expected, the flock size retained a positive sign, because of the non-availability of fodder for large flocks

Table 3. Status of temporary sheep migration in semi-arid zone of Rajasthan

Category of rearers	Migrating flocks		Non-migrating flocks	
	No.	Per cent	No.	Per cent
Small	2	6.9	27	93.1
Medium	7	16.7	35	83.3
Large	14	38.9	22	61.1
Overall	23	21.5	84	78.5

Table 4. Average of variables included in the Logit analysis

Particulars	Migrating flocks	Non-migrating flocks	Overall
Age (years)	42.87	44.92	44.48
Literacy (dummy: 1 for literate 0 for illiterate)	1.61	1.63	1.63
Family size (no.)	12.70	8.68	9.54
Caste (average of dummy)	2.26	2.19	2.21
Operational holding (ha)	6.22	4.67	5.00
Technology adoption index	0.51	0.36	0.40
Flock size (no.)	78.96	47.5	54.26

Data source: Field survey.

in the locality. The smaller flocks managed with the available resources. The scale economy also worked in favor of migration of large flocks. Contrary to expectation, the family size was not a significant factor, possibly because the farmers opted for migration depending on fodder scarcity, irrespective of family size. Age of the farmer, though retained a negative sign, was insignificant.

The size of the operational holding retained a negative sign, but was insignificant, perhaps because, the crop and the sheep management practices were not much related as in the case of crop and bovines. The sheep depended mostly on pastures and other grazing resources, rather than the crop residues from cultivated fields.

Cost and return in sheep farming

The sheep rearing in the locality was of semi-intensive and extensive types where the animals were fed little concentrate mixture. Only recurring cost was considered for the analysis, as fixed cost was heritable in nature from year to year. The imputed value of family labor also was not included in the analysis. The major costs involved in sheep rearing were feed and fodder, veterinary care, hired labor and interest on variable cost (Table 6). The overall average cost was Rs. 3520, of which the feed and fodder cost accounted for 56% followed by medicine and veterinary care (29%). The total cost for migrant rearers was Rs. 6646 compared to Rs. 2663 for non-migrant flocks. The migrant flocks had an average size of 79, whereas for non-migrant it was 48. The cost due to feed and fodder was higher in non-migrant for flocks (60.3%) compared to migrant flocks (49.9%) because the non-migrant flocks were sometimes fed concentrates and grains particularly for breeding rams. The increased labor cost for migration is reflected in the share of hired labor as it accounted for 18% in case of migrant flocks and only 4% in case of non-migrants.

The major items of return were sale of live animals (mainly for meat purpose), milk, wool and manure. The sale of live animal accounted for 81% of the total return of Rs. 28252. Usually male animals of 4-6 month age as well as the aged females of the stock (replaced by the young one) were sold. Wool, manure and the milk accounted for 9, 7 and 3%, respectively. The overall return over cost was Rs. 24732 (Fig. 2). The share

Table 5. Logit regression estimates of temporary migration of sheep rearers in semi-arid zone of Rajasthan

Variables	Coefficient	Standard error	t value
Constant	-8.821**	2.642	-3.338
Age of the sheep breeder	-0.015	0.026	-0.572
Literacy of the sheep breeder	0.741	0.691	1.073
Family size	0.056	0.064	0.877
Caste of the farmer	1.050*	0.550	1.908
Size of operational holding	-0.008	0.066	-0.126
Technology Adoption Index. (TAI)	8.016**	2.360	3.400
Flock size	0.027*	0.012	2.243
Log likelihood	-38.200		

** and * indicate significance at 1 and 5% level.
Data source: Field survey.

Table 6. Cost and return of migrant and non-migrant sheep flocks in semi-arid zone of Rajasthan (Rs. flock^{-1} year^{-1})

Particulars	Migrant flock		Non-migrant flock		Overall	
	Rs.	Per cent	Rs.	Per cent	Rs.	Per cent
Number of animals per flock	79		48		54	
Cost						
Feed and fodder	3318	49.9	1605	60.4	1974	56.1
Medicine	1747	26.3	800	30.0	1004	28.5
Hired labor	1205	18.1	107	4.0	343	9.7
Interest on capital	376	5.7	151	5.6	199	5.7
Total cost	6646	100.0	2663	100.0	3520	100.0
Returns						
Sale of live animals	31636	77.9	20618	82.9	22987	81.4
Sale of milk	2618	6.5	456	1.8	921	3.2
Sale of wool	3577	8.8	2135	8.9	2445	8.7
Manure	2763	6.8	1663	6.5	1899	6.7
Total return	40595	100.0	24872	100.0	28252	100.0
Return over cost	33948		22209		24732	

Data source: Field survey.

of animal sale in the total returns of migrant rearers was less (78%) compared to the non-migrant rearers (83%) possibly due to the higher mortality of animals in the migrant flock or due to higher energy loss during migration. The value of milk for the migrant farmer was nearly 5% point higher. This was perhaps because the sheep was the only source of milk for migrant rearers during migration, whereas the non-migrant flocks were usually not milked as most of them had bovines for milk purpose.

The average cost per animal was Rs. 65, the fodder and feed and hired labor accounted for 56% and 29%, respectively. For migrant flocks, the cost per animal was Rs. 84 and for non-migrant flocks it was Rs. 56. The difference was due to the difference in fodder and feed cost and hired labor charge, which accounted for 50% and 18% for migrant flock and 60% and 4% for non-migrant flocks. The overall return was Rs. 521 per sheep. The net return over cost was Rs. 430 for migrant flocks and Rs. 468 for non-migrant flocks.

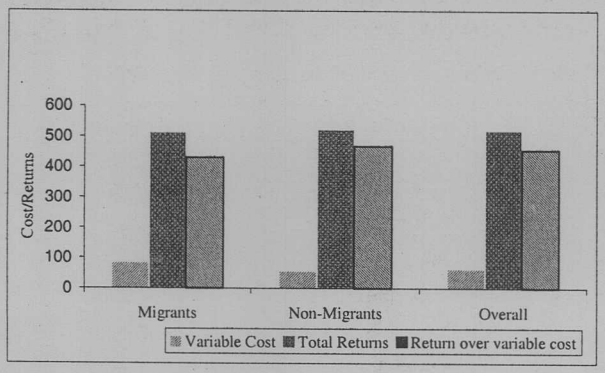

Fig. 2. Per animal comparative cost and return of migrant and non-migrant animals in semi-arid zone of Rajasthan (Rs./animal/year). Data source: Field survey.

Conclusions

Temporary sheep migration was found to be related to rainfall, which explained the increasing share of temporary migration in total migration in the semi-arid zone of Rajasthan. Nearly 22% rearers migrated to the nearby districts or states at the end of winter and returned at the onset of monsoon. The flock size, caste of the rearers and technology adoption index were significant in determining the migration decision. The net return over cost was higher for the non-migrant flocks, mainly due to the cost advantage in hired labor charges and higher return in animal sales. Though the non-migrant flocks are yielding more, the migration can be considered as an essential mechanism for saving large animal flocks from fodder scarcity.

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