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Livestock Farming in Cholistan Desert of Pakistan: Setting the Development Strategies

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Abstract: Identifying and developing the potential areas of livestock production in the country is part of the overall developmental strategy for this sector. Livestock in Cholistan represents a notable proportion of total animal population of Punjab province where livestock farming is primarily practiced under very difficult environment as no other livelihood opportunities prevail in the area. Herders with their animals keep moving from one toba to the other. It was found that due to lack of coordination, institutions of the area are working in isolation and much duplications in their work can be easily noticed. The average herd sizes are fairly large, mainly maintained to cover the diseases and drought risks. Besides this physical capital, low quantities of other capitals like human capital, natural capital and financial capital are present in the area. However, social capital is found to be quite strong. Other characteristics of the area are livestock production in isolation from amenities/necessities of life. Split grazing and natural breeding methods are observed in the area. Relatively more peculiar problems noticed include limited supply of forage and fodder, more physical exertion of animals while grazing, frequent incidence of diseases and drought, difficulties in getting health services and vaccination, least opportunities of getting children educated while moving from one toba to the other, poor health of the animals, low milk productivity per animal, highly limited milk marketing opportunities, non-existence of milk preservation facilities with the herders leaves few options like early consumption of milk, feeding to young stock, and/or processing for making ghee and low prices of live animals received when sold. A number of short-term or high priority, as well as long-term or low priority areas are delineated for the researcher, development planners and policy makers for the overall development of livestock farming in the desert.

Key words: Cholistan Desert, livestock farming, herders, milk products, grazing.

In rural Pakistan, rearing livestock is an essential and an integral part of farming, source of food and livelihood in irrigated, rainfed as well as desert environments. This is the only sub-sector, which serves as almost regular source of income and a readily cashable asset for farm families. At national level, livestock has attained the status of a major sector in Pakistan agriculture by sharing almost half of the agricultural value added and about 11%

of the country's GDP. This sector is employing about 35 million rural people, and a significant proportion is either small farmers or landless livestock herders. Despite the *laissez faire* type of developmental approach, this sector is growing at an impressive rate. This is the only sub-sector, which has never experienced a negative growth since the birth of Pakistan and experienced average growth rates of 2.26% in 1950s, 1.95%

in 1960s, 2.54% in 1970s, 5.27% in 1980s, 5.02% in 1990s and 3.87% in 2000s. It is estimated that the country has produced 33.1 billion liters of milk, worth more than that of combined value of wheat, cotton and sugarcane (Farooq, 2005; Government of Pakistan, 2007). Pakistan, situated in the neighborhood of world's largest milk producer (i.e. India), is the fifth largest milk producer in the world (Government of Pakistan, 2006).

In future, the demand for livestock products is expected to increase at quite higher rates induced by various factors. Firstly, the growth in population will bring direct increase in the demand for livestock products. Secondly, the animal-based products are required for fulfilling the protein and calcium requirements of the population on health grounds. Thirdly, the income elasticity of demand for meat and milk has been greater than one (Ali and Abedullah, 1998; Farooq *et al.*, 1999; Farooq and Ali, 2002) implying that with the rise in per capita income, more than proportionate expansion in the demand for these animal-based products is expected. Fourthly, the changes in consumption patterns induced by urbanization and rural-urban migration and socioeconomic developments in the country will also be expected to generate additional demand for animal based products.

Identifying and developing the potential areas of livestock production in the country is part of the overall developmental strategy for this sector. A notable proportion of

livestock population¹ is present in desert regions where the herders have no other major source of livelihood. Livestock economy of Cholistan² has a lot of production potential that needs to be exploited. Cholistan desert is located between latitude 27° 42' and 29° 45' north and longitudes 69° 52' and 73° 05' east. The length of the desert is about 480 km and breadth varies between 32-192 km. It is spread over about 26,100 sq. km, of which 2,800 sq. km is irrigated and the remainder is arid rangelands. Livestock farming is practiced under the two production systems, i.e. pastoral and agro-pastoral, and is entirely dependent upon rains, whereas crop production opportunities are also limited due to scarcity of canal water and higher salinity level in the underground water (Iqbal *et al.*, 2000).

In the past, scanty or probably no information was available about the status of livestock production in Cholistan. Therefore, in order to design livestock development strategies for the area, such information is a pre-requisite. The primary objectives of this exercise were: (i) to study the socio-economic characteristics of livestock farmers in the study area; (ii) to review the research and development policies initiated by various agencies/organizations involved in the development of Cholistan; (iii) to study the livestock rearing practices and to examine the nature and extent of livestock production limitations; and (iv) exploring and prioritizing the strategies for increasing livestock production in Cholistan.

¹ According to National Livestock Census 1996, 15% buffaloes, 20% cattle, 26% goats, 23% sheep and 36% camel population is present in the dry plateaus and desert ecologies of the country.

² Cholistan is a Turkish word, means waterless wasteland. The local people also call Cholistan as 'Rohi'.

The Lifestyle in Cholistan Desert

The climate of Cholistan is arid, sub-tropical continental type, characterized by low and sporadic rainfall, high temperature, low relative humidity, high rates of evaporation and strong summer winds. Most of the rainfall is received in July-September, but some of it also falls in January-March. The annual rainfall varies between 100-200 mm. Summer rain infiltrates into the sandy ground and is conserved for plant utilization along with creating run-off, which accumulates in *tobas*, *kunds* and wells and is used for livestock and human consumption. The winter rains do not generate sufficient runoff. The temperature in this area rapidly rises from April onward and reaches 44°C as normal and occasionally to 49°C during May-June. During this period, strong winds and dust storms also occur throughout the day and humidity usually falls below 32%. The mean winter (December-January) temperature is about 15°C with the lowest as -2°C. Frost also occurs occasionally for a few nights during winter. Wind blows in two distinct directions, i.e. from south to south-west and south-east during May to October; and from the north to north-east, north-west and west in winter. The velocity of summer winds is stronger (speed 1 to 5.7 knots) than the winter winds (speed 0.2 to 3.8 knots). The winter cold winds sometimes cause mortality in livestock herds. Occurrence of droughts is also quite common and it usually extends over 2 to 5 years in the eastern arid part (Bahawalpur

zone) and 4 to 7 years in the western part (Khanpur side). The drought from 1984 to 1991 was one of the worst in the area.

The population of Cholistan is estimated to be around 0.15 million people, of which a large majority represents the Seraiki speaking culture of the Central Indus valley. Beside Seraiki, they also use the words from Marwari Rathi and Sindhi languages. The population is generally scattered, sparse and some are transhumant. People are predominantly Muslims, however Hindu and other communities also live in harmony with the Muslims. The social and political life of Cholistanies is governed largely by the traditional institutions of the tribes or *clan* or sub-tribes or *biradries* or *qoams*. They are all aware of the larger tribes to which they belong. Marriages are mostly arranged within *clans* or *biradries*. For more than a century, the *numberdars* of the *clan* are key link between *biradri* and various Government Departments. These *numberdars*³ are also responsible for collecting *tirini* or head tax on livestock and land revenue from arable lands.

As per law of the land, the Government of Pakistan owns all desert lands of both Greater and Lesser Cholistan and has vested the responsibility of its management to the Forest Department. In practice, the desert *clans* have established customary rights to specific *tobas*, *kunds*, wells, *dhars* and grazing areas⁴. They named them after the names of their ancestors, *clan* leaders or important nearby area. Right to a *toba* means the right to camp near it and use its water

³ The numberdari system was established in Bahawalpur in 1869 during the reform of the states Revenue Department. The numberdars have replaced old Sardars or Waderas of the area.

⁴ *Tobas* are man-made ponds, generally not covered and their water is used for drinking by human beings and livestock. *Kunds* are covered water reservoirs and their water is consumed by human

for self and livestock drinking as well as grazing in the surrounding areas till the exhaustion of water in *toba* and/or depletion of vegetation around it. It is customary not to refuse grazing or watering at *tobas* falling on the way to a migrating herd from one place to the other. However, the owners of the *toba* or head of the clan at that *toba* may deny camping around/near the *toba*. Livestock herders/travelers can drink water from the private *kunds*, but their animals are not allowed to take water from *kunds*. Some communal *kunds* are also built by Sheikh of Abu Dhabi in southern Cholistan and at various places by Cholistan Development Authority.

Cholistan economy is heavily dependent upon livestock production. Cattle are the most precious livestock followed by sheep, goats and camels. People tend to raise cattle in large numbers ranging from 10-200 animals per herd and even more in some cases. Livestock herders are primarily transhumant, keep migrating from one *toba* to the other and between *Rohi* and irrigated settlements in search of water and vegetation. However, livestock production systems in Cholistan can be broadly classified into pastoral and agro-pastoral systems. Under the agro-pastoral system the farmers along with livestock husbandry are also involved in crop farming on irrigated parcels of land in the settlements. This system has important crop-livestock interactions and provides food and fodder security to the farm households

and their livestock. Livestock is well integrated with their crop production system, i.e. relying heavily on fodder crops and crop residues for feeding livestock on arrival from Greater Cholistan. The duration of their stay in *rohi* varies from 4-6 months depending upon the quantity of rainfall and the magnitude of vegetation available in pastures. The pastoral system of livestock farming is characterized by simultaneous movement of families of livestock herders and their animals, from one *toba* to the other in search of water and grazing areas⁵. The schedule of their movement is determined by the onset of monsoon rains and distribution of rainfall in Cholistan. After monsoon rains, they return to *rohi* from irrigated areas or settlements of Lesser Cholistan. Distances traveled vary from a 10 to 100 km. The pastoralists' livestock production mainly depends on grazing on natural vegetation and drinking rainwater gathered in *tobas*. Since, pastoralists do not possess any agricultural land, their incomes mainly depend upon the sale of live animals (usually male young stock and the aged animals) and their products such as milk, ghee, wool and hairs etc. Some pastoral farmers also participate in wheat harvesting activity and thus, earn some grains for family consumption.

Research, Extension and Development Institutions' Support

The importance of development of Cholistan was realized long ago. Many

beings only. Wells are artificially made to use underground water which can be drunk by both humans and livestock depending upon the extent of its salinity. Communication systems in deep areas of Cholistan are very poor and traveling is mainly on foot or camels. Jeeps, single or double-cabin vans operate on barren paths locally called 'dhars'.

In our survey, some of the family members of pastoralist type of livestock graziers keep staying in Lesser Cholistan. However, the information about the activities of family members of Lesser Cholistan was not gathered.

institutions and organizations were established from time to time for its development. Presently various federal, provincial and private agencies are involved in research, extension and development activities in Cholistan and all are situated in Bahawalpur. Four research institutions are busy in conducting research on the crop and livestock related issues. These are: i) Pakistan Council of Research in Water Resources (PCRWR); ii) Cholistan Institute of Desert Studies (CIDS); iii) Arid Zone Research Institute (AZRI); and iv) Jojoba Research Station (JRS). The common features noticed about the research institutions working in Cholistan include low pace of technology generation, the limited scientific manpower, meagre funds and little coordination with fellow research organizations, extension and other agencies. A closer coordination and collaborated research activities of these organizations may help in resolving the problems.

At present, at least four agencies are involved in extension activities in the Cholistan, i.e. Livestock and Dairy Development (L&DD) Department; Cholistan Range Management, Punjab Forest Department, Punjab Wildlife Department, Provincial Agricultural Extension Department. The L&DD department has the primary responsibility of providing appropriate services on animal husbandry and veterinary health care against major livestock diseases in Cholistan. The department is also supposed to help Cholistan Development Authority in establishing livestock markets at appropriate places in Cholistan. The main functions of Cholistan Range Management Department are,

establishment of woodlots, controlling illegal cutting and removal of trees, planting and promoting fodder trees, building new tobas, kunds and wells, reseeding of grasses and khar⁶ and conservation of wild fauna. The Punjab Wildlife department is mainly responsible for protection and preservation of wildlife of the area. The department also has the responsibility of improvement of wildlife and their habitat through rehabilitation of natural habitat and replenishing wildlife population through captive breeding.

Among development institutions, Cholistan Development Authority (CDA), Bahawalpur, is the most important institution responsible for the development of Cholistan. The Gulf Rulers (from Dubai and Abu-Dhabi) and Bahawalpur Rural Development Project (BRDP), Bahawalpur, are the other prominent agencies contributing to the development of Cholistan. CDA has a number of development functions in the areas like: a) a forestation, plantation, cultivation and reclamation of land; b) colonization and allotment of government land; c) provision of irrigation and drinking water in the area; d) provision of communication facilities, parks, livestock and dairy farms; e) provision of education and health facilities; f) encouragement of rural trades, handicrafts and industries; and g) promotion of tourism. The rulers of Dubai, Abu Dhabi and Qatar have their traditional love for desert and strong associations with the people of Pakistan. Dignitaries from these Gulf States visit Cholistan every year during winter for hunting of Houbara Bustard. As a gesture of friendship and goodwill, these dignitaries are contributing a lot to the development of Cholistan. Sheikh of Abu Dhabi has constructed roads, schools, *kunds*

⁶ A naturally grown weed, a rich source of soda ash used in soap industry.

and wells in the Rahim Yar Khan District of Cholistan and has provided windmills, a solar pump and a number of diesel engines for pumping of the underground water. All installation, operating and maintenance costs as well as salaries of pump operators are borne by the Sheikh of Abu Dhabi. There is also one veterinary dispensary to dispense free medicines to the pastoralists. The International Airport and Sheikh Zaid Hospital in Rahim Yar Khan are the other projects financed by the ruler of Abu-Dhabi. Establishment of a wildlife sanctuary on 4150 acres near Abu-Dhabi Palace is another contribution by him. BRDP is bestowed the responsibilities like construction of rural roads, farm to market and other roads, providing electricity and lining/improvement of water channels in Bahawalpur division.

No doubt, the objectives/functions assigned to these agencies are laudable in their own place, but there is duplication of the efforts across agencies is present. For instance, the function of plantation of forest and fodder trees is being performed by Cholistan Development Authority as well as Arid Zone Research Institute, PCRWR and Forestry Department of Cholistan. Similarly, Arabs are found replicating efforts of PCRWR and CDA. This clearly signifies the lack of co-ordination among the institutions. On the other hand, local population is hardly aware of their activities as is evident from the negligible adoption of most of the technological developments made so far. This is also because most of the technologies generated so far are still in the experimental stage and are not extensively demonstrated. Akbar and Arshad (1999) also made similar observations about the working of these institutions in Cholistan. It is suggested that there should be one

co-ordinating department in the area made responsible for careful scrutiny of the research, extension and development plans. This department should also investigate into the methods of creating awareness in Cholistanies along with promoting local involvement in testing and the adoption of latest technological developments in crop and livestock production in Cholistan. CDA may take this responsibility by opening a new section for monitoring and co-ordinating the activities of all agencies/departments operating for Cholistan.

Socio-economic Profile of Livestock Farmers in Cholistan

The average age of the household head is about 48 years and he has mean experience of about 32 years in livestock herding. Due to the dominance of joint family living patterns, the average family size of the respondent families was estimated as about 13 persons per household, comprising approximately 1 old person (>60 years), 6 adults (>16-60 years) and 6 children (upto 16 years). The average family size of the agro-pastoralists was bigger than that of the pastoralists, which is attributed to including their family members in Lesser Cholistan while reporting family size. A very low level of formal education prevailed among the respondent families. Average of the highest education among the male and female family members was 5.9 and 0.5 years of formal schooling, respectively. The livestock farmers were found allocating major proportion of adult male labor force to grazing/rearing livestock in Greater Cholistan, followed by crop-cum-livestock production activities in Lesser Cholistan. Very little adult labor force was found apparently unemployed (Table 1).

Table 1. Socio-economic profile of livestock farmers in Cholistan Desert of Pakistan

Profile indicators	Farm types		Overall
	Pastoralists	Agro-pastoralists	
Age (years)	50.16	46.88	48.09
Livestock husbandry experience (years)	35.82	30.43	32.45
Average family size (nos.)	11.62	14.38	13.36
Family composition			
Old (>60 years)	0.91	1.01	0.98
Adults (>16-60 years)	5.69	6.75	6.36
Children (\geq 16 years)	5.02	6.61	6.02
Maximum education (family level)			
Males (years)	4.98	6.49	5.94
Females (years)	0.42	0.61	0.54
Total number of adult males: Allocation of male labour	3.40	3.40	3.40
Members left for Greater Cholistan (nos.)	2.42	2.42	2.42
Members kept in Lesser Cholistan (nos.)	0.09	0.09	0.09
Off-farm employment as ordinary labor	0.20	0.20	0.20
Crop/livestock business (nos.)			
Private/government service (nos.)	0.02	0.02	0.02
Other sectors off-farm employment (nos.)	0.04	0.04	0.04
Un-employed (nos.)	0.63	0.63	0.63
Combinations of energy sources for cooking and lighting			
Firewood (% households)	27.30	31.10	29.70
Firewood and dung (% households)	36.30	40.50	39.00
Firewood and kerosene oil (% HH)	2.30	4.00	3.40
Wood, dung and kerosene oil (% HH)	31.80	20.30	24.60
Wood, dung and mustard oil (% HH)	2.30		0.80
Wood, dung, kerosene oil, others (% HH)		4.10	2.50
Average farm size (acres)		13.58	13.58
Average herd size			
Animal heads (nos.)	49.86	64.74	59.25
Animal units (nos.)	47.13	79.04	69.19
Tobas owned in Greater Cholistan (nos.)	2.00	3.00	2.00

The average size of the operational land holding of agro-pastoralists was 13.6 acres. The average livestock herd size was nearly 60 animal heads or more than 69 standard

animal units⁷. The agro-pastoralists were operating relatively larger herds than their counterparts which is partly attributed to the ownership of agricultural lands in the

⁷ The conversion factors used were: milking buffalo, camel breeding bull, male camel, milking camel, dry camel = 1.5; bullock, buffalo breeding bull and male buffalo = 1.2; breeding bulls, milking cow and camel heifer = 1; dry cow = 0.8; buffalo heifer = 0.6; donkey, camel young stock = 0.5; buffalo young stock = 0.3; cattle young stock, adult sheep, breeding ram, adult goat, breeding buck = 0.25; and sheep/goat young stock = 0.05.

Table 2. Average distance to various places (km) in Cholistan Desert of Pakistan

Places	Cholistan Desert Regions		Overall
	Lesser Cholistan	Greater Cholistan	
Transport pick-up point	5.51	50.13	27.82
Milk collection centre	9.58	29.29	19.44
Crop output markets	15.11		15.11
Grocery market	12.18	61.38	36.78
Livestock market	21.99	70.51	46.25
Primary school for boys	3.14	53.01	28.08
Primary school for girls	4.75	56.81	30.78
Middle/High school for boys	8.63	61.58	35.11
Middle/High school for girls	10.19	63.63	36.91
BHU/Dispensary for human beings	8.80	55.39	32.10
Medical store (human medicines)	12.97	63.90	38.44
Veterinary hospital/dispensary	11.84	60.29	36.07
Medical store (veterinary medicines)	15.54	64.60	40.07
Commercial bank	13.71	66.24	39.98

Lesser Cholistan. Each herder family, on an average owned 2 *tobas* with agro-pastoralists occupying higher number of *tobas* than the pastoralists. The major sources of energy for cooking and light in Cholistan include firewood, animal dung, kerosene oil, mustard oil, etc. The use of firewood alone, in combination with animal dung and simultaneous use of firewood with dung and kerosene oil were the main sources of energy for cooking and lighting reported by 29.7%, 39.0% and 24.6% respondent families, respectively (Table 1).

In Lesser Cholistan, the average distance of various facilities from village/settlement locations of the respondents ranged from 3 to 22 km. In Greater Cholistan, the respondents had to travel relatively longer distances from their original *toba(s)*/locations to reach the important places with large variations among various districts. The averages of these distances ranged from 30

to over 70 km with lower and upper limits much higher than the corresponding limits in lesser Cholistan. This indicates that the general living environment of livestock farmers of Cholistan is highly strenuous when compared with other irrigated parts of the Punjab (Table 2).

In Greater Cholistan, as the public veterinary health services were situated at quite large distances from *toba(s)* of the respondents, therefore, some general quarries about livestock health care like diagnosing various animal diseases, suggestion of treatment, managing intra-muscular injections and handling delivery complications (if any), were also probed. It was found that either some of the family members or somebody at *toba* was available to diagnose various livestock diseases. A quite large proportion of respondents (59.1%) reported that they or any member of their family could manage an intra-muscular

injection; whereas a small proportion of livestock farmers (11.3%) reported that they could not find any body who was able to handle delivery complications in livestock.

Regarding communication patterns, nearly one-fifth of the respondents reportedly felt no such needs. The proportion of such respondents was relatively higher (as expected) among pastoralists because all the family members of most of the pastoralist herders migrate together with their livestock. More than one-third (36%) of the respondents reported a need based communication (such as money, food items or grocery need; events like marriage, incidence of serious illness or death, etc.) through direct visits by the family member(s). The concerned persons usually traveled on camel back or on foot and also exchange information/messages of several other fellow herders and their families during the visit.

Livestock Ownership and Composition

Cattle is the most important animal of Cholistan and on an average each herder owns about 51 heads of cattle comprising about 1 bull, 33 cows and 17 heifers/young stock. Among the large ruminants, camel is the second important species raised by the farmers in the area. The average number of camels in a herd is about 4 to 5 heads including 1 male, 2 to 3 females and a heifer/young stock. Buffalo was the least frequent species among the large ruminants with an average incidence of 1 head per herd and was confined to the irrigated areas of Lesser Cholistan. Sheep ownership averaged 61 heads per herd including 1 ram, 49 sheep and 11 young stocks. The

average number of goats in a herd was about 19 heads. Breeding rams and bucks were found with very few herders. The agro-pastoralists farmers keep bigger herds of each type of animals except camels and goats (Table 3). This finding is in-line with FAO/ADB (1993), but contradicts with the findings by Akbar and Arshad (1999). A few herders also keep donkey for carrying earth during de-silting of *tobas* and as a pack animal for transporting consumption provisions of the herders and new born infants while moving out for grazing or migrating from one *toba* to the other.

About 95% of the herders were involved in cattle farming. Relatively higher proportion of agro-pastoralists found raising buffaloes than their counterpart. Camel was the second important species among the large ruminants and was raised by 45% of the respondents. Among the small ruminants, the raising of sheep (50% farms) in Cholistan was relatively less common as compared with goat farming (67% farms); however, the average herd size of sheep was larger than goats. Higher proportion of agro-pastoralists were found keeping small ruminants than their counterparts (Table 4).

In Cholistan, the size of herd and livestock enterprise mix (number of species raised) is determined by various factors like productivity of the animals kept; tolerance to harsh climate of the desert like high temperature, availability and quality of water and vegetation; the intensity of care demanded; resistance to diseases; size and composition of farming family; risk aversion behavior of the farmers; and marketing prospects of livestock and by-products, etc. It was found that single enterprise livestock farming was not popular among the respondent farmers. About 8% of the herders

Table 3. Animal types and composition by farm types in Cholistan desert of Pakistan (average number of heads)

Livestock	Farm types		Overall
	Pastoralists	Agro-pastoralists	
Cattle			
Breeding bulls	0.73	0.87	0.82
Bullocks	0.04	0.05	0.05
Milking cows	7.40	11.45	9.96
Dry cows	20.42	25.42	23.57
Heifers	7.47	9.42	8.70
Young stock	5.96	9.05	7.91
Total	42.02	56.26	51.01
Buffaloes			
Milking buffaloes	0.24	0.54	0.43
Dry buffaloes	0.20	0.45	0.36
Heifers	0.04	0.13	0.10
Young stock	0.16	0.27	0.23
Total	0.64	1.39	1.12
Camel			
Breeding bulls	—	0.01	0.01
Male camels	0.71	0.69	0.70
Milking camels	1.93	1.12	1.42
Dry camels	0.73	1.58	1.27
Heifers	0.44	0.42	0.43
Young stock	0.67	0.38	0.48
Total	4.48	4.20	4.31
Sheep			
Rams	0.31	0.73	0.57
Adult sheep	35.78	56.83	49.06
Young stock	6.13	14.05	11.13
Total	42.22	71.61	60.76
Goats			
Bucks	0.20	0.30	0.26
Adult goats	18.18	12.48	14.58
Young stock	4.42	4.73	4.61
Total	22.80	17.51	19.45
Donkeys	0.33	0.47	0.42

were raising cattle as a single enterprise. Majority of the herders (57%) were practising multiple livestock enterprising with various combinations of animal types. Cattle were

included in almost all the major livestock enterprise mixes. The following livestock activity combinations were found to be common in Cholistan:

Table 4. Distribution of animal species kept by sample herders by farm types in Cholistan Desert of Pakistan (per cent respondents)

Livestock	Farm types		Overall
	Pastoralists	Agro-pastoralists	
Cattle	91.11	97.40	95.08
Buffalo	17.77	22.08	20.49
Camel	40.00	48.05	45.08
Sheep	44.44	53.25	50.00
Goat	64.44	72.73	67.21

- Cattle + Camels + Sheep + Goats: 16.3%
- Cattle + Sheep + Goats: 14.75%
- Cattle + Goats: 13.11%
- Cattle + Camel: 11.48%
- Cattle 8.19%

The major objectives of cattle farming are ranked in a descending order of importance including the sale of young stock, dairy products, adult animals and home consumption. Buffaloes were raised primarily to meet the family requirements of milk consumption. The other objectives of buffalo keeping include sale of dairy products, income from the sale of young stock and the sale of adult animals. Majority of the livestock herders were keeping camels mainly for traveling and transportation. In sheep, sale of young stock and adult animals were leading objectives of sheep husbandry. Goats were kept for the sale of young stock, sale of adult animals and sale of *Qurbani* animals (Table 5).

Livestock Grazing and Feed Management

In Cholistan Desert, the livestock farming is primarily grazing dependent. Limited stall-feeding is also practiced during their stay in Lesser Cholistan where kharif fodders and supplemental feeding of

concentrates are served to animals. Generally, under agro-pastoralist livestock production system, a small proportion of milking cows, all buffaloes and some sheep and goats are retained in Lesser Cholistan where they are mainly stall fed on fodder crops as well as grazing on crop residues and weeds. The purpose of retention of these animals is primarily milk/ghee production for domestic use and part of it is sold also to meet the urgent cash needs. In Greater Cholistan, grazing practices vary by herders and livestock species. For instance, some people perform grazing during the day whereas others prefer night grazing. Night grazing is usually performed in areas where there is high incidence of irritating flies. Livestock management is essentially a males' specific activity and grazing is mainly performed by men and boys locally called *chheru*. Young boys/teenagers are usually accompanied with some elderly adult who besides getting help in grazing also teach grazing methods and familiarize with various types of rangeland vegetation, medicinal plants, veterinary diseases and ways of finding right path, if lost. In other words, in the above manner, technical knowledge of livestock production in Cholistan is transferred to young generation.

Table 5. Livestock farming objectives of livestock herders by farm types in Cholistan Desert of Pakistan (mean scores in percentage)

Livestock products	Farm types		Overall
	Pastoralists	Agro-pastoralists	
Cattle			
Sale of young stock	31.34	34.54	33.42
Sale of dairy products	31.09	28.65	29.50
Sale of adult animals	17.40	18.47	18.10
Home consumption	16.92	14.86	15.58
Others	3.23	3.48	3.40
Buffaloes			
Home consumption	59.46	44.26	47.80
Sale of dairy products	29.73	24.59	25.79
Sale of young stock	2.70	19.67	15.72
Sale of adult animals	8.11	11.48	10.69
Camels			
Loading/pack animals	57.15	68.06	64.19
Sale of young stock	20.95	9.59	13.85
Sale of adult animals	12.38	10.99	11.49
Others	9.52	11.00	10.47
Sheep			
Sale of young stock	41.55	38.86	39.61
Sale of adult animals	23.94	28.26	27.06
Prod. for wool/hair	20.42	20.38	20.39
Others	14.09	12.50	12.94
Goats			
Sale of young stock	43.16	50.38	48.02
Sale of adult animals	24.74	22.76	23.40
Sale in Qurbani months	11.05	15.86	14.29
Home consumption	13.68	5.88	8.43
Others	7.37	5.12	5.86

Regarding the movement of herders in Cholistan, majority of the herders (especially cattle herders) reach irrigated settlements of Lesser Cholistan during the month of March and April when temperature in the desert starts rising beyond tolerance limits, and water and vegetation availability deteriorates. About 86% and 89% of pastoralists and agro-pastoralists, respectively, arrive in Lesser Cholistan by the end of April. However, the camel herds continued coming

till June. The departure for Greater Cholistan starts after monsoon rains, mostly takes place in the months of July and August. About 80% and 85% pastoralists and agro-pastoralists farmers, respectively, departed for Greater Cholistan from June to August. In this way, there are no differences in the arrival and departure patterns between pastoralist and agro-pastoralist type of herders. This implies that the movement schedule of the herders is determined by

Table 6. Distribution of mean arrival and departure times of herders to Lesser Cholistan (per cent livestock farmers)

Arrival/Departure	Months	Farm types		Overall
		Pastoralists	Agro-pastoralist	
Arrival	Jan.-Feb.	14.30	7.40	8.70
	March	—	25.90	20.60
	April	71.40	55.60	58.80
	May	14.30	7.40	8.80
	June	—	3.70	2.90
Departure	May	14.30	11.00	12.00
	June	22.90	21.90	22.20
	July	25.70	37.00	33.30
	August	31.40	26.00	27.80
	September	5.70	4.10	4.60

temperature and the availability of water and vegetation in the area (Table 6).

Split grazing of adults and young stock of large ruminants was mainly observed in the area, irrespective of the size of herd maintained. The main reason reported was that split grazing has no danger of sucking milk by young stock from their lactating mothers. So, the young stock of large ruminants was mostly sent for grazing with sheep and goats, which are always guarded by a herder. The adult cattle are usually not accompanied by any herder and follow the guide cow to the desert for grazing and back to their *toba* for milking and/or drinking water. Almost every adult cow⁸ and her progeny are given a name to which they respond whenever called. These are very special features of cattle farming in Cholistan. The above mentioned discussion confirms the movement schedule of livestock farmers presented in Table 7.

Livestock Production and Health Management

In Cholistan, male young stock of large ruminants are usually sold before reaching their sexual maturity, therefore, castration in large animals is rare. In small ruminants, males are castrated. The castration is traditionally done by knife during winter months, but veterinary staff uses castrators. Although, sire remains with the herds throughout the year, but livestock breeding seasons are reasonably well defined as majority of births take place in spring (March to May). In good seasons, sheep and goats also have a second breeding between September and November months. Small size herders usually do not have their own sire, hence, are dependent on others for services. The sires are usually selected from own herds based on some characteristics such as better milk yield

⁸ This is usually an old cow having enough knowledge about the area and well familiar with the owner. A bell is hanged in her neck and all the fellow cows of the herd keep grazing near the sound distance of this bell-bearing cow. Whenever the owner calls this bell-bearing cow by her name, all cows in the herd come along her.

Table 7. Movement schedule and activities of herders between Lesser and Greater Cholistan

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

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

performance of the mother, color, physical health of the sire and its beautiful look.

All the respondent farmers reported practising natural method of animal reproduction, which is mainly attributed to ethical reasons. The un-controlled and controlled natural breeding methods are commonly practiced by 45% and 55% farmers, respectively. Under the controlled natural breeding, the livestock farmers select a bull (owned or borrowed) with required characteristics for breeding. These farmers also carefully monitor the heat periods of female adults in their herd. Under un-controlled breeding method, the farmers are not conscious about bull selection as well as monitoring heat periods of females in the herd. In other word, any bull either from their herd or from another herd can mate or is mated with some heated cow. A quick replacement of a breeding bull was a very common practice in the study area. This is because the livestock farmers keep sire in the herd till his progeny reaches puberty and becomes ready for further

reproduction. In other words, because of kinship relations, further reproduction from a father bull through daughter cows is considered customarily un-ethical. There was not much difference in the average staying period of sires of cattle, buffaloes and camels. Their sires can be replaced at any time during fourth year. Similarly, staying periods of rams and bucks among their herds are almost same and can be replaced during second year of their stay.

In Cholistan, frequent epidemic and disease incidence were reported among the large as well as small ruminants. The most common diseases occurring in various livestock species are:

Large ruminants: Haemorrhagic Septicaemia, Black Quarter, Foot and Mouth Disease, Anthrax, Mange, Sura, Camel Pox, Endo- and Ecto-parasites, etc.

Small ruminants: Enterotoxaemia, Pleuropneumonia, Sheep and Goat Pox, Anthrax, Liver Fluke and Endo- and Ecto-parasites etc.

Only a small fraction of camel herders (5.5%) reported incidence of disease(s) among the camel at their farms. The disease incidence was quite high among sheep, cattle and goat herds. The incidence of disease occurred on about 46%, 59% and 34% of the sheep, cattle and goat farms, respectively. The proportion of livestock population affected with diseases was relatively high in small ruminants. The percentage of the sheep and goat population that suffered from diseases were 12.2% and 19.4%, respectively. Mortality rate due to disease was highest among the sheep and goats, whereas it was lowest among the camels (Table 8). Majority of the herders (three-fifths) failed to provide veterinary treatment to their sick animals. A large number of herders did not get their herds vaccinated and those who practiced, often failed to comply with the proper vaccination schedules.

Production and Marketing of Milk

Cattle are the major milk producing species in Cholistan. The livestock farmers ranked milk production and sale of dairy products as the first or second most important objective of cattle raising. In cattle, milking is usually performed twice a day, i.e. before departure of the herd for grazing and after the arrival of herd from rangelands. The daily milk production is either used for domestic consumption or processed and sold as liquid. Wide variations in average milk yield per cow

were observed during summer and winter seasons. Overall, the average daily milk yield per cow was estimated as 3.99 and 2.35 L animal⁻¹ during summer and winter seasons, respectively. The milk yields ranged between 1 to 13 L during summer and 0.5 to 10 L in winter season. The mean milk yield of cattle on agro-pastoralist farms during summer was relatively higher as compared with their counterparts. This may be due to the fact that agro-pastoralist farmers also had better access to kharif fodder as they possessed some agricultural land. However, in winter, the average milk yield/cattle was same on both farm types.

Total milk production of farming household depends on the number of lactating cows and average milk yield per animal. Milk produced can be used for home consumption, fed to infants/young stock as food supplement, processed and/or sold. The summer season daily milk production at the respondents' farms was over 42 L whereas the winter milk production per day was about 23 L⁹. In summer, about 9% of the daily milk production was used for domestic consumption, 56% was processed into *desi ghee*, 6% was fed to infants/young stock (for quick growth) as a feed supplement and about 29% was sold as fresh milk. During winter despite decline in total milk production, the proportions of milk consumed at home and marketed increased (i.e. from 9% to 16% for home consumption

⁹ This observation seems opposite to what is generally perceived that milk production decreases in summer compared to winter. This is because in severe summer, all cattle farmers reaches near the river banks of Lesser Cholistan and stall-feeding along with keeping animals under trees is practiced, therefore, cattle milk yield does not decrease. In winter, the cattle are in Greater Cholistan and exposed to lower extremes of temperature which causes decline in milk productivity. Secondly, this may also be because of relatively low forage available in the area during winter.

Table 8. Disease incidence, population suffered and mortality due to various diseases (per cent)

Items	Cattle	Buffalo	Camel	Sheep	Goat
Farms reported disease incidence	45.69	12.00	5.45	59.02	34.12
Per cent population suffered	5.64	2.88	1.65	12.19	19.37
Mortality	2.72	1.44	0.55	9.31	7.78

and from 29% to 31% for marketing purpose) whereas the percentage of milk in other uses (processed for *ghee* making and fed to young stock) declined (Table 9). This implies that home consumption and marketing of milk are two important sectors in which least cuts are made by the farmers. This also indicates that change of weather does not seriously disturb the supply of milk in the market. The higher percentage of milk processed during summer may be attributed to various factors: i) herds are scattered deeper in Cholistan with little opportunity to sell; and ii) high summer temperatures increase the risk of milk spoilage.

Information about the number of milkmen or *dodhies*, the quality of milk collected from Cholistan and distributed in nearby cities is not available. But this business is entirely in the hands of traditional milkmen or *dodhies*. It was reported that

in cities, tea stalls (cafeteria), hotels, milk shops, manufacturers of sweets and bakers, and some consumers are their major buyers. Some of the milkmen from irrigated belts of Lesser Cholistan also supply milk to army messes on regular basis. *Dodhies* in the Greater Cholistan usually have motorbikes and confine themselves to the *tobas/kunds* falling close to roads and *dhars* or flat plains. The milk is collected early in the morning and every milkman has 5 to 7 clients within a radius of 8-10 km. The quantity of milk procured from herders does not remain constant throughout the year because of various factors such as migration of herders to other *tobas/kunds*, depletion of water and vegetation, general decline in the milk yields due to droughts, risk of more frequent spoilage of milk in summer, risk of non-availability of transport (buses and single cabin vans), etc. As far as method of payment is concerned, the payment to the farmers for the milk procured

Table 9. Average daily milk production and its use patterns by farm types in Cholistan

Items	Farm types				Overall	
	Pastoralists		Agro-pastoralists		Summer	Winter
	Summer	Winter	Summer	Winter		
Milk yield of cattle (L animal ⁻¹)	3.14	2.34	4.41	2.35	3.99	2.35
Av. milk prod/family (L day ⁻¹)	30.68	20.52	48.86	24.99	42.42	23.44
Household consumption (%)	11.11	19.25	8.43	14.77	9.10	16.12
Processed (%)	49.25	48.20	58.13	47.74	55.87	47.87
Fed to infants/Young stock (%)	1.24		7.90	6.56	6.20	4.61
Sold (%)	38.40	32.55	25.54	30.93	28.83	31.40
Av. price received (Rs. L ⁻¹)	6.19	7.13	5.03	6.00	5.54	6.50

Table 10. Livestock sale patterns by farm types in Cholistan Desert of Pakistan (per cent livestock farmers)

Sale patterns	Farm types		Overall
	Pastoralists	Agro-pastoralists	
Need based	44.50	62.20	55.70
Monthly	5.60	3.30	4.10
Quarterly	2.80	6.60	5.20
Bi-annually	11.10	4.90	7.20
Annually	36.00	23.00	27.80

today will be made tomorrow¹⁰. This is to check the mixing of water in the milk. It was further reported that the quality of the yogurt deteriorated if water is mixed in the milk. If there is some complaint about mixing of water in the milk, the respective farmers have to face price cuts next day. Milkmen also receive their payments with a delay of one day. The payment from urban consumers is sometimes received on weekly, fortnightly or even monthly bases. In late 1990s, *Nestle* had started collecting milk from Yezman and Marot areas of Cholistan and milk price is paid on the basis of fat contents.

Since milkmen commute daily between rural and urban areas, they offer a number of facilities to their client farmers. For instance, some milkmen would take the list of grocery (like purchase of tea, sugar, wheat flour, vegetables, etc.) from their clients and buy groceries for them, milkmen having single cabin vans also supply concentrates but don't charge transportation costs, sometimes *dodhies* provide free pick and drop facilities to farmers between *tobas/kunds* and main traffic roads or *dhars*¹¹.

In Cholistan, marketing of *desi ghee* mainly takes place outside '*rohi*' or near urban centers. *Desi ghee* is a regular and principal dairy product of Cholistan. A varying proportion (depending upon the daily milk production) of cattle milk is regularly processed by the livestock farmers to make *desi ghee*. Making *desi ghee* from milk is a regular feminine activity. Women keep gathering the daily produced *desi ghee* in 'canisters' till a fairly large quantity is accumulated. This *ghee* is then sold in the nearby urban markets to buy groceries. Overall, on average, more than 13 kg per household of *desi ghee* was reported being sold every month. The average quantity of *ghee* sold per household by pastoralists was almost double than their counterparts.

Marketing of Live Animals

The livestock herders in Cholistan generally avoid selling their animals unless some urgent need arises (Table 10). Since the major portion of the livestock population spends most of the time in areas far away from livestock markets, animals are mostly sold directly to livestock traders or *beoparies* who travel to specific *tobas* and wells in the desert or settlements in irrigated belts

¹⁰ In summer, this strictness is often relaxed as they themselves also put ice in the milk.

¹¹ Since only one milkman respondent was interviewed, therefore, whether other milkmen also extend similar services to their clients or not, could not be further inquired. How they recovered these costs from farmers was also not known.

Table 11. Animals first sold by farmers by farm types in Cholistan desert of Pakistan (per cent livestock farmers)

Livestock	Farm types		Overall
	Pastoralists	Agro-pastoralists	
Male calves/young stock	58.80	44.90	49.50
Female heifers	—	1.50	1.00
Old females	2.80	11.60	8.60
Adult males	13.10	7.30	9.50
Multiple (male calves+others)	25.10	34.70	31.40

of Lesser Cholistan to buy animals. However, most of the animal sale takes place when the herds are in irrigated parts of Lesser Cholistan. This is due to the ease of access to livestock markets in irrigated areas and increased money needs for buying supplementary feed and fodder for the herds. The clearing/disposal prices of animals vary with age, sex, supply and the general health conditions. Regarding animals selling patterns, about half of the livestock farmers reported the first disposal of male calves/young stock of cattle whereas cattle heifers were least sold as they were kept for further reproduction. More than 30% of the farmers reported selling of male calves/young stock in combination with old females and culled sires, etc. (Table 11).

The livestock herders sold their animals due to a multiple reasons including urgent monetary needs, regular marketing of

animals, animal sale at *Eid-ul-Azha*, culling of old animals, prolonged drought conditions, etc. Among them, urgent money need was the most important reason with a frequency of 48.5%. The other notable reasons included regular marketing, culling of animals and prolonged drought conditions with almost an equal frequency of occurrence slightly above 10% each. It can be concluded that the urgent monetary need was the major reason for selling of livestock in the study area (Table 12). Considering livestock marketing channels, the animals in the area are mostly sold through animal traders or *beoparies* and/or butchers. A small proportion of the herders sold their animals through livestock markets. Relatively high percentage of agro-pastoralists was selling their animals through livestock markets (Table 13).

Table 12. Reasons of selling livestock by farm types in Cholistan Desert of Pakistan (per cent livestock farmers)

Marketing reasons	Farm types		Overall
	Pastoralists	Agro-pastoralists	
Urgent monetary needs	47.13	49.30	48.48
Regular marketing	8.05	11.81	10.39
Culling of animals	10.34	11.81	11.26
<i>Qurbanis</i> /sacrificial animals sale	11.50	5.56	7.79
Prolonged drought conditions	8.04	13.19	11.26
Other reasons	14.94	8.33	10.82

Table 13. Marketing channels of livestock by farm types in Cholistan Desert of Pakistan (per cent livestock farmers)

Marketing channels	Farm types		Overall
	Pastoralists	Agro-pastoralists	
<i>Beoparies</i> or livestock traders	51.90	46.90	48.70
Butchers	18.50	6.10	10.50
Livestock market	3.70	14.30	10.50
<i>Beoparies</i> + fellow herders	—	2.00	1.30
<i>Beoparies</i> + butchers	22.20	20.40	21.10
<i>Beoparies</i> + livestock market		10.20	6.60
Butcher + livestock market	3.70	—	1.30

Livestock Production Problems in Cholistan

As animal keeping is the main source of livelihood in the area, therefore, the average herd size maintained is fairly large to cover the risks against diseases and droughts. However, a number of problems are faced by the farmers in their livestock farming business. Relatively more peculiar problems include limited supply of forage and fodder, poor health of the animals, more physical exertion of animals while grazing, frequent incidence of diseases and droughts, difficulties in getting health services and approaching all herders in vaccination campaigns, least opportunities of getting children educated (especially of pastoralists) as the herders keep moving from one *toba* to the other, low milk productivity per animal, highly limited milk marketing opportunities, non-existence of milk preservation facilities with the herders leaves few options like early consumption of milk, feeding to young stock, and/or processing for making *ghee*. Since marketing of live animals is mostly taken

place in summer on arrival of herders in Lesser Cholistan near Sutlej River and canal banks, therefore, the benefits of sudden rise in animal supply¹² are harvested by livestock traders or *beoparies* and butchers. This leads to sub-optimal returns to the year long hard work of the herders.

Development Strategies for the Livestock Economy of Cholistan

The economy of Cholistan is mainly livestock-based. Livestock farming in this area is practiced under two major production systems, i.e. pastoral and agro-pastoral. Pastoralist families keep on moving with their livestock in search of water and grazing pastures whereas agro-pastoralists simultaneously manage both agricultural lands and livestock. Livestock farming in Cholistan is characterized by low productivity, poor animal health and time to time occurrence of droughts. Live animals, milk, *desi ghee*, wool, etc., are the main livestock products of Cholistani farming system and none of these items is produced on commercial lines. In other

¹² High rate of animal selling is because of many reasons like expenditure on marriages, annual purchasing of non-food items like clothes, shoes etc., financing stall-feeding expenses and lowering overall stall-feeding expenses of the herd.

words, livestock is kept by Cholistanies as a mean to socio-economic security, a way of saving and a sign of wealth and social status. In order to determine and quantify the conditions prevailing in Cholistan and to find ways and means to impart commercial orientation to the prevailing farming system, the present study was conducted.

The livestock economy of Cholistan can be characterized as an economy entirely dependent on one important sub-sector of Pakistan agriculture with the primary objective of making livelihood by selling adult males of small ruminants and young stock of large ruminants and dairy products mainly for subsistence. Low human capital, little infrastructure facilities and livestock production in isolation from various amenities, necessities of life and business (such as schools, roads, dispensaries, hospitals, banks, grocery and marketing facilities for livestock and its products etc.) are the major characteristics of most of the livestock farms in Cholistan. Majority of the livestock farmers were managing small and medium size herds and were engaged in multiple enterprising. Almost every farmer was keeping cattle and few animals of other species and the average herd size is fairly large to cover the risks against diseases and drought. Uncontrolled grazing and browsing on rangelands vegetation is the major source of feeding animals, but experts are of the view that the carrying capacity of Cholistani rangelands is much below the requirements. Wide milk yield variation in cattle has been observed with an average gap of 5 and 4 liters per day per cattle during summer and winter seasons, respectively. Most of

the milk production was being processed for conversion into *desi ghee*, consumed at home or fed to young stock because of little milk marketing opportunities. A large number of the farmers (34%) did not own breeding bulls and on ethical grounds, the services of sires are used for limited time, i.e. till their female progeny reaches the age of puberty. The diseases like Black Quarter, Haemorrhagic Septicemia (Galhoto), Foot and Mouth disease, Enterotoxaemia, Diarrhoea and Pleuropneumonia caused considerable deaths among the livestock in Cholistan. Majority of the herders (three-fifths) failed to provide veterinary treatment to their sick animals. A large number of herders did not get their herd vaccinated and those who practiced, often failed to comply with the proper vaccination schedules.

In the light of operational realities prevailing in Cholistan's farming system, general discussions with the animal herders during the survey and perceived priority ranking expressed by the respondent farmers, the following high and low priority development areas are diagnosed:

High priority areas include: (i) increasing the availability of rangeland vegetation and green fodder; (ii) increasing rain water harvesting capacity in the area; (iii) improvement in the genetic potential of local livestock breeds through selection and improved management; (iv) provision of efficient livestock health coverage; (v) enhancing milk and wool production; (vi) introduction and promotion of milk collection and processing activities in the area, and (vii) intensifying production of fodder crops and cereals to improve both

food and fodder security on the agricultural lands owned by agro-pastoralists; and (viii) milk productivity enhancing programs through artificial insemination and bull lending to the livestock herders during breeding season.

Low priority areas include; (i) development of wool processing, carpet and other handicrafts industries in the area; (ii) establishment of mobile elementary education schools; (iii) allotment of agricultural lands to pastoralists; (iv) provision of institutional credit to livestock herders; and (v) provision of metalled roads in the interior Cholistan.

It is suggested that some comprehensive feasibility studies should also be conducted before implementing some development projects such as installation of milk processing plants and compound feed manufacturing industries, etc. In irrigated areas of Lesser Cholistan women have the opportunities of supplementing household income through cotton picking and in some cases harvesting of wheat. Women are generally illiterate, suffered from malnutrition and are unskilled. Hence, there is lot of scope/challenges for the NGOs' interventions related to women development in areas like better healthcare, education and nutrition. Special programmes may be launched for training them in embroidery, handicraft making and other income generating activities using local inputs, which will certainly contribute towards generation of additional income for the families. Nevertheless, it is hoped that the limitations present in the area do not seriously distort the general arguments advanced, the conclusions drawn and various development strategies proposed.

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