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Enhancing Livestock Productivity in the Desert Ecologies of Pakistan: Setting the Development Priorities

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1. INTRODUCTION

Livestock farming is practiced in all over Pakistan by millions of farming and landless households. The livestock sub-sector constitutes a more important source of food and means of sustenance in rainfed, mountainous and desert ecologies of Pakistan. Livestock farming is main agricultural activity in deserts because in these areas crop farming opportunities are relatively few due to very low rainfall, sandy soils and meagre availability of good quality ground water. This sector shares by 53.2 percent in the total agricultural value added and about 11.4 percent in national GDP [Pakistan (2010)]. Pakistan is situated in the neighborhood of world's largest milk producer (i.e. India) and herself is world's 4th largest milk producer. Livestock farming in Pakistan can broadly be classified into grazing and stall feeding based. The grazing based is the peculiarity of the mountainous, rainfed, saline affected and desert areas of Pakistan while stall-fed farming is mainly found in irrigated areas of Pakistan.

The total area of Pakistan is 79.6 million ha, of which 88 percent is arid to semi-arid. About 50.88 million ha (or 63.9 percent) are rangelands.[1] The ecologies of NWFP and Northern Areas are semi-arid to humid. The Sindh province is primarily arid while Punjab and Balochistan have arid-semiarid ratios as 58:29 and 43:57, respectively. By ecologies, 51.5 percent of total country area is arid, 36.9 percent is semi-arid, 5.4 percent is sub-humid and 6.2 percent is mixed. About 41 million ha is solely arid including about 11 million ha comprising deserts where mostly the climate is hyper-arid [PCRWR (1999); Iqbal, *et al*. (2000)]. The rangelands of Pakistan extends from alpine pastures in the northern mountains to temperate and Mediterranean ranges in the western mountains and arid/semi-arid deserts of the Indus Plain. Due to bio-climatic variations, the rangeland vegetation varies from one area to the other. Because of low prospects of crop

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[1]Pakistan's rangelands are: Western Balochistan ranges (18.50 million ha), Central Balochistan ranges (8.00 million ha), Desert rangelands (7.97 million ha), Eastern Balochistan ranges (5.00 million ha), trans-Himalyan grazing lands (3.50 million ha), Kohistan ranges (2.38 million ha), Alpine pastures (1.68 million ha), Pothwar scrub ranges (1.68 million ha), Suleiman mountain ranges (1.50 million ha) and Himalayan forest grazing lands (0.67 million ha).

cultivation and availability of grazing vegetation, livestock farming is an important source of livelihood for the dwellers in rangelands, deserts and marginal lands. For instance, in Balochistan, livestock farming primarily depends upon rangelands. Sheep and goats obtain about 60 percent of their feed from rangeland vegetation [Zaffaruddin (1977)] while in Balochistan, 90 percent of the required livestock feed is provided by rangelands [FAO (1983)]. Most rangelands in Pakistan are over-exploited due to uncontrolled nomadic grazing, grazing places being common tribal (or village property), their carrying capacity[2] is declining because of little rehabilitation/regeneration efforts. On the other hand, rapidly increasing demands for livestock products further intensifying the already enormous triggered pressure on these rangelands [Pakistan (2007a)].

The sandy desert falling districts of Pakistan contain about 8.1 percent of buffalo, 13.5 percent of cattle, 15.3 percent of sheep and 14.4 percent of goat population in the country[3] [Pakistan (2007b)]. In a situation when the contribution of livestock sub-sector is more than half of the total agricultural GDP, whereas its only one product (i.e. milk) is worth more than the combined value of wheat and cotton. Moreover, this sector had never experienced a negative growth. It is not plausible to ignore desert economies possessing such a notable proportions of different livestock species.

The livestock farming in the desert economies also deserve special attention of researchers and policy makers on all types of poverty indicators (e.g. income, nutritional, access to research, extension, education and other institutional support etc.), and much lagging behind in the infrastructure development (roads, electricity, transport, means of communication etc.). Before taking any developmental initiative for the livestock sector, it is imperative to have some empirical information on the livestock farming in deserts of Pakistan. Generally, livestock farming in these areas is characterised as low paid because of poor animal health attributed to limited supply of forage and fodder, more physical exertion of animal during grazing, frequent incidence of diseases and droughts cycles, difficulties in getting health services and vaccination, highly limited milk marketing opportunities, non-existence of milk preservation facilities with the herders, and a generally poor institutional support. A highly limited literature was available on livestock farming in deserts of Pakistan till year 2000. In year 2000, a relatively detailed baseline survey was carried out in Cholistan desert of Punjab, but this information was limited to only one desert. Secondly, this study lacked information on various aspects like economic analysis of livestock farming, grazing and stall feeding patterns, feed composition during stall feeding and stall feeding expenditures for small and large ruminants, trading intensity of various age groups of different animal species, etc. This study fills such gaps and expands the scope of the work to other deserts namely Thal and Tharparkar. The major objectives of this exercise are: (a) to examine the similarities and differences in socio-economic characteristics, livestock composition, grazing and feeding systems and marketing aspects; (b) to carry out economic analysis of livestock farming in desert ecologies; (c) to review the socioeconomic, institutional and policy constraints faced by the livestock sector in the desert areas of Pakistan; and (d) to suggest guidelines for the

[2]Carrying capacity means the natural capacity of land and/or rangeland to feed human and/or animal population at given technological level [Tiffen and Mortimore (2002)].

[3]The district falling in sandy desert include Cholistan, Bahawalpur, Bhawalnagar and Rahim Yar Khan from Cholistan desert; Bhakkar, Layyah, Khushab from Thal desert; Tharparkar and Umerkot from Thar desert; and Chagai, Awaran and Kharan from Chagai-Kharan deserts.

development of the livestock farming in deserts of Pakistan. It is expected that the suggested recommendations shall positively contribute in increasing livestock productivity in the area along with contributing to poverty alleviation as in MDGs, we are committed to halve poverty incidence in the country by 2015.

The rest of the paper is organised in to five sections. Section 2 describes analytical techniques under the tile of research methodology. Section 3 named as results and discussion is devoted to discuss the research findings. Section 4 is pertained to conclusions and suggestions. The references quoted at various stages in the paper are detailed in fifth section.

2. RESEARCH METHODOLOGY

Sampling Design and Survey Methods

Sampling is the first step towards empirical analysis after conceiving the problem, literature review and deciding about the study area. Before going for actual sampling, variations in the physical and socio-economic environment were considered. Since the livestock farming is spread over the desert, therefore, geographical area of the desert dominated tehsils/talukas were taken as the basis for research study sampling. The sample villages in these tehsils/talukas were selected after consulting the officials from the Livestock Department, Animal Husbandry Department, the Department of Agricultural Extension present in the area and the local NGOs.

Regarding the respondents selection, a true randomisation was not possible mainly because of lack of information about the number of livestock farming households. Even if such information were available, it was again difficult and costly to trace the selected farmers in deserts as they might have left for grazing, migrated to other places. Hence chance meeting method of respondent selection was adopted. Under this method, some resource person or *wadera* or old person from the villages/settlements was first contacted. The survey objectives were explained to him to win his confidence. Later on, based on the composition by herd size, livestock species and herder types, a request for the desired number of respondents was placed to him. This procedure greatly helped in drawing a representative sample of needed size.

Regarding sample composition, 122, 120 and 120 livestock farmers/herders data were gathered from Cholistan, Tharparkar and Thal deserts, respectively. In this way, the results discussed in subsequent section pertain to total sample of 362 livestock farmers. The primary level data were formally gathered through field surveys in the three deserts by using a pre-tested questionnaire. The survey teams were consisted of Economists, Agricultural Economists, Statistician, Agricultural Extensionists and Rural Sociologists. The surveys were cordially facilitated by the staff of the provincial animal Husbandry/ Livestock and Dairy Development Department, the Department of Agricultural Extension and the local NGOs.

The data for these studies pertains to year 2000 for Cholistan, year 2006-07 for Thal and year 2007-08 for the Tharparkar desert.

Analytical Procedures

Conversion Factors Used for Various Livestock Species

Because of large variations in age, sex and type composition, the livestock were expressed in equivalent adult animal units for comparison purposes. The weights assigned to various livestock species by age and sex for computing adult livestock units were taken from Iqbal, *et al*. (2000).

Method of Scoring the Priority Orders/Objectives/Development Needs

In the questionnaire, the respondents were asked to delineate and prioritise the objectives of keeping various types of animals in their herds. For instance, the feedback of the respondent farmers was recorded by using Likert scale.[4] For instance, the priority order was recorded as '0' if 'not important', '1' as 'least important', '2' as 'important', '3' as 'very important', '4' as 'highly important' and '5' if 'most important'. The recorded scores for each quarry type were transformed into percentages by using the following transformation.

$$W_i = \frac{X_i}{\sum_{i=1}^{n} X_i} . 100 \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad (1)$$

where

W_i = Percent weight of the ith objective of keeping a specific type of animal.
X_i = Score of the ith objective of keeping a specific type of animal.
$\sum X_i$ = Total sum of the scores of all included objectives of keeping that animal.
i = 1, 2, ….. 5 are the objectives of keeping a specific type of animal.

Livestock Breed Diversity

From methodological perspective, breed diversity could be estimated using various diversity measuring index (e.g. Inverse Herfindahl Index, Simpsons Diversity Index etc.), but here for simplicity purposes, on the number of breeds of an animal species was utilised.

Livestock Trading Intensity

The livestock trading intensity on sample farms was estimated as follows:

Trading intensity = ((animals bought + animals sold)/total population)*100

Economic Analysis of Livestock Farming

Livestock farming in the deserts is consisted of grazing and stall feeding components. The grazing cost is estimated on the basis of number of animal heads a grazer can manage easily and the prevailing wages of grazers (in terms of monthly salary) during the survey period. For estimating inputs costs, the value of purchased items were directly considered

[4]In this study, the questions were recorded in the form of order of importance of suggestions, objectives and/or reasons of carrying out certain activity or degree of urgency of some developmental needs of the area. The scales used in the questionnaire were from 0 to 5 and 0 to 4.

on the cost side whereas the imputed costs/shadow prices were used for home-contributed items like family labour, grazing labour, self-grown feed items (dry fodders, grains etc.), domestically consumed milk and dairy products, interest on the capital invested, as these items are weakly marketed. For other cost items, various assumption (also narrated in the foot notes of the tables) based on informal discussion with the knowledgeable farmers of the area were also used. For estimating animal quality depreciation, various methodologies are available in the literature, but in this study for cattle, we assumed that 5-7 pregnancies per working life and salvage value at the end of working life were considered. In this way, the annual animal quality depreciation allowance came about 10 percent per annum. Among sheep/goats, the average productive life is 4 years but the salvage value is very low and there is a high probability of suffering from diseases in small ruminants. Considering these factors, the animal depreciation allowance considered was again 10 percent per annum.

On the returns side, for cattle, the value of milk produced/annum, value of infant born and value of the animal at the end of the year (because females are kept for further reproduction) were summed to estimate gross value of output. In case of small ruminants the male sheep became marketable as slaughter purpose animal at the age of 9 months and goats at one year of age. For drawing inferences, net profit per adult animal, returns per month per animal and average monthly income per herd were estimated for both ruminant types.

3. RESULTS AND DISCUSSION

3.1. Socioeconomic Profile of Livestock Farmers

The average age of the household head ranged from 36 in Tharparkar to 48 years in Cholistan. Their mean crop farming experiences vary from 15 years in Cholistan to about 22 years in Thal. The mean livestock farming experience vary from 19 years in Tharparkar to 32 years in Cholistan. Large variations in possession of formal education were observed across deserts, the lowest in Cholistan and almost primary level in Thal and Tharparkar deserts. Likewise, the proportion of sample respondents able to read and write was also lowest in Cholistan (Table 1).

The average family size of the respondent families was about 13 persons, composed of 1 old person, about 6 adult persons and 6 children. Joint family living pattern is dominant in all three deserts. The human resource development was probed through children education. Out of six children per family, nearly two were in primary schools and about 0.5 children were in middle/high schools. A negligibly small number of children were in colleges/universities. In Thal desert, relatively more number of children was in college/university. While examining allocation of adult male family labour, variations across deserts were observed. For instance, the number of adults engaged in livestock farming was higher in Cholistan than other two deserts.

The number of standard animal units or "*sau*" managed per person was about 26.8 *sau* in Cholistan, 16.7 *sau* in Tharparkar and 14.5 *sau* in Thal. The mean operational holding managed per person was about 10.45 acres in Cholistan, 40.97 acres in Tharparkar and 56.08 acres in Thal desert (Table 1). Less per person land allocation in Cholistan is because of their agricultural lands are lying in Lesser Cholistan where seasonal canal irrigation facilities are

Table 1

Socioeconomic Profile of Sample Livestock Farmers in Three Deserts of Pakistan

Items	Cholistan	Tharparkar	Thal
Age (years)	48.09	36.36	43.5
Crop farming experience (years)	15.44	17.95	21.5
Livestock farming experience (years)	32.45	19.18	21.2
Livestock trade experience (years)	n.a.	4.98	10.1
Formal education (years)	1.05	5.45	4.8
Can read and write (% Yes)	4.85	69.20	61.7
Family size (#)	13.36	11.56	12.6
Living pattern (% Joint)	61.50	85.00	71.7
Family Composition (Nos.)			
– Old males (> 60 years)	0.49	0.38	0.6
– Old females (> 60 years)	0.49	0.32	0.6
– Adult males (16–60 years)	3.18	3.12	3.6
– Adult females (16–60 years)	3.18	2.80	3.0
– Boys (upto 16 years)	3.01	2.73	2.5
– Girls (upto 16 years)	3.01	2.22	2.3
Children Acquiring Education (Nos.)			
– Boys in primary school	n.a.	1.34	1.2
– Girls in primary school	n.a.	0.93	0.6
– Boys in high school	n.a.	0.30	0.5
– Girls in high school	n.a.	0.06	0.1
– Boys in college/university	n.a.	0.06	0.2
– Girls in college/university	n.a.	–	0.1
Household Labour Distribution (Nos.)			
– Adults in crop farming	1.30	0.71	1.30
– Adults in livestock farming	2.40	1.35	1.20
– Adults in off-farm activities	0.18	0.16	0.20
–Adults in non-farm activities	0.18	1.03	0.80
Farm and Herd Size per Labourer Allocated			
– Farm area per person (acres)	10.45	40.97	56.08
– Animal units of livestock per person (#)	26.80	16.70	14.53
Family Contact Methods (%)			
– Mobile	n.a.	23.30	43.50
– Messenger	46.50	1.70	21.70
– Telephone/V-Phone	n.a.	65.80	21.70
– Mobile + Telephone	n.a.	6.70	–
– Other	54.50	2.50	13.00
Fuel Source for Cooking/Heating (%)			
– Firewood	29.70	46.70	35.00
– Firewood + Dung cakes	39.90	18.30	49.20
– Firewood + Dung cakes + Kerosene oil	24.60	27.50	13.30
– Firewood + Dung cakes + LPG/other	0.80	–	2.50
– Other	5.90	6.60	–

available and at least one person on full time basis needs to be present there for caring crops and other household members. In other two deserts, the livestock and crop farming activities operate simultaneously, therefore, livestock farming labour also assist crop farming labour during peak season.

For communication with family members and relatives, the use of wireless telephones (V-Phone) and cellular/mobile phones was more common in Thal and Tharparkar deserts and about same may be prevailing in Cholistan because the information presented in Table 1 about Cholistan desert pertains to year 2000 when the communication facilities were not as developed as it is now-a-days. In conclusion, least heterogeneity across deserts may be prevailing regarding utilisation of communication facilities. About sources of energy for cooking and heating, firewood and dried animal dung cakes (firewood separately and with dung cakes also) are main sources of energy for cooking among sample households (Table 1).

Crop Farming Profile of Livestock Farmers

The average farm size, consisted of 2-3 parcels was smallest (about 14 acres) in Cholistan followed by Tharparkar and Thal deserts. Majority was owner operators. Animal muscle was main source of traction power for plowing in Tharparkar while tractor is common used for ploughing in Cholistan and Thal. Being desert ecology, the soils of the area were mainly sandy followed by sandy loam. On irrigated parcels, well/tubewell irrigation was applied in Cholistan and Thal, whereas, in Tharparkar, the sample farms were mainly rainfed. In Thal, 95 percent farmers reported low to medium brackish under ground water, 70 percent in Tharparkar whereas a high degree of brackishness in under ground water was generally reported in Cholistan (Table 2).

Table 2

Farm Characteristics of Livestock Farming Households in Three Deserts of Pakistan

Items	Cholistan	Tharparkar	Thal
Total operational holding (acres)	13.58	28.68	72.90
Own land (acres)	12.00	25.92	67.20
Tenancy status (% owners)	81.80	73.30	71.40
Number of parcels	n.a.	2.18	2.90
Source of Power for Plowing (% Farms)			
- Animals	3.90	70.30	–
- Animals + Tractor	1.30	27.00	6.70
- Tractor	94.00	2.70	93.30
Soil Type of Major Parcel (% Farms)[1]			
- Sandy	81.00	66.70	77.30
- Sandy loam	–	31.50	16.80
- Loam	2.00	1.80	4.30
- Sandy + sandy loam	–	–	1.60
- Saline sodic	17.0	–	–
Tubewell as irrigation source (% farms)	68.30	5.40	68.30
Brackishness in Ground Water (% Farms)			
- Low	n.a.	43.60	72.41
- Medium	n.a.	26.40	22.99
- High	n.a.	30.00	4.60

3.2. Livestock Ownership, Composition and Livestock Farming Objectives

The average herd size was much larger in Cholistan than Tharparkar and Thal deserts. This may be because of simultaneous management of crop and livestock farming in Tharparkar and Thal deserts. In Cholistan, crop+livestock and livestock farming was carried out by family members staying in Lesser and Greater Cholistan, respectively. Cattle are the most important animal of all three deserts. Buffaloes were reported at only 5 percent sample farms in Tharparkar, nearly 21 percent and 55 percent farms in Cholistan and Thal deserts, respectively. In Cholistan, goats were present on two-third farms while camels and sheep were present on almost every second herd in the area. In Tharparkar, almost every farmer kept goats along with cattle while camel and sheep were present in about half of the sample farms. In Thal, majority of the farmers kept cattle and goats simultaneously, while sheep were present on 77 percent farms, buffaloes on 54 percent farms and camels on 48 percent farms (Table 3).

Table 3

Animal Species Kept by Sample Herders (Percent Yes) in Three Deserts of Pakistan

Animal Species	Cholistan	Tharparkar	Thal
Buffalo	20.5	5.0	54.2
Cattle	95.1	76.7	95.8
Camels	45.1	48.3	48.3
Sheep	50.0	54.2	76.7
Goats	67.2	95.0	95.8
Animal species/farm (#)	2.2	2.8	3.8

Considering the composition of different livestock species, in large ruminants, the average number of cattle per farm was the largest in all three deserts. Camel was the second most kept animal in Cholistan and Tharparkar deserts while the average number of camels per household in Thal is quite low. The total number of small ruminants per household in Cholistan was highest followed by Tharparkar and Thal deserts. Regarding composition of sheep and goats, the average number of sheep per household were much higher than goats in Cholistan, while opposite was true in Tharparkar desert. In Thal desert, the difference in the number of sheep and goats per household was quite narrow. Donkey is a pack animal in all three deserts, however, their number per herd was the highest in Tharparkar compared with other two deserts (Table 4). These findings are almost similar to the results reported by earlier studies carried out in the area [e.g. Mahmood, *et al*. (1987); Khan, *et al*. (1993); Iqbal, *et al*. (2000)].

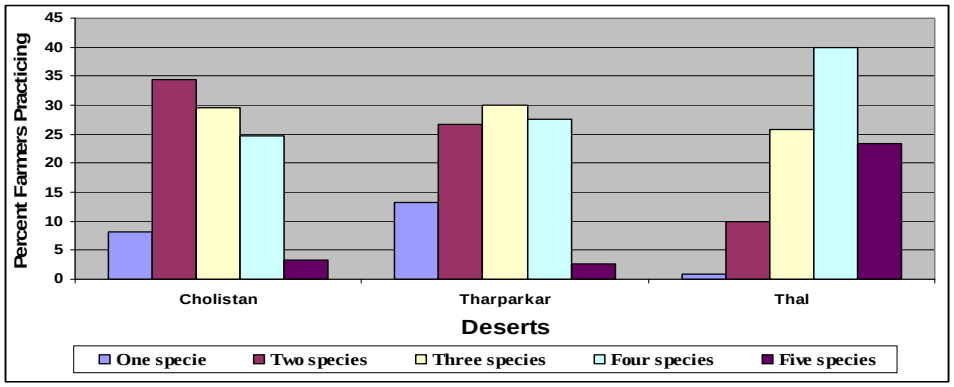
In Cholistan and Tharparkar, 2–4 animal species, while in Thal, 3–5 species were commonly present on sample farms (Figure 1). On two species farms, cattle+goats was more commonly available combination in all three deserts. Among three species farms, cattle-sheep-goats combination was relatively more common. In Tharparkar, cattle-camels-goats combination was also common. Amongst four species farms, more common combination was cattle-camel-sheep-goats. In Thal, cattle-buffalo-sheep-goats combination was also almost equally popular in addition to cattle-camels-sheep-goats. Having all five animal species was least practiced except in Thal, where this combination was present on

Table 4

Livestock Types and Composition on Sample Farms in Three Deserts of Pakistan

Animal Types	Cholistan	Tharparkar	Thal
Cattle (No. of Heads)	**51.01**	**9.37**	7.00
– Cow	33.53	6.59	4.21
– Bullocks/bulls	0.05	0.18	0.09
– Heifers	8.70	1.84	0.87
– Sires	0.82	0.05	0.12
– Young stock	7.91	1.84	1.72
Cattle breed diversity (# of breeds)	**n.a.**	**1.07**	**2.89**
Buffaloes (No. of Heads)	**1.12**	**0.31**	**2.52**
– Buffaloes	0.79	0.18	1.46
– Male buffaloes	0.00	0.01	0.05
– Heifers	0.10	0.08	0.35
– Sire	0.00	0.01	0.03
– Young stock	0.23	0.04	0.06
Buffalo breed diversity (# of breeds)	**n.a.**	**1.00**	**1.00**
Camels (No. of Heads)	**4.31**	**1.60**	**0.89**
– Female camels	2.69	1.08	0.48
– Male camels	0.70	0.39	0.22
– Heifers	0.43	0.03	0.03
– Sires	0.01	0.01	0.00
– Young stock	0.48	0.09	0.16
Camel breed diversity (# of breeds)	**n.a.**	**1.03**	**0.66**
Sheep (No. of Heads)	**60.76**	**17.83**	**16.55**
– Adult sheep	49.63	13.31	14.37
– Young stock	11.13	4.52	4.88
Sheep breed diversity (# of breeds)	**n.a.**	**1.09**	**1.51**
Goats (No. of Heads)	**19.45**	**43.23**	**22.81**
– Adult goats	14.84	33.23	16.36
– Young stock	4.61	10.01	6.65
Goats breed diversity (# of breeds)	**n.a.**	**1.08**	**2.13**
Donkeys (No. of heads)	0.42	2.13	0.21
Mules (No. of heads)	0.00	0.04	0.06
Other animals (No. of heads)	0.00	0.08	0.08
Total Livestock Heads (Nos.)	**136.65**	**72.33**	**49.76**
Total Animal Units (#)	**63.62**	**22.54**	**17.44**

Fig. 1. No. of Species Commonly Present on Sample Farms in Three Deserts of Pakistan



about ¼th of the sample farms (Table 5). Thus, on all two or more species farms, both small and large ruminants were kept. The possible reasons of keeping small with large ruminants were: (i) the non-significant additional labour, feed and/or grazing expenses involved; and, (ii) small ruminants are easy to sell to meet monetary needs.

Table 5

Livestock Enterprise Combinations (Percent Farms) Practiced in Three Deserts of Pakistan

Species Combinations	Cholistan	Tharparkar	Thal
Single Specie	**8.2**	**13.3**	**0.8**
– Cattle only	8.2	0.8	–
– Buffaloes only	–	–	–
– Camels only	–	–	–
– Sheep only	–	2.5	–
– Goats only	–	10.0	0.8
Two Species	**34.4**	**26.7**	**10.0**
– Cattle and Buffaloes	2.5	–	–
– Cattle and Camels	11.5	0.8	–
– Cattle and Goats	13.1	19.2	6.7
– Cattle and Sheep	3.3	–	1.7
– Buffalo and Sheep	0.8	–	–
– Buffalo and Goats	0.8	–	0.8
– Camels and goats	–	1.7	–
– Sheep and Goats	2.4	5.0	0.8
Three Species	**29.5**	**29.9**	**25.8**
– Cattle, Sheep and Goats	14.8	11.7	15.0
– Cattle, Buffaloes and Goats	1.7	0.8	5.8
– Cattle, Camels and Buffaloes	1.6	–	–
– Cattle, Camels and Goats	8.2	12.5	2.5
– Cattle, Camels and Sheep	1.6	0.8	–
– Buffaloes, Sheep and Goats	0.8	0.8	–
– Camels, Sheep and Goats	–	3.3	1.7
– Cattle, Buffaloes and Sheep	0.8	–	0.8
Four Species	**24.6**	**27.5**	**40.0**
– Cattle, Camels, Sheep and Goats	16.4	26.7	16.7
– Cattle, Buffaloes, Sheep and Goats	5.7	0.8	15.0
– Cattle, Buffaloes, Camels and Goats	2.5	–	6.7
– Cattle, Buffaloes, Camels and Sheep	–	–	1.7
All Five Species	**3.3**	**2.6**	**23.3**
– Cattle, Buffaloes, Camels, Sheep and Goats	3.3	2.6	23.3

Since cattle and sheep/goats are major animals in all three deserts, the objectives of keeping them were recorded on Likert scale in a prioritised fashion which then transformed into percent scores. Overall, home milk consumption and selling of adults and young stock were the primary objectives of livestock farming in all the deserts. A very small proportion of households found producing animals for selling on *Eid-ul-Azha*, to sell these animals at premium prices (Table 6). Perhaps this low percentage is mainly because the ecological conditions of desert do not permit the farmers to produce premium quality animal. It is also equally possible that local livestock traders may not be offering satisfactorily higher prices for better quality animals to the farmers as livestock markets in the desert ecologies are situated at far distant places.

Table 6

Objectives (Percent Scores) of Keeping Various Animal Types in Three Deserts of Pakistan

Animal Species/Objective Types	Cholistan	Tharparkar	Thal
Cattle			
– Home consumption of milk	15.6	37.5	44.5
– Sale of young stock	33.4	22.5	18.7
– Sale of adult animals	18.1	17.3	12.3
– Sale of dairy products	29.5	9.7	2.5
– Sale as sacrificial animals	0.4	5.7	12.5
– Status symbol	0.8	4.5	3.8
– Sale as breeding animals	0.7	1.1	4.6
– Draft animal for plowing	–	0.4	–
– Other	1.5	1.3	1.2
Sheep/Goats			
– Home consumption of milk	6.7	30.8	16.6
– Sale of young stock	43.8	22.0	29.1
– Sale of adult animals	25.2	21.0	20.4
– Sale of sacrificial animals	9.3	9.8	18.2
– Sale of wool/hairs	11.1	7.8	6.9
– Status symbol	0.5	3.7	2.1
– Sale of dairy products	–	3.0	0.5
– Sale as breeding animals	0.6	1.1	4.4
– Other	13.2	0.8	2.0

3.3. *Livestock Grazing and Stall Feeding Practices*

Both separate and combined grazing of small and large ruminants found practiced by livestock herders in the area. Separate grazing was dominant in Cholistan, while it was practiced by 2/3rd of the sample farmers in Tharparkar and Thal. In Tharparkar and Thal, mixed grazing was practiced by 33 percent and 27 percent farmers, respectively. Separate grazing was also generally practiced by large herd sized farmers, which seem intuitively justified (Table 7).

Table 7

Livestock Grazing Methods (Percent Farmers) Practiced in Three Deserts of Pakistan

Items	Cholistan	Tharparkar	Thal
No grazing or only stall feeding	–	–	4.2 (13.7)
Separate grazing of small and large ruminants	91.5 (n.a.)	66.3 (28.7)	65.8 (18.2)
Mixed grazing of both small and large ruminants	8.5 (n.a.)	33.7 (18.0)	26.7 (12.5)
Both separate and mixed grazing	–	–	3.3 (26.3)

Figures in parentheses are herd size estimated in standard animal units.

Since livestock farming in Cholistan is mainly grazing based and herders frequently travel between its Lesser and Greater parts, their movement patterns are given in Table 8. Also, in deserts, herders generally travel to distant places for gazing and return home after 2-3 days. Both family and hired labour were used for grazing. Two systems, i.e. monthly salary and payment on per animal basis, prevail in the area. The salaries vary across deserts, but fairly homogenous within deserts. In Tharparkar, average monthly grazing charges per cattle, camel and sheep/goat were Rs 115, Rs 200-250, and Rs 30 respectively, during 2007.

Table 8

Movement Schedule and Activities of Herders between Lesser and Greater Cholistan

Months	Location/Movement and Livestock Production Activities Carried Out
July–August	Migration from irrigated areas of Lesser Cholistan, canal and riverbanks to the owned *tobas*. Livestock generally grazes on the vegetation around *tobas*.
September–October	Depending upon the size of *tobas* and water available, generally, movement to temporary encampments at *tobas/kunds* started. Livestock grazes distance from *tobas/ kunds* increases.
November–December	Movement to *tobas/kunds* in search of water and vegetation continues. Livestock grazes relatively at very distant places around *tobas/kunds*.
January–February	Movement to *tobas/kunds* in search of water & vegetation continue with slow retreat to Lesser Cholistan. Livestock grazes relatively at very distant places around *tobas/ kunds*.
March–April	Return to irrigated fringes of Lesser Cholistan increases as wheat harvesting period arrives closer. Livestock grazes relatively at very distant places around *tobas/kunds*.
May–June	Stay in villages and temporary congregations on wastelands. Livestock is fed by grazing and stall feeding of purchased or self-planted fodder.

Source: FAO/ADB (1993) and some survey observations.

The stall-feeding practices were investigated by ruminant type by recalling memories of the respondents about feed types, their feeding periods and approximate quantities fed. In Tharparkar, ten different types of fodders were fed to large ruminants. In various calendar months, 6–9 types of fodders were fed. Among them sorghum/millet straw followed by guar seed straw remained dominant throughout the year while minor quantities of food grains were also fed to lactating animals (Figure 2). In feed composition, again sorghum/millet straw remained dominated around the year and its maximum proportions were fed in December-January (Figure 3).

Fig. 2. Stall-feeding Patterns (Percent Farmers) of Large Ruminants in Tharparkar Desert

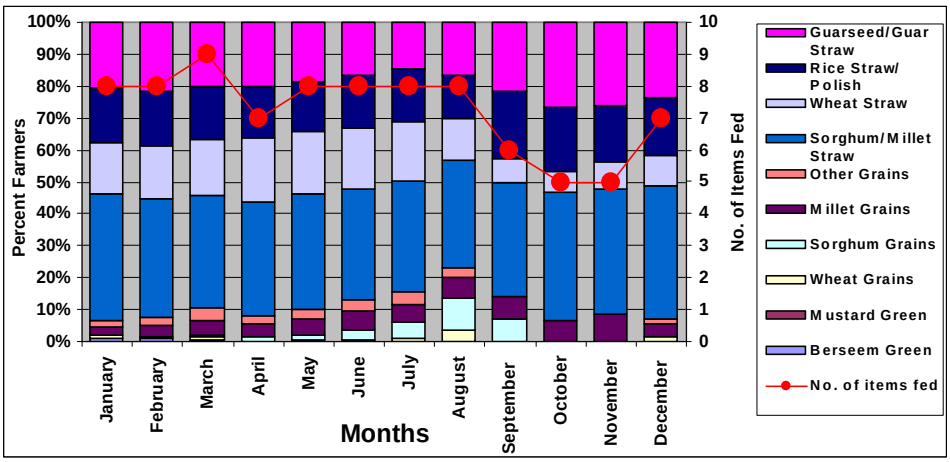
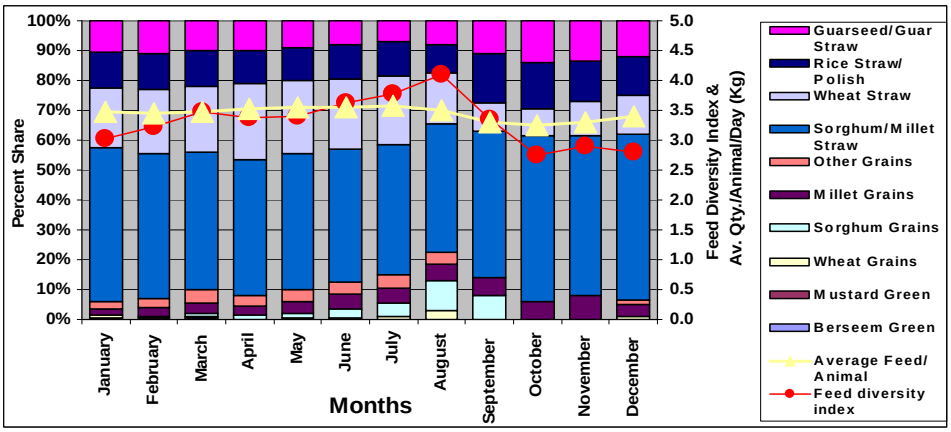


Fig. 3. Stall-feed Composition (Percent Share) of Large Ruminants in Tharparkar Desert



Like Tharparkar, in Thal, ten different types of fodders and crop by-products were fed by sample respondents to large ruminants. These were wheat straw followed by lucern, other green fodder, other dry fodders, mustard, green wheat, green and dry stalks of sorghum and millet, and gram straw. In various calendar months 6–9 types of fodders were used. Among them, wheat straw and other dry fodders remained dominant all over the year while lucern was increasingly fed during December to April, March whereas gram straw was utilised from May to September (Figure 4). Regarding feed composition, again wheat straw remained dominated ingredient throughout the year and its maximum quantity was fed in June-July months (Figure 5). The share of lucern was highest in February and March. The average quantity of feed during stall feeding varied from 23.3 kg/day/animal during June to 15.8 kg/day/animal during February-March months. The feed diversity index was as low as 1.5 in June and as high as 2.8 in December.

Fig. 4. Stall-feeding Patterns (Percent Farmer) of Large Ruminants in Thal Desert of Pakistan

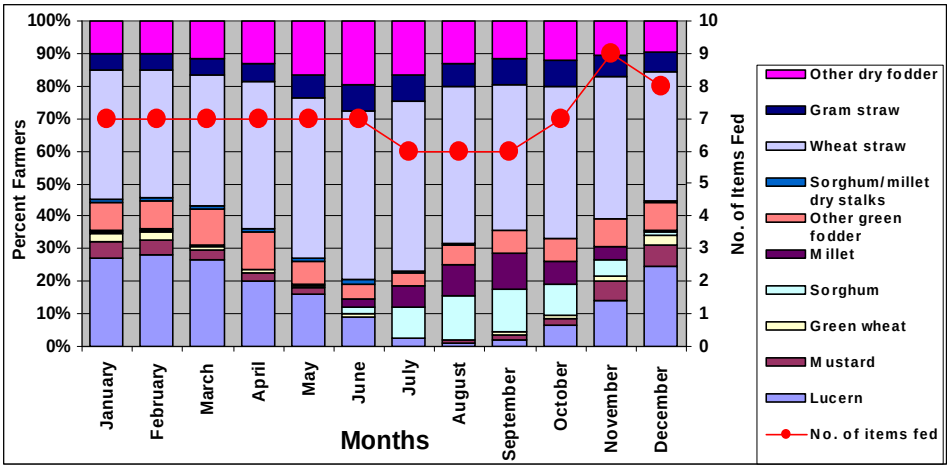
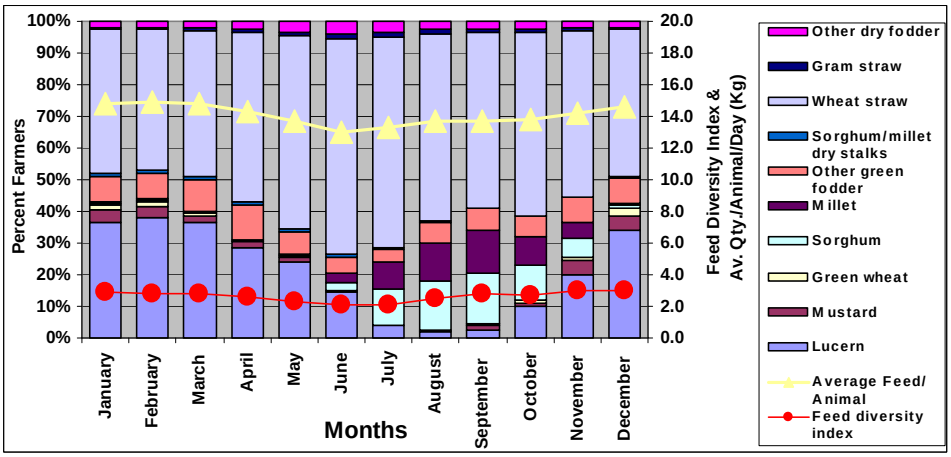


Fig. 5. Stall-feed Composition (Percent Share) of Large Ruminants in Thal Desert of Pakistan



Considering stall-feeding to small ruminants, in Tharparkar, again the longest fed item was guar seed straw followed by millet straw, fruit plant leaves and rice straw. A highly limited use of food grains like millet, mung bean/moth beans and wheat grains was also reported (Figure 6). In Thal desert, ten types of fodders were fed during stall feeding, i.e. wheat straw, gram straw, dried hay, berseem, wheat grain, gram grains, green leaves of the plants/trees and stalks of maize, sorghum and millet. Wheat straw was the most frequently fed item followed by gram straw, hay, berseem/lucern, wheat grain, maize, green leaves, sorghum and millet stalks (Figure 7). The above discussion leads to conclude that the crop byproducts/dry straws are main stall-feeding items of both small and large ruminants. The use of food grains is very small and limited to lactating and sale purposes small ruminants. Khan, *et al*. (1993) also reported same for Thar.

Fig. 6. Stall-feeding Patterns (Number of Days) of Small Ruminants in Tharparkar Desert

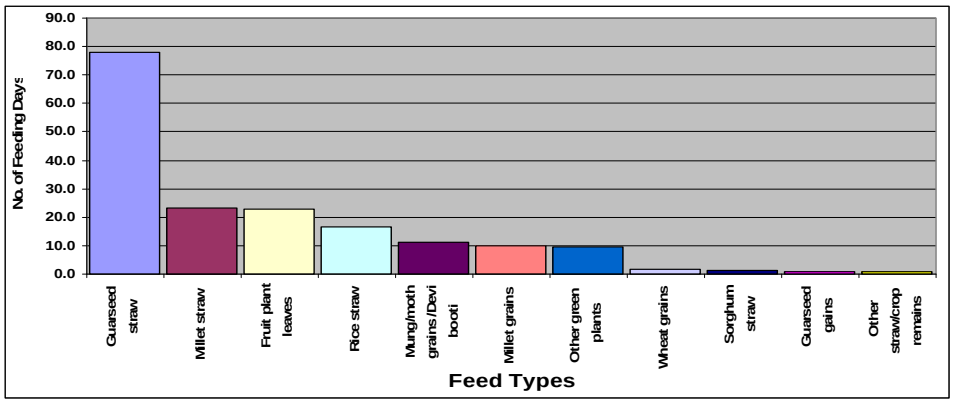
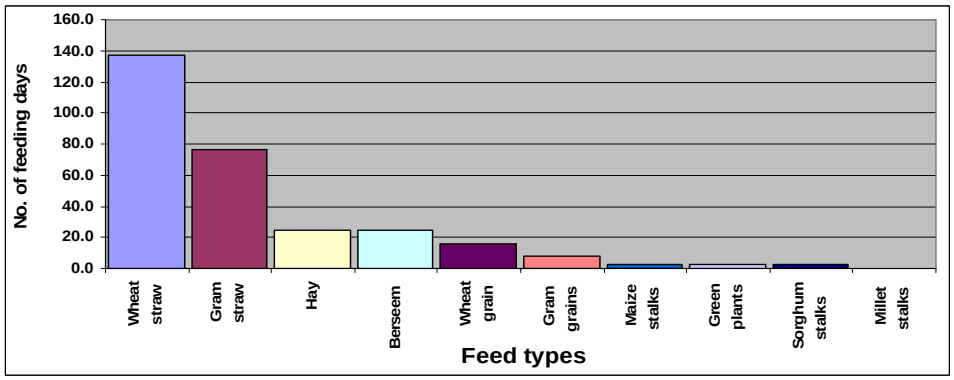


Fig. 7. Stall-feeding Patterns (Number of Days) of Small Ruminants in Thal desert



3.4. Livestock Reproduction and Health Management

Natural breeding is predominantly practiced in all desert ecologies with due ethical considerations.[5] Small sized herders usually do not have their own sires, hence, are dependent on other herders' for sire services. The sires (from own or other herds) are usually selected on the basis of characteristics like better milk yield of the offspring and its mother, colour, physical health, better conceiving rate and its beautiful look. Sometimes the sires of other herds incidentally mates as herds get mixed during grazing in an area. In this way, both controlled and uncontrolled natural breeding methods found practiced in all three deserts. The chances of uncontrolled natural breeding are relatively high in small ruminants. It was found that natural breeding is dominant in all three deserts. Between natural controlled and uncontrolled methods, natural controlled is dominant in Thal and relatively more adopted in Cholistan. In Tharparkar, practicing natural uncontrolled is more common than natural

[5]In large ruminants, the services of a sire are utilised by a herd for 3-5 years because by the time his daughters attain sexual maturity. The farmers in the area are of the view that it is not good to breed this sire with his own daughters. Therefore, the owners of breeding bull either sell it out or exchange with other owners in the area. In small ruminants, sires are replaced in 2-3 years.

controlled method, mainly because of dominance of one breed (i.e. Thari) and frequent mixing of herds having breeding bulls with other herds during grazing (Table 9).

Male young stock of large ruminants are usually sold before reaching to their sexual maturity, therefore, castration in large animals is minimal. In small ruminants, males are castrated by traditional method by using knife while, veterinary hospitals' staff uses castrators for this purpose. The sires remain with the herds during grazing. The livestock breeding seasons are reasonably well defined as majority of births take place in spring. In good seasons, sheep/goats also have second breeding during September-November.

Table 9

Livestock Breeding Methods (Percent Farmers) Practiced in Three Deserts of Pakistan

Breeding Methods	Cholistan	Tharparkar	Thal
Natural controlled	54.9	35.8	60.8
Natural uncontrolled	45.1	47.4	6.7
Artificial insemination	–	1.8	10.0
More than one from the above	–	15.0	22.5

About disease incidence, in Cholistan, frequent disease epidemics were reported among both small and large ruminants. The common diseases of large ruminants were Haemorrhagic Septicemia, Black Quarter, Foot and Mouth Disease, Anthrax, Mange, Sura, Camel Pox, Endo- and Ecto-parasites, etc. The small ruminants' common diseases were Enterotoxaemia, Pleuro-pneumonia, Sheep/Goat Pox, Anthrax, Liver Fluke, and Endo-/Ecto-parasites, etc. A small fraction of camel herders (5.5 percent) reported disease(s) incidence among camels in their herds. The disease occurrence was reported on about 46 percent, 59 percent and 34 percent of sheep, cattle and goat farms, respectively.

Similarly in Tharparkar, the common diseases of large ruminants were Black Quarter, Foot and Mouth Disease, Enterotoxaemia, Anthrax, contagious Caprine Pleuro-Pneumonia, Sura and Mange. Diseases like Haemorrhagic Septicemia, Sheep and Goat Pox, Mastitis and abortion were relatively less prevalent. Black quarter in cattle and Enterotoxaemia and Anthrax in sheep/goats are more common [Mahmood, *et al.* (1987)]. In Thal, highest incidence was reported for Foot and Mouth followed by haemoglobin-urea, Enterotoxaemia, Haemorrhagic Septicaemia and Pneumonia.

3.5. Marketing of Livestock and Livestock Products

Information about livestock trade on sample farms shows that in Cholistan and Tharparkar, the adult animals trading intensity was lower than the young stocks whereas in Thal, the trading intensity of all age groups was almost same. In Cholistan, the adult animals trading intensity varied from 5.3 percent in cattle to 9.5 percent in goats, in Tharparkar from 2.7 percent in cattle to 15.7 percent in goats, in Thal from 7 percent in buffaloes to 15.5 percent in camels. On the other hand, the young stock trading intensity varied from nearly 15 percent in cattle to nearly 24 percent in camel; in Tharparkar from 22.1 percent in goats to 46.4 percent in cattle; in Thal from 7.3 percent in buffaloes to 15.8 percent in camels (Table 10).

Table 10

Livestock Trading Intensity (Percent Animal Population Traded) by Age Group of Animal Species in Three Deserts of Pakistan

Animal Species	Cholistan	Tharparkar	Thal
Adults			
– Buffaloes	n.a.	0.00	7.03
– Cattle	5.32	2.69	11.70
– Camels	3.76	5.01	15.48
– Sheep	7.41	13.71	9.29
– Goats	9.54	15.73	10.44
Heifers			
– Buffaloes	n.a.	0.00	14.63
– Cattle	n.a.	3.17	11.54
– Camels	n.a.	25.00	50.00
Young Stock			
– Buffaloes	n.a.	0.00	0.00
– Cattle	14.96	46.43	7.28
– Camels	23.97	27.27	15.79
– Sheep	22.18	22.07	8.52
– Goats	19.17	22.07	8.52

Cattle are the major milk producing animal and wide variations in average milk yield/animal were observed during summer and winter seasons. In Cholistan, the average daily milk yield/cow was 3.99 and 2.35 liters in summer and winter, respectively. The average summer season daily milk production per household was over 42 liters, whereas, the winter milk production per household was about 23 liters. In summer, about 9 percent of the daily milk production was used for domestic consumption, 56 percent processed into *desi ghee*, 6 percent was fed to infants/young stock (for quick and better growth) as a feed supplement and about 29 percent was sold as fresh milk. In winter despite decline in total milk production, the proportions of milk consumed at home and marketed increased (i.e. from 9 percent to 16 percent for home consumption and from 29 percent to 31 percent for marketing purpose), whereas, the percentage of milk in other uses (processed for *ghee* making and fed to young stock) steadily decreased. In Tharparkar, the average daily milk

production per household was about 26 liters, more than half of which was from sheep/goats. Approximately, one-fifteenth of total milk produced is sold within or nearby villages and remaining is consumed at home as liquid milk, yogurt, and/or converted it into butter or *desi ghee*. The average production of *desi ghee*/household was around 3 kg/household/month. A small part of *desi ghee* is domestically consumed and remaining is sold to shopkeepers in the villages and nearby towns. In Thal, the average daily milk production per household was 13-14 litres, of which sheep/goat milk constitutes about 36 percent. About 15 percent–50 percent of total milk produced is sold within or nearby villages and remaining is consumed as liquid milk, yogurt, converted to butter and *desi ghee*. The average production of *desi ghee* per household was about 6.50 kg/month. The produced *desi ghee* is sold to village shopkeepers and nearby towns.

3.6. Economic Analysis of Livestock Production

Economic analysis of livestock farming is a dire felt need of policy and development circles in Pakistan because such information is highly scarce in general and no such information exist for desert ecologies. To fill this gap, an economic analysis of livestock farming in Thal and Tharparkar deserts was carried out, while the information was updated for Cholistan after gathering the update on prices from the study area for the year 2007-08. The livestock farming in both Tharparkar and Thal deserts is grazing-cum-stall feeding type. Referring to Table 8, the average stall feeding period in Cholistan is about 3 months. As feed composition varies during a calendar year, therefore, monthly information on quantities of different items fed by animal type was used for cost estimation. For Cholistan, the average stall feeding expenses per cattle were almost same as in Tharparkar.

The economic analysis of cattle and sheep/goat farming in Cholistan, Tharparkar and Thal deserts is given in Tables 11 and 12, respectively. Various assumptions (narrated in footnotes of the tables) based on informal discussions with knowledgeable farmers of the area were also used during economic analysis of cattle and sheep/goats farming. From economic cost accounting perspective, in Cholistan, the net income per adult cattle was Rs 2383 per annum, whereas, sheep and goats farmers earned Rs 148 and Rs 305 per adult animal, respectively. On average herd size bases, the net income per month from cattle (for milk purpose), sheep and goats (for meat purpose) farming were Rs 10128, Rs 990, and Rs 508, respectively. In Tharparkar, the net income per adult cattle was Rs 1176 per annum, whereas, sheep and goats farmers earned Rs 161 and Rs 92 per adult animal, respectively. On average herd size bases, the net income per month from cattle (for milk purpose), sheep and goats (for meat purpose) farming were Rs 918, Rs 322, and Rs 331, respectively. In Thal desert, for cattle production, the net income per adult cattle was Rs 783 per annum whereas sheep and goats farmers earned Rs 196 and Rs 287 per adult animal, respectively. On average herd size basis, the net income/month from cattle (for milk purpose), sheep and goats farming (for meat purpose) were Rs 457, Rs 360, and Rs 552, respectively (Tables 11 and 12).

Table 11

Economic Analysis of Cattle Farming in Three Deserts of Pakistan

Items	Cholistan (Rs/Animal Head)	Tharparkar (Rs/Animal Head)	Thal (Rs/Animal Head)
Costs Side			
– Stall feeding expenses (3 months)	2115.00	8457.03	6477.72
– Grazing and livestock management[1]	4200.00	3600.00	2400.00
– Value of the cattle	25000.00	25000.00	25000.00
– Health management expenses	600.00	412.19	350.00
– Animal quality depreciation allowance[2]	2500.00	2500.00	2500.00
– Interest on capital invested[3]	3441.50	3996.92	3832.77
Total Cost	**37856.50**	**43966.14**	**40400.49**
Returns Side			
– Opportunity value of milk production[4]	11239.50	16141.92	12183.50
– Value of infant born	4000.00	4000.00	4000.00
– Value of the cattle[5]	25000.00	25000.00	25000.00
Total value of output (live animal + milk produced + baby born)	**40239.50**	**45641.92**	**41183.50**
Returns Analysis			
Net profit per adult animal	2383.00	1175.78	783.01
Returns per month per animal	198.58	97.98	65.25
Average monthly income/herd (Rs) (using sample average of 51 animals in Cholistan, 9.37 animals in Tharparkar and 7 in Thal desert)	**10127.75**	**918.09**	**456.75**
Returns per Rupee Investment (%)	**6.29**	**2.67**	**1.94**

[1]From the informal discussions with the farmers in Tharparkar and Thal deserts, it was found that keeping in view the localised conditions like availability of grazing vegetation and mean grazing hours, one man can easily manage grazing and other tasks of 20 cattle in Tharparkar and 25 cattle in Thal. The prevailing mean opportunity wage rate (in the forms of cash and kind) for the livestock grazier were Rs 6000 per month in Tharparkar and Rs 5000 per month in Thal.

[2]There are various methodologies available in the literature for working out animal depreciation allowance. Based on 5–7 pregnancies per working life and salvage value at the end of working life, the annual animal quality depreciation allowance came about 10 percent of the total value of the animal at beginning of the year.

[3]Interest on invested capital was calculated @ 10 percent per annum.

[4]According to Iqbal, *et al*. (2000), average milking days of cattle in Cholistan are 236 days/annum and average milk yield was 4 liters/day in summer and 2.35 liters/day in winter. For Cholistan, the average milk price during the 2007-08 was Rs 15/day. In Tharparkar, the average milk yield per cattle was 4.82 liters/day and average milk price in the area was Rs 14.63/liter. The value of one day old cattle baby was taken as Rs 3500. In Thal, the average milk yield per cattle was 3.5 liters/day and average milk price in the area was Rs 14.75/liter. The value of one day old cattle baby was taken as Rs 4000.

[5]Here, the value of animal was taken as such because the animal quality deterioration is already taken care of in the item on interest on capital invested on the cost side.

Table 12

Economic Analysis of Small Ruminants' Production in Three Deserts of Pakistan

	Cholistan		Tharparkar		Thal	
Items	Sheep[1] (Rs/Head)	Goats (Rs/Head)	Sheep[1] (Rs/Head)	Goats (Rs/Head)	Sheep[1] (Rs/Head)	Goats (Rs/Head)
Costs Side						
– Stall feeding expenses	125.00	150.00	339.29	452.39	500.72	667.63
– Grazing and livestock management[2]	900.00	1200.00	825.00	1100.00	900.00	1200.00
– Infant value	500.00	700.00	466.40	559.03	500.00	600.00
– Health management expenses	120.00	100.00	109.57	66.03	179.08	108.12
– Animal quality depreciation allowance[3]	220.00	300.00	233.20	279.51	279.10	350.70
– Interest on capital invested[4]	186.50	245.00	197.35	245.70	235.89	292.65
Total cost	**2051.50**	**2695.00**	**2170.81**	**2702.66**	**2594.79**	**3219.10**
Returns Side						
Average sale price per adult animal	**2200.00**	**3000.00**	**2332.00**	**2795.14**	**2791.00**	**3507.00**
Net Returns						
Net profit per adult animal	148.50	305.00	161.19	92.48	196.21	287.91
Returns per month per animal	16.50	25.42	17.91	7.71	21.80	23.99
Average monthly income/herd of 60 sheep and 20 goats in Cholistan, 18 sheep and 43 goats in Tharparkar, 16.5 sheep and 23 goats in Thal desert	**990.00**	**508.30**	**322.39**	**331.39**	**359.72**	**551.82**
Returns/Rupee Ivestment (%)	**7.24**	**11.32**	**7.43**	**3.42**	**7.56**	**8.94**

[1] The mean animal raising period in sheep was 9 months and one year in goats, before it becomes ready for sale.

[2] In Tharparkar desert, the average herd size of farmers raising more than 10 adult animal equivalents was 59.4 animals per herd. Based on discussions with local farmers, one person can easily manage grazing etc. of a herd of 60 sheep/goats. The monthly salary of shepherd was Rs 5500/month. In Thal desert, the average herd size of farmers raising more than 10 adult animal equivalents was 45 animals per herd. Based on discussions with local farmers, one person can easily manage grazing etc. of a herd of 60 sheep/goats. The monthly salary of shepherd was Rs 5500/month.

[3] There are various methodologies available in the literature for working out animal depreciation allowance. In case of small ruminants, the average productive life is 4 years, however, the number of babies born during productive life is quite high, but the salvage value is very low and there is also a high probability of suffering from diseases. In order to take care of these factors, again an annual animal quality depreciation allowance for sheep/goats was taken as 10 percent of the total value of the animal at beginning of the year.

[4] Interest on invested capital was calculated @ 10 percent per annum.

The net returns per rupee investment in cattle farming were as 6.29 percent, 2.67 percent and 1.94 percent in Cholistan, Tharparkar and Thal deserts, respectively. The net returns per rupee investment in sheep farming were as 7.24 percent, 7.43 percent and 7.56 percent in Cholistan, Tharparkar and Thal deserts, respectively. The net returns per rupee investment in goat farming were as 11.32 percent, 3.42 percent and 8.94 percent in Cholistan, Tharparkar and Thal deserts, respectively (Tables 11 and 12). Many conclusions can be drawn from the above discussed economic analysis: (i) returns to both small and large ruminants farming are very low in all the deserts; (ii) returns to small ruminants' farming are relatively higher than cattle farming; (iii) returns to investment in cattle farming contain relatively larger variations across deserts than sheep/goats farming. This implies a strong need of introducing livestock productivity enhancing measures in all deserts under consideration.

3.7. Socioeconomic, Production, Institutional and Policy Constraints to Livestock Productivity

From the economic analysis of small and large ruminants farming, it is clear that returns from livestock farming are quite low. A number of socio-economic, institutional and policy related constraints are associated with it. The discussion in the subsequent sub-sections is based on already discussed findings, literature review and observations during the survey.

Socioeconomic Constraints

Relatively more peculiar socioeconomic problems in Cholistan include limited supply of forage and fodders, poor health of the animals, more physical exertion of animals during grazing, frequent incidence of diseases and droughts, difficulties in getting health services and approaching all herders in vaccination campaigns, least opportunities of getting children's education as the herders keep moving from one *toba* to the other, low milk productivity per animal with high seasonal variations, highly limited milk marketing opportunities, non-existence of milk preservation facilities with the herders leaves few options like early consumption of milk, feeding milk to young stock, and/or processing for making *ghee*. Since marketing of live animals mostly takes place in summer on arrival of herders in Lesser Cholistan, therefore, the benefits of sudden rise in animal supplies are harvested by livestock traders or *beoparies* and butchers. This leads to sub-optimal returns to the year long hard work of the herders [Iqbal, *et al*. (2000)].

In Tharparkar, livestock farming was seriously constrained by low carrying capacity of the rangelands and frequent droughts. On the other hand, the average farm and herd sizes were fairly large, therefore, creating serious difficulties in animal feed management, particularly during droughts. Limited crop farming opportunities (mostly confined to kharif season) and high tubewell irrigation cost, little availability and high levels of brackishness in ground water, negligibly small proportion of total operational holding is irrigated. This leads to heavy dependence of livestock farming upon grazing. The average daily grazing hours of cattle and sheep/goats are quite long and grazing is performed within a radius of 4.5 to 5 kilometers. There is a dearth of supply of the sires of improved breeds having high breeding performance. The availability of health facilities, the veterinary hospitals/dispensaries and veterinary medicines' shops are located at very long distances. As only 42 percent sample villages were electrified, therefore, the households cannot keep refrigerator for chilling milk till it is disposed off to some milk marketing agency. These conditions compel the farmers to either consume the milk immediately or preserve it by heating and then converting into various products. Due to distant location of livestock markets, livestock traders or *beopries* are the only major market intermediary in the area [Farooq, *et al*. (2008b)].

Livestock farming in Thal desert has income-supplementing role in total household income, as the mean operational land holdings of farming households are quite large. The average herd size was estimated as about 17 standard animal units (SAU). Wheat and gram straws are main source of animal feeding in stall-feeding. On average, the cattle and sheep/goats graze in the rangelands for 4 and 6 hours/day, respectively. The mean quantity of fodder provided to cattle ranges from 12.3 kg/day to 15.8 kg/day, and 1.16 kg/day to sheep/goats, which is quite high when compared with stall feeding in

Tharparkar desert. This also indicates the death of rangeland vegetation in the desert as well as substantial monetary needs for financing stall-feeding expenditures. This also partially explains the smallest herd size of the Thal desert farmers compared to other two deserts (Ref. Table 4). The stall-feed is mainly composed of wheat and gram straws, thus seriously deficit in minerals and vitamins requirement, i.e. below the Recommended Dietary Allowances. For improving milk and meat productivity, the natural cross-breeding method is mainly used. The farmers on their own are trying to increase cattle milk productivity by crossing them with Sahiwal, Friesian and Jersey breed bulls. For sheep breeding, the rams of *Kajli* breed and in goats the bucks of *Beetle* and *Teddi* breeds are also available in the area, but their supply is quite limited than the demand of the area. On one hand, this indicates that the farmers of the area are trying to increase their livestock sector income by increasing milk productivity which may be partly used for financing their stall-feeding expenditure. On the other hand, it shows that by better feeding and producing good quality cross-bred animals, they shall be able to earn more from the sale of live animals. However, due to distant location of milk and livestock markets, livestock traders or *beopries* are the only major market intermediary in the area. In general, the farmers have to accept lower prices (than reserve price) of their animals when sold to local *beoparies* [Farooq, *et al*. (2008a)].

Production Constraints

As livestock farming in all the desert ecologies is heavily dependent on sufficient availability of vegetation in the rangelands, sweet water availability for drinking of the animals, human beings and irrigation purposes. Cholistan has a variety of vegetation ranging from under-grasses to tall trees having feed, medicinal, timber and shelter values. Unfortunately, due to various reasons like frequent incidence of droughts, land degradation, over grazing, slow re-plantation of forage trees, the carrying capacity of rangelands has been declining fast. Thus the carrying capacity of rangelands is much below the requirements. Seven to ten hours daily grazing cannot fulfil the forage requirements of the animals. Therefore, the need of supplementary stall-feeding is increasing for both small and large ruminants. Unfortunately, the supplementary feeding is also expensive because of meagre crop production opportunities and purchasing crop by-products are highly costly.

Institutional Constraints

At present, the agricultural research and extension, water research and development, provincial departments like Livestock and Dairy Development Department/Animal Husbandry, Forest Department/Range Management Circles and Agricultural Extension, and numerous NGOs (the largest number in Tharparkar desert compared to other two deserts), NRSP and development authorities are working in the desert areas. No doubt, the objectives/ functions assigned to these agencies are laudable in their own place, but there is no institutional coordination or coordinating agency presently observed in the area. This is why, despite all the efforts, no significant developments has taken place in these deserts since ages and livestock productivity and rangelands carrying capacity related issues are persistently low in the desert ecologies [Iqbal, *et al*. (2000); Farooq, *et al*. (2008a, 2008b)].

Policy Constraints

The Prime Minister of Pakistan approved the first livestock development policy on March 1st, 2006 [Afzal (2007)]. On the other hand, like other parts of the country, no market regulations or regulatory framework were implemented in the study areas. However, the meat price fixing policies of the local governments is more seriously affecting the incentives of producing quality animals. Therefore, a significant proportion of the farmers of the study area opted to keeping *desi* breeds of cattle, sheep and goats. The farmers of the area are attempting to increase their livestock sector incomes on their own by adopting self-devised measures like purchasing good quality animals from co-villagers and using the services of high-repute sires (e.g. sires of Sahiwal, Friesian breeds) through natural breeding, but their efforts are partly successful because of the non-existence of milk and livestock marketing infrastructure as a serious constraint in this regard. In sheep and goats the rams/bucks of improved breeds are present with few farmers in the area. The remote presence of livestock markets and exploitive role of *beoparies* are serious bottlenecks. Strong developmental potential exists in the area, if the strategies delineated in the livestock policy 2006 are also implemented along with provision of market linkages.

4. CONCLUSIONS AND RECOMMENDATIONS

The livestock farming is an important source of food and means of sustenance in rainfed, mountainous and desert ecologies of Pakistan. Livestock farming is also main agricultural activity in deserts because of highly limited crop farming opportunities. Wage earnings opportunities from adjacent irrigated of these deserts provide substantial support in total household income. A notable proportion of total livestock population of the country is present in desert ecologies of Pakistan. It is not plausible to ignore livestock farming in desert economies on various grounds like, they have equal right to be benefited from development activities in livestock farming, their livestock productivity is very low, the incidence of poverty by any measure is very high in these areas, and dwellers of these areas are far behind in human resource development—a necessary condition for contributing to household income through non-farm employment.

The common livestock farming constraints are longer grazing hours, highly sub-optimal stall feeding, periodic occurrence of droughts leading to expansion in bigger average herd sizes as shield against financial/drought shocks, poor health coverage, poor performance of rangeland development institutions leading to low carrying capacity of vegetation, poor animal health. Negligible existence of milk marketing system and poor livestock marketing linkages further reduces farmers' returns to livestock farming. Larger average herd sizes further exert pressures, feed, fodder, heath and other agro-ecological systems of the areas. Live animals, milk and *desi ghee* are the main livestock products of the area and none of these items is produced on commercial lines. Thus, livestock is kept as a mean to social security, a way of saving and a sign of wealth and social status. With this low input–low output type of livestock farming in the area, a highly institution-coordinated comprehensive approach is needed to increase the carrying capacity of the rangelands and planting drought tolerant varieties of food and fodder crops in areas where underground water is less brackish in order transform the livestock farming of the area from low

productive and low marketable surplus oriented to a highly productive market oriented and commercial farming system. To rectify this situation, the following suggestions for the overall development of the livestock sector in the area are hereby proposed:

High Priority Areas

1. Increasing availability of rangeland vegetation and green fodders: Availability of rangeland vegetation and livestock productivity are directly correlated. Local Forest and Rangeland Departments are recommended to re-plant palatable fodder plants/trees and shady trees (as shelter places for animals and humanity during mid-day rest hours) with proper fencing (for prohibiting grazing till some recommended age for allowing grazing /browsing) in rangelands of the deserts with the active participation of local communities along with demonstrating their management practices. Moreover, the farmers of the area should be educated about benefits of controlled grazing.

2. Improvement of the genetic potential of local livestock breeds: A number of local livestock breeds like Cholistani and Thari cattle, Thali breed of sheep are highly productive under highly variant weather conditions. The farmers in the area are trying to increase their milk and meat production through wild crossing their animals. As a result, the proportion of non-descriptive breeds is increasing in the area. There is a strong need of organised efforts for increasing genetic potential of local livestock breeds. The provincial Livestock/Animal Husbandry Departments are suggested to design animal genetic potential enhancing projects for the area, in which the breeding bull of genetic purity and high breeding efficiency are selected and reared under recommended animal husbandry management practices. The services of these sires should be offered to the farmers of the area during breeding seasons. At the same time, the local communities should be trained to learn managing pedigree records of their animals to use it for getting premium prices for their live animals.

3. Provision of efficient livestock health coverage: At present a number of provincial veterinary hospitals, dispensaries and veterinary centres are present in desert areas. These veterinary health institutions are facing serious shortage of funds and unable to effectively manage widespread incidence of some fatal diseases. Effective control of major fatal diseases by launching regular vaccination campaigns and prompt medical coverage of the affected animals is needed. Mobile veterinary services on call basis are suggested for all the deserts of the country on urgent basis.

4. Establishment of milk collection centres linked to some milk processing plants: A number of national and multinational firms are now entered in milk processing and its marketing. These firms established their milk collection centres in deep rural areas. For instance, Nestle is engaged in collecting milk from Lesser Cholistan and Halla (cooperative society) has recently started milk collection from Thal desert. Such interventions should be replicated in other deserts of the country. The local government are suggested to offer appropriate monetary and fiscal incentives to promote milk collection from these neglected areas.

Low Priority Areas of Long-term Impacts

1. Regulatory framework for milk and livestock marketing: There is also a strong need to design some regulatory framework for milk and livestock marketing

systems in order to increase due returns to the farmers' effort and attracting investment in livestock farming on commercial lines. Popularising sale-purchase of animals on their live-weight basis is one of policy measures need to be implemented for slaughter purpose animals as early as possible in livestock markets of the country.

2. Human capacity building: Substantially high ratio of primary level students indicates a further need of middle and high schools at close distances to the settlements. It is suggested to either up-grade the existing primary schools as poor families cannot afford sending their children to distant places. The dearth of colleges also a genuine necessity of the area as high education will facilitate successful out-migration of talented youth of the area. The District and Tehsil Nazims are suggested to increase their struggles for developing infrastructures like opening new schools, up-gradation of roads, human and veterinary hospitals, establishing new milk and livestock markets for their respective area. The National Vocational and Technical Education Commission (NAVTEC) is also suggested to include Veterinary Assistant courses for agricultural neglected areas in heir vocational training programs with appropriate stipend and other incentives.

3. Institutional credit facilities: The institutional credit facilities should be provided to the farmers in the areas for installing tubewells where underground water is suitable for irrigation. To improve feed and fodder security, the cultivation of appropriate varieties of fodder crops should be introduced in the area. Local communities should be mobilised for re-plantation of multi-purpose and fast growing fodder trees, shrubs and grasses in order to fulfill the feed, timber and fuel needs of the dwellers of the deserts.

4. Various incentives may be offered to the veterinary staff posted in the area and the rotation of replacement should be shortened to avoid lowering the morals of those serving in the area as they are generally deprived of various facilities during their posting period. Incentives like providing scholarships to the children of staff posted in deserts, awarding high scores to posting periods in deserts during departmental promotions, etc. are proposed for those posted in hard areas like deserts.

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