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Returns and Economic Efficiency of Sheep Farming in Semi-arid Regions: A Study in Rajasthan

A. Suresh*, D.C. Gupta and J.S. Mann
Central Sheep and Wool Research Institute (Indian Council of Agricultural Research),
Avikanagar, Jaipur - 304 501, Rajasthan

Abstract

The economics of sheep-farming and its economic efficiency have been reported using field level data collected from the semi-arid regions of Rajasthan in 2005. The net return per average flock of 54 has been found Rs 25000 per year. The sheep-farming activity attracts labour employment of 581 mandays per annum, more than three-fourths of which is engaged in grazing. The female labour has been found to contribute 12 per cent of the total labour requirement. The main items of expenditure are feed and fodder, veterinary care, hired labour charges and interest. The major modes of return are sale of live-animals, wool, milk and manure. The overall average economic efficiency has been found to be 75 per cent, indicating that the returns could be improved by another 25 per cent with the present resource-use level. More than two-thirds of the farmers have been recorded distributed in the economic efficiency range of 70-85 per cent. The resource-poor farmers have been observed to realize higher economic efficiency than their rich counterparts. The major factor responsible for inducing improvement in efficiency has been identified as membership in farmers' organisations, which probably provides them better access to technical knowledge and improves their bargaining power.

Introduction

India ranks seventh in the world sheep population. The state of Rajasthan possessed highest sheep population till recently. As per 2003 Livestock Census, Rajasthan had about 10 million sheep population, accounting for 16 per cent of the total sheep population of the country (GoI, 2003). The state produced nearly 20 million kg wool in 2006, accounting for 40 per cent of the total wool production. In India, sheep wool is primarily used to manufacture carpets, whose export earned more than Rs 3000 crore as foreign exchange, recently. Most of the Indian sheep breeds are used for dual purpose, viz. mutton and carpet wool. The important sheep breeds of the north-western arid and semi-arid regions are Chokla, Nali, Marwari, Magra, Jaisalmeri, Malpura and Sonadi. The Chokla and Nali breeds found in Rajasthan are the best carpet-wool producing sheep breeds. Moreover, the domestic demand for non-vegetarian food in general and for mutton in particular, is highly income elastic. The demand for non-vegetarian food products is increasing due to high per capita income growth, urbanization and changes in the taste and preferences of consumers (Birthal and Rao, 2004). As of 1999-2000, the total meat consumption in India was of 3.1 million tonnes. It has been projected to rise to 8.0-9.0 million tonnes by 2020, in which contribution of mutton would be substantial (Birthal and Taneja, 2006). Further, the small ruminant meat from India is highly preferred in

* Author for correspondence,
Email: sureshcswri@ gmail.com

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the export market due to lean meat and organic nature of production.

To meet the domestic and international demands for mutton and wool products, the domestic production of sheep has to be enhanced. The production enhancement can be achieved only through improvement in productivity in the long-run. Of various components, improvement in the efficiency of resources is of great concern. Under this background, this paper has explored the economics of sheep farming and its efficiency and has identified the determinants of economic efficiency in sheep farming in the semi-arid zone of Rajasthan.

Analytical Tools

Model

The stochastic frontier model used to analyse the economic efficiency in sheep production is given by Equation (1):

$$\ln Y = \beta_0 + \beta_F \ln F + \beta_V \ln V + \beta_L \ln L + v_i - u_i \quad \ldots(1)$$

where,

Y = Return per sheep per year (Rs/sheep)

F = Cost of fodder and feed per year (Rs/sheep)

V = Cost of veterinary care per year (Rs/sheep)

L = Labour employed per sheep per year (humandays/sheep), and

β_is are the parameters to be estimated.

MLE techniques were used to estimate the equation by using the programme Frontier 4.1.

Determinants of Economic Efficiency

After analyzing the stochastic frontier production function, the determinants of economic efficiency were identified. Since the estimated economic efficiency values were bound by 0 and 1, the model was specified as per Equation (2):

$$\ln\left[\frac{EE}{1-EE)}\right] = \alpha_0 + \alpha_1 \ln (OPH) + \alpha_2 \ln (FLSIZE) + \alpha_3 \ln (AGE) + \alpha_4 \ln (FASIZE) + d_1 (LIT) + d_2 (MEM) + e_i \quad \ldots(2)$$

where, OPH = Operational holding (ha), FLSIZE= Flock size (number), AGE = Age of the farmer (years), FASIZE = Size of the family (number), LIT = Dummy variable for literacy, MEM = Dummy variable for membership of farmers in various organisations, and α_i and d_i are the parameters to be estimated. Land is one of the valuable assets in the rural areas and is considered as proxy for wealth and participation in the decision-making process (Batra, 1986; Rajagopalan and Anuradha, 1987). Therefore, the variable was expected to carry a positive sign. The family-size was considered as a proxy for potential household labour supply. Moreover, the bigger is the size of family, better the farmers can take decisions based on their collective experience. Therefore, we expected positive sign for this variable also. The elder farmers being a source of accumulated experience and traditional knowledge, its impact might be positive on the efficiency of farming. The literacy was expected to have a positive sign on behalf of its impact on the quality of decisions and adoption of better management practices. A dummy variable was used for the same with a value of 1 for literate and 0 for illiterate farmers. Some farmers were members of some of the farmers' organisations or local bodies or NGOs and a positive sign was expected for this variable on the efficiency as these farmers could have access to knowledge on better sheep management. Therefore, a dummy variable was used for the analysis with a value of 1 for membership in at least one organisation and 0, otherwise. Larger flock-size was expected to give scale efficiency in sheep farming and therefore, a positive sign was expected for it.

Data Collection

In the study, primary data collected from 107 sheep-rearers belonging to 20 villages of Malpura and Toda Rai Singh Tehsils in the Tonk district of Rajasthan during March, 2005 was used. These villages were selected purposively since they had been identified to be covered under the Transfer of Technology Programme of Central Sheep and Wool Research Institute, Avikanagar. From the identified villages, farmers were selected randomly and data were collected by personal interview, using a structured survey schedule.

Results and Discussion

Socio-economic Status

The important characteristics of farmers in the study area have been summarised in Table 1. The small, medium and large categories of farmers accounted for 27 per cent, 39 per cent and 34 per cent of the total farmers, respectively. The average number of sheep per flock was 24 for small, 43 for medium and 91 for large farmers, with an overall average flock size of 54 sheep. The animals in the reproductive age (adult) group constituted nearly 65 per cent of the total flock. The adult animals were mainly ewes with one to three rams per flock. One healthy ram was maintained in the flock for nearly 30 ewes. The average age of the rearers varied between 42 and 47 years.

Agriculture was the main occupation (51%), followed by animal husbandry (48%). The average size of operational holding was 5 ha, varying from 2.58 ha in the small to 6.97 ha in the large categories of sheep breeders. The popular belief that 'sheep-rearing is the occupation of very poor households' was found gradually fading in the rural areas. Nearly 64 per cent semi-medium, medium and large rearers accounted for 70 per cent of the sheep, whereas 36 per cent landless, marginal and small rearers possessed only 30 per cent of the total sheep population. Such results have been reported in some other studies also (Pasha, 1991). However, sheep-

Table 1. Socio-economic status of sheep-rearers in semi-arid region of Rajasthan

Sl No.	Particulars	Small (up to 30)	Medium (31-60)	Large (> 60)	Overall
1.	No. of sheep-rearers	29	42	36	107
2.	Average age of sheep farmers (years)	44.4	42.8	46.5	44.5
3.	Size of operational holding (OH) (ha)	2.58	4.98	6.97	5.00
4.	Percentage of rearers based on OH				
	a. Landless	6.9	2.4	5.6	4.7
	b. Marginal	17.2	14.3	0	10.3
	c. Small	24.1	21.4	19.4	21.5
	d. Semi-medium	31.2	26.2	22.2	26.2
	e. Medium	17.2	19.0	27.8	21.5
	f. Large	3.4	16.7	25	15.8
5.	Family details (No.)				
	a. Males	3.33	4.48	6.42	4.81
	b. Females	3.57	4.19	6.27	4.73
	c. Total	6.90	8.67	12.69	9.54
6.	Type of family (per cent to the total)				
	a. Joint	37.9	47.6	72.2	53.3
	b. Nuclear	62.1	52.4	2.8	46.7
7.	Literacy status (per cent)	20.7	54.8	30.8	37.4
8.	Livestock status (mean No.)				
	a. Sheep	24	43.4	91.4	54.3
	b. Goat	6.7	4.8	8.9	6.7
	c. Cattle	1.4	2.3	3.8	2.6
	d. Buffalo	1.6	2.8	5.5	3.4
	e. Total livestock	33.7	53.3	109.5	66.9
	f. Adult Cattle Unit (ACU)	9.7	15.7	31.2	19.3

ACU was calculated as: 1 Cattle= 0.75 Buffalo = 5 Goat = 5 Sheep

rearing was the major livelihood for the resource-poor farmers. Joint-family system was the dominant settlement of sheep rearers (53%) because more members could manage larger flocks. Individual ownership and joint management of flocks was also common in the joint-family systems. Among large flocks, 72 per cent belonged to the joint families.

The average family-size was of 9.54, varying between 6.9 in the case of small flock-rearers to 12.7 in large flocks. Illiteracy was a major hindrance in the socio-economic development of sheep-rearers. Only 37 per cent farmers were literate with minimal education. The case of female literacy was worse, accounting for less than 10 per cent. The scheduled caste and scheduled tribes comprised 16 per cent of the sheep- rearers, whereas the backward community accounted for 82 per cent and the remaining were of forward communities. The sheep-rearers also possessed other livestock like goat, cattle and buffalo. The overall livestock possession expressed in the form of Adult Cattle Unit (ACU) was 19, ranging from 10 in the case of the small sheep-rearers to 31 in large sheep-rearers. Nearly two-thirds of the total ACU was contributed by small ruminants alone.

The sheep flock are generally raised on the common grazing lands. Although feeding of concentrate mixture and mineral supplements has a significant positive effect on various production traits of sheep, its adoption was very low due to various economic and institutional constraints. Some fodder trees and harvested lands were reported to be leased also for a fixed period.

Labour Utilization

Sheep husbandry being highly labour-intensive, is one of the major employment providers for rural population. The average labour employment was for 581 humandays per annum (Table 2). The major labour-absorbing activities were grazing of animals, supplying of feed and fodder, veterinary care, milking, breeding and lambing management, etc. The major employment absorbing activity was grazing (nearly 75%). At least one full-time person was needed to take animals from the shed to grazing lands and back. The grazing activity was mainly managed by male members, whereas female members were mostly engaged in household activities related to sheep farming.

Table 2. Utilization of labour in sheep production

(humandays/annum)

Category	Total labour, %			Total humandays
	Male	Female	Child	
Small	78	15	7	549
Medium	84	10	6	582
Large	80	12	8	604
Overall	80	12	8	581

Cost and Returns in Sheep Farming

The economics of sheep farming was worked out and has been given in Table 3. Only variable cost was considered for the analysis, since the fixed cost was heritable in nature from year to year. The imputed value of family labour was also not included in the analysis. The cost in sheep-rearing was maximum on feed and fodder, followed by veterinary care, hired labour and interest on capital. The overall annual average variable cost was Rs 3520/flock. The maximum return was from the sale of live-animals, followed by sale of milk, wool and manure, together giving a return of Rs 28252 for a flock of 54. The return over variable cost (net return/ profit) was found as Rs 24732, giving the per animal return of Rs 456 per annum. The animals (male lambs) of 6-8 months were sold, particularly during the peak demand season of the year. They were sold mainly to the village agents/middlemen (*khatiks*) who were in regular contact with the villagers. The price at which the selling agreement arrived depended on the relative bargaining strength. The existence of this type of marketing channel in goat has been reported by Bhatia *et al*. (2005) and Pandit and Dhaka (2005). Sometimes, these animals were sold directly to the retailers (small numbers). The village agents supplied the animals to the wholesaler who transported them to cities (Jaipur), metros (Delhi) or adjacent states. The veterinary care was one of the important aspects of sheep management as they were susceptible to various diseases. The average mortality was 14 per cent and was largely due to foot and mouth disease, enterotoxaemia and pneumonia. The farmers were found to depend mostly on the government veterinary clinics for treatment of animals.

Table 3. Cost and returns in sheep production

(Rs/flock)

Item	Category of farmers			Overall
	Small	Medium	Large	
Expenditure				
Fodder and feed (%)	62.50	58.57	52.69	56.08
Medicine (%)	26.30	32.03	27.18	28.52
Hired labour (%)	5.48	3.73	14.48	9.74
Interest (%)	5.63	5.67	5.66	5.65
Total variable cost (Rs)	2115	2735	5567	3520
Returns				
Animal sale (%)	77.35	82.31	81.69	81.36
Milk (%)	4.87	2.63	3.26	3.26
Wool (%)	11.00	8.10	8.46	8.65
Manure (%)	6.87	6.96	6.59	6.72
Total returns (Rs)	12395	21822	48528	28252
Return over variable cost (ROVC) (Rs)	10280	19087	42961	24732
ROVC per animal (Rs)	428	440	470	456

Economic Efficiency of Sheep Farming

The production function estimates have been given in Table 4; both OLS and MLE estimates have been given for a comparison. The coefficients of OLS estimates for all inputs were found negative and were significant in the case of expenditure on veterinary care. The negative sign could be due to the fact that some of the farmers who did not have veterinary expenditure, had better returns, may be due to their better bargaining power. Moreover, since sheep were raised on the extensive system on common pastures, the possibility of getting affected with contagious diseases was high. In these cases, the individualistic approach of treatment was ineffective and a collective approach was warranted. The coefficients in the MLE estimates were more or less similar to those of

Table 4. Estimates of stochastic frontier production function

Variable	OLS		MLE	
	Coefficient	Standard error	Coefficient	Standard error
Constant	6.670*	0.194	6.781*	0.185
Fodder and feed (Rs)	-0.033	0.031	-0.001	0.033
Veterinary care (Rs)	-0.123*	0.047	-0.121*	0.046
Labour (humandays)	-0.045	0.051	-0.006	0.057
λ			0.660	
σ^2			0.230*	0.052
σ_V^2			0.161	
σ_U^2			0.070	
γ			0.303*	0.123
log likelihood			-40.52	
R^2	0.09			
Mean economic efficiency			0.752	

Note: * denotes significance at 1 per cent level

the OLS estimates. The significant one was veterinary care which again showed a negative sign. The elasticity coefficients were -0.001, -0.12 and -0.006 for fodder and feed, veterinary care, and labour utilization, respectively.

The other important parameter σ^2 showed a positive sign and ó was statistically significant at 1 per cent level. The estimated values of σ_u^2 and σ_v^2 were 0.161 and 0.070, respectively, indicating that the inefficiency was not because of chance alone, but due to individual inefficiency also. The value of γ (the ratio between variance due to inefficiency to total variance) was 0.30, indicating that 30 per cent of the variation was due to economic inefficiency. The average economic efficiency of the farmers was found as 0.752, indicating that the farmers were realising only 75 per cent of the production potential and the present return could be enhanced by another 25 per cent by prudent management practices.

Distribution of Economic Efficiency

The economic efficiency was found to vary widely across farms; it ranged from 0.30 to 0.94 with a mean value of 0.75 (Table 5). The highest mean efficiency was obtained by landless farmers (0.81) and the least by medium farmers (0.73). The study has indicated that less-resourceful farmers were more efficient economically than the more-resourceful farmers. This might be due to the more attentive nature of the resource- poor farmers to generate more income. For a better indication of the distribution of individual efficiencies, frequency distribution of economic efficiency within a range of 0.05 was made and has been presented in Table 6. The overall highest economic efficiency (38%) was in the category range of 75-80 per cent, followed by 70-75 per cent (17%) and 80-85 per cent (15%) categories. Nearly 13 per cent of the farmers had economic efficiency greater than 85 per cent and 7 per cent had it less than 60

Table 5. Descriptive statistics of economic efficiency

Category	Minimum	Maximum	Mean	Standard deviation
Landless	0.7471	0.9356	0.8102	0.0864
Marginal	0.5403	0.9085	0.7637	0.1029
Small	0.5269	0.9185	0.7737	0.0857
Semi-medium	0.2999	0.8957	0.7396	0.1088
Medium	0.3658	0.8842	0.7274	0.1258
Large	0.3577	0.8676	0.7553	0.1156
Overall	0.2999	0.9356	0.7526	0.1076

Table 6. Distribution of farmers by level of economic efficiency

(per cent)

Economic efficiency category	Landless	Marginal	Small	Semi-medium	Medium	Large	Overall
Below 60	0	9.09	8.70	7.14	8.70	5.88	7.44
60-65	0	0	0	3.57	0.00	0	1.86
65-70	0	9.09	8.70	3.57	11.76	11.76	8.37
70-75	20	27.27	13.05	21.42	11.76	11.76	16.74
75-80	40	27.27	34.80	49.98	29.40	29.40	38.13
80-85	0	0	30.45	7.14	29.40	29.40	14.88
85-90	20	18.18	4.31	7.14	11.76	11.76	9.30
Above 90	20	9.09	4.35	0.00	0.00	0.00	2.79
Total farmers	5	11.0	23.0	28.0	23.0	17.0	107.0

Table 7. Determinants of economic efficiency

Variables	Coefficient	Standard error	t-value
Constant	0.749	0.744	1.002
Operational holding size	-0.142*	0.065	-2.187
Flock size	0.031	0.101	0.307
Age	0.028	0.187	0.146
Family size	0.173	0.121	1.433
Literacy	-0.067	0.114	-0.588
Membership of organization	0.299*	0.299	1.908
R^2	0.10		
N	107		

Note: * denotes significance at 5 per cent level

per cent. Nearly 80 per cent of the farmers had economic efficiency in 60-85 per cent range.

Determinants of Economic Efficiency

The results of regression analysis to identify the determinants of economic efficiency have been recorded in Table 7. The value of R^2 was low at 0.10, indicating that some other variables not included in the regression analysis, might be important in explaining the economic efficiency. Amongst different factors, size of operational holding and organisational membership turned out to be significant. Contrary to our expectations, the elasticity of operational holding size was -0.14, indicating that this variable was significantly reducing the economic efficiency of the farmers. As indicated earlier, it might be because of less attention being paid by the resource-rich farmers to manage the flocks. The dummy variable of organisational membership had a significant positive effect on efficiency. It was probably due to the better access to scientific information on sheep-rearing or attaining of better bargaining strength by the farmers. Other variables like flock-size, age of the family-head, family-size and literacy of the farmers were statistically insignificant.

Conclusions

In Rajasthan, farmers raise sheep on common grazing lands with application of external inputs. They are mostly illiterate and live in a predominantly joint-family setup. The average net return per flock of 54 has been found nearly Rs 25000 per year, with the average net return of Rs 456 per animal. The major modes of return are sale of live-animals, wool, milk and manure, whereas the major items of expenditure are feed and fodder, veterinary care, interest and hired labour. The sheep production is highly labour-intensive and absorbs nearly 581 humandays per year for an average flock, with nearly 80 per cent of labour being employed in the grazing activity. The frontier production function analysis has shown the average economic efficiency to be nearly 75 per cent, indicating that the farmers realize only three-fourths of their production potential. The major positive factor affecting the economic efficiency has been found to be the membership of an organisation which provides them better access to technical knowledge and helps in enhancing their bargaining power. The sheep breeders are highly unorganised and no functional farmers' organisation exists to safeguard their interests, as exist in the case of cotton and sugarcane growers. They are not able to realise better prices from the organised contactors/ traders. Formation of such co-operatives/societies can go a long way in improving the economic efficiency of sheep breeders.

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