7.4.5 Animal Feeding in the Agro-ecological Zones

As discussed above, the forms of animal feeding in Sindh are divided into those of the irrigated and non-irrigated areas, and the animal feeding system is closely related to cropping pattern, this section describes the current situations of feed resources and feeding management, and in turn examines the potentials, limiting factors, and countermeasures for the agro-ecological zones as mentioned in 7.2.2.

(1) Irrigated Area

(i) Feed resources and feeding management

(a) Feed Resources

- Upper Zone: Main feed resources are rice straw, wheat straw, pulses haulms, pulses husk, native grasses at crop fields, regrowth and leaves at stubble.
- Middle Zone: Main fodder resources include wheat straw, green forage, the sugar cane tops and native grasses growing around the fields, and the leaves of cotton plants after they are harvested. In spite of crop residue, cotton leaves represent a nutrient rich forage for livestock. The leaves of cotton (dry matter content 90%) contain a crude protein content of 20.1%. The digestibility of this for cattle is 68% and 69% for sheep[12]
- Lower Zone: Principal forage resources are the crop residues of rice, sugarcane, wheat, etc. as well as rice herbage of soiled-growing stage and native grasses. Here, there has also been the early cutting and harvesting of green rice herbage just above ground level before heading as a forage resource. This is done by harvesting the top parts of the rice plants (approx. 80 cm in height) 30 to 40 days after they are transplanted into field. This is used as green forage, and the regrowth is allowed to maturity, and the rice is then harvested. Surprisingly, some farmers harvest the green forage twice during the growing season before they harvest the rice. Moreover, they report obtaining greater rice yields than not harvesting green forage. In addition, along the paddy levee leguminous shrubs such as Jantar (*Sesbania spp.*) are grown for forage, where rice farming has been intensively developed.

Table 7-4-7 Availability of Major Crop Residues in Irrigated Area of Sindh (2008/09)

	Wheat straw	Rice straw	Sugercane top (Fresh)	Sunflower leaves	Cotton leaves	Maize stover	Millet stover	Sorghum stover	Barley straw	Rape & Mustard
Agro-ecological zone	'000t	'000t	'000t	'000t	'000t	'000t	'000t	'000t	'000t	'000t
Upper	1,230.30	2,411.63	107.10	9.98	295.12	0.30	0.40	42.40	2.47	81.60
Middle	3,000.70	189.80	1,722.30	255.58	1,593.36	3.90	13.20	84.00	0.26	102.40
Lower	218.10	696.28	1,474.25	886.07	84.04	0.00	2.80	2.80	1.82	16.40

Source: Crop Area and Production (By District) 2007-08 & 2008-09, Government of Pakistan, Ministry of Food and Agriculture (Economic Wing) 2010

[12] Sümer Hsimogle et al. 1982. Composition of Various Indigenous Feeding Stuffs of Sindh Province, Pakistan and Their Use, Sind Agriculture University

Table 7-4-8 Availability of Pulse Residues in Irrigated Area of Sindh (2008/09)

	Cluster bean haulms	Chickpea haulms	Green gram haulms	Black gram haulms	Lentil haulms	Field pea haulms	Kharif pulse haulms	Rabi pulse haumls	Groundnut haulms
Agro-ecological zone	'000t	'000t	'000t	'000t	'000t	'000t	'000t	'000t	'000t
Upper	2.13	112.80	0.04	0.11	11.65	142.60	0.03	0.53	1.35
Middle	14.49	10.40	5.42	0.60	1.75	3.68	1.25	0.14	0.86
Lower	0.23	0.00	0.12	0.24	0.44	0.18	0.18	0.13	0.00

Source: Crop Area and Production (By District) 2007-08 & 2008-09, Government of Pakistan, Ministry of Food and Agriculture (Economic Wing) 2010

A woman cutting grass by a canal at sugarcane field

Rice field and date trees in Sukkur

(b) Feeding management: A system of providing forage through a combination of grazing and harvested forage is rooted in traditional farming systems and based on prevalent local environmental conditions. This self-sufficient system is based on long experiences that make good use of local resources. Management systems of livestock using such a self-sufficient farming system of combining grazing and forage collection can be classified according to size as follows:

- Small scale farmer and small scale tenant farmer: For self-sufficient small scale land holders and tenant farmers with no land holdings, there is an emphasis on milk production. Feed is provided at no cost through a self-sufficient grazing and forage collection system. Yields are low and the milk is mostly self-consumed. In this situation, farmers have not specialized in milk production, but rather sort of stability of livelihood through raising a diversity of animal species. There are great benefits for dairy farmers to get cash if they can sell milk every day. However when just selling a little surplus milk, it is difficult to get sufficient volumes to attract middlemen to buy regularly. In reality, however, the farmers are forced to sell their livestock in order to get money. If there are adult buffaloes, even for non-lactating and non-pregnant animals, they can be sold for Rs.30,000 to 40,000. Although farmers are not without the desire to raise productivity, limitation on feed sources is a serious bottleneck for increasing weight gain and milk production per head, and therefore they tend to maintain herd sizes at current levels.

  During the day buffaloes are grazed around harvested fields and beside waterways. The available forage can vary greatly depending on the season. This is supplemented with cut green fodder, and the purchase of feed, such

as cheap millet residue. Moreover, when grazing resources are scarce they are forced to travel more than 2 km away from the village in search of grazing pasture using up much energy in the process.

A village on the outskirts of Hyderabad was chosen for the periodical survey of small scale farmers. Most of the inhabitants of this village are related, and many, except for the landlord who lives in Hyderabad city, are livestock farmers who do not own land. This farmer milks late lactating buffalo and gets 2 litres per day. Although the buffalo are raised mainly by grazing, lactating buffalo are fed supplemental feed (see table). Judging from the nutritive value of this feed, the nutrition required to maintain the body and produce 2 litres of milk per day is 4.17kg TDN and 0.58 DCP. When the nutritive value obtained from supplementary feed is subtracted from this, it is estimated that 50% of TDN and 38% of DCP need to be obtained from grazing.[13]

Table 7-4-9 Value of Supplemental Feed for Milking Buffalo

	DM intake	TDN	DCP
	----------	Kg	----------
Wheat straw	2.3	0.91	0
Wheat bran	1.13	0.83	0.14
Cotton seed cake	0.44	0.35	0.08
Total		2.09	0.22

Note: DM: Dry Matter, TDN: Total Digestible Nutrients, DCP: Digestible Crude Protein

Source: Surveyed by the Project Team

- Medium sized farmers: Even for medium-sized farmers there is limited growing of forage crops, since food and cash crops are given a priority for most of the farmland. However, since the food, oil and cash crops provide extra crop residues available for use as forage, increases in livestock production that utilize these resources are possible. Moreover, even without planting forage crops in summer, the winter legume crops of berseem and lucerne, which are in an integral part of the crop rotation system, provide high quality green forage in a very limited period of time. For those medium-sized farmers who have sufficient forage, leftover green forage can often be observed in the fields.

  For the periodical survey of a medium sized livestock farm, a farm in Mirpurkhas located about 6 km from the center of the district was selected. This farm is a part of the property owned by a large landowner (owning 500 acres in total) who is a resident on the property and employs his brother to run the livestock farm, who in turn hires a farmer to look after the animals. The informant farmer himself, cultivates 2 ha of the land that he rents, (1 ha in wheat and the other 1 hectare in sugar cane), while working for the landowner. The livestock being raised are 7 buffaloes (2 for milking), 2 draft cattle, and 1 goat (he owned 3 goats, but 2 were sold recently). Feeding of the livestock is mainly through grazing on fallow land owned by the land owner, on roadside and along the watercourse, on land that has just been harvested, and on the leaves of cotton plants after the cotton is picked. Depending on the season, the tops of sugar cane plants, berseem, leguminous shrubs (Sesbania sp.), wheat straw

[13] The details of the calculation are shown in Appendix F.

are used as feed as well. This farmer gets 3.8 litres per day in March and April. It is estimated that the nutritional requirement for this period is 5.05kg TDN and 0.83kg DCP. The feed during this period is shown in Table 7-4-10. Twenty kilograms of beseem and 30kgs of cane tops are fed to the buffalo in twice a day. Judging from the nutritive value of this feed, the TDN intake has been fully met, and 30% of DCP intake needs to be gained elsewhere[14]. It is estimated that the DCP shortfall is made up by grazing.

A characteristic of this informant farmer is the relationship he has with the landowner. Apart from returning half the crop harvested from the rented land to the landowner, the farmer also uses the crop residues and graze livestock on the uncultivated land of the landowner, which ensures a diverse source of feed.

Table 7-4-10 Value of Supplemental Feed for Milking Buffalo

	DM intake	TDN	DCP
	----------	Kg	----------
Sugercane top	7.54	3.71	0.22
Berseem(vegetative)	2.3	1.52	0.39
Total		5.23	0.61

Source: Surveyed by the Project Team

Milking buffalos in cattle colony

Feed preparation in cattle colony

- Large sized farmers purchased feed stock: Cattle colonies are large dairy herds located in urban and peri-urban areas. One of the benefits of such large sized dairy farmers who purchase all their fodder is that it is not necessary for them to invest in land, farm machinery or manpower. On the other hand, the disadvantages include the substantial cost of feed, and the availability of this feed is affected by the occurrence of crop pests, weather, seasonal, and yearly variations in production. For example, in 2010 due to floods, the cost of green forage escalated from Rs.100 to 200/40kg. For these dairy farmers adjacent to the big city markets, there is an incentive to tap the genetic milking potential of the livestock and the cost effectiveness of the feed/diets in order to reap the greatest commercial benefit. It would be better to give the appropriate quantity of feed depending on the production capacity of each cattle. In cattle colonies,

[14] The details of the calculation are shown in Appendix F.

even though the milk yield between buffalo varies significantly, they are all fed the same amount of feed. It is thought that the necessary nutritional requirement needed to obtain an average of 9 litres of milk per head per day is being met. The feed mixture is determined by personal experience and exchange of information between dairy farmers.

Table 7-4-11 Value of House Compounded Feed for Milking Buffalo

	kg/animal/ day	DM intake kg/day	TDN (kg)	DCP (kg)
Maize(Green)	7.4	1.62	0.99	0.09
Wheat straw	4.3	3.96	1.43	0
Cotton seed cake	1.7	1.51	1.19	0.3
Wheat bran	3.4	3.07	2.25	0.39
Mung Churi	1.8	1.63	0.92	0.19
Gram Churi	1	0.9	0.65	0.07
Rice polish	0.4	0.365	0.29	0.04
Mineral premix	0.008			
Total	20.008	13.055	7.72	1.08

Source: Surveyed by the Project Team

(ii) Potentials

(a) Feed resources

There are diverse and abundant feed resources such as crop residues, agricultural by-products, native pastures and leguminous trees. Those feed resources and available volumes are as listed below[15].

Crop residues: wheat straw (4.6 million tons), rice straw (3.3 million tons), sugarcane top (3.3 million tons) and trash (931,280 tons), cotton leaves (2.0 million tons), pulses haulms (315,520 tons), maize/millet/sorghum stovers (317,000 tons), etc. (see Table 7-4-12). The crude protein (CP) content of the abundant wheat and rice straw is a low 3~5%. With a TDN of around 40%, this is a poor quality roughage. With ammonia or urea treatment, the CP can be increased by up to 3 to 4% and the TDN by 5 to 6%, substantially improving the quality of this feed resource. Since straw costs only Rs.6 to 8/kg it is a relatively inexpensive feed to purchase.

Milling by-products: wheat bran (283,220 tons), rice bran (202,970 tons), crushed pulses, etc. wheat bran contains a relatively high CP of about 15%, and with high fiber content, it is a good quality feed. It can be used as one of the main ingredients for a feed composite. Rice bran, on the other hand, has a higher fat content than wheat bran, and thus care needs to be taken with the blending ratio.

Oil seed by-products: cotton (148,940 tons), mustard, rape and canola (35,770 tons), sunflower (201,870 tons), groundnut (2,810 tons), sesame (2,430 tons), linseed (1,850 tons), seed cake, etc. (Table 7-4-13). Because of the high protein content, oil seed cake is an important supplement to the roughage such as crop residues, forage crops, and native grasses, which accounts for a large percentage of feed (Table 7-4-1). The price is relatively expensive at Rs.25 to 28/kg.

[15] The information on nutrition, yield and feed quality of forage crops, such as sorghum, s.s. hybrid, oats, berseem and lucern, have been documented by research institutes such as Fodder Research Institute, Sargodha. High yielding forage seed is available in the market.

Agro-industrial by-products: According to Pakistan Sugar Mills Association, 1,536,332 tons (928,514 tons in Punjab, 493,079 tons in Sindh, and 114,739 tons in NWFP) of molasses, a by-product from sugar production, was produced in 2008/09, and out of which 936,338 tons (61%) was exported. The rest was used for livestock feed, industrial alcohol production, and tobacco blending in the country. There are 32 sugar mills in Sindh, and out of which 5 mills produce molasses for sale between November and April every year. Molasses is a cheap (Rs.0.12/kg) energy resource, but currently little of it is being used for feed. Another sugar industry by-product is bagasse. It is used as fuel in the factories, and raw material for paper and chipboard. However, by treating urea and molasses, it can be used as maintenance feed for the ruminants. In addition, there are the other agricultural industry by-products such as fruit juice pulp, alcohol brewing dregs, and rejected dates. Raw by-products from juice pulp and brewing have a high moisture content, which can be mixed with straw species or bran to produce good quality feed. According to the estimate based on the statistics on the export of ethyl-alcohol in 2004/05, brewery effluent discharged 513,377 tons throughout the country.

Native grasses around the field: *Cynodon dactylon*, *Dactyloctenium aegyptium*, *Cenchrus setigerus*, *Echinochloa spp.*, and so on.

Leguminous trees: *Acacia nilotica*, *Sesbania spp.*, *Leucaena leucocephala*, *Prosopis juliflora*, *Cajanus cajan*, *Albizia lebbek*, and so on.

Fodder crop/Pasture: S.S.Hybrid (Multi-cut Sorghum), Mott grass (*Pennisetum purpureum*), Berseem (*Trifolium alexandrinum*), Lucerne (*Medicago sativa*), Oats (*Avena sativa*), and so on.

Table 7-4-12 Production and Potential Availability of Residues (fibrous by-products) of Major Crops in Sindh 2008/09

Category	Crops	Residues	Production '000' t	By-products '000' t	Multiplier *1	Remarks
Cereal &	Wheat	Straw	3,540.30	4,602.39	1.3	
Cash crop	Rice	Straw	2,537.10	3,298.23	1.3	
	Maize	Stover	1.40	4.20	3.0	
	Millet	Stover	45.00	180.00	4.0	
	Sorghum	Stover	33.20	132.80	4.0	
	Barley	Straw	3.60	4.68	1.3	
	Sugercane	Tops	13,304.30	3,326.08	0.25	Fresh
	Sugercane	Trush	13,304.30	931.28	0.07	
	Cotton	Leaves	506.60	2,026.40	4.0	Dry matter
Pulses	Green gram	Haulms	5.83	23.32	4.0	Dry matter
	Bluck gram	Haulms	0.34	1.36	4.0	Dry matter
	Kharif pulses	Haulms	0.68	2.72	4.0	Dry matter
	Chick pea	Haulms	31.60	126.40	4.0	Dry matter
	Lentir	Haulms	3.56	14.24	4.0	Dry matter
	Field pea	Haulms	36.66	146.64	4.0	Dry matter
	Rabi pulses	Haulms	0.21	0.84	4.0	Dry matter
Oil seed	Sunflower	Leaves	288.39	576.78	2.0	Dry matter
	Groundnut	Haulms	4.68	9.36	2.0	Dry matter
	Cluster bean	Haulms	34.51	69.02	2.0	Dry matter

Source: Crop Area and Production (By District) 2007-08 & 2008-09, Government of Pakistan, Ministry of Food and Agriculture (Economic Wing) 2010

*1: Vappu Kossila 1988 The Availability of Crop Residues in Developing Countries in Relation to Livestock Populations, Proceedings of Workshop Held at ILCA Addis Ababa, Ethiopia 7-10 December 1987

Table 7-4-13 Potential Availability of Concentrates in Sindh 2008/09

Category	Crops	By-products	Production '000 t	By-products '000 t	Extraction rate (%) *2	Remarks
Cereal &	Wheat	Bran	3,540.30	283.22	8.0	
Cash crop	Rice	Bran	2,537.10	202.97	8.0	
	Sugercane	Molasses	10,148.60 (Crushed)	493.08	4.86	*3
Oil seed	Cotton	Seed cake	506.60	148.94	84.0	Seed 35%
	Sunflower	Seed cake	288.39	201.87	70.0	
	Groundnut	Cake	4.68	2.81	60.0	
	Sesame	Cake	3.47	2.43	70.0	
	Cluster bean	Cake	34.51	24.16	70.0	
	Linseed	Cake	2.64	1.85	70.0	
	Rape & Mustard	Seed cake	51.10	35.77	70.0	

Source: Crop Area and Production (By District) 2007-08 & 2008-09, Government of Pakistan, Ministry of Food and Agriculture (Economic Wing) 2010

*2: Ministry of Agriculture 1992 All-India Final Estimates of Principal Crops (1991-1992), Directorate of Economics and Statistics, New Delhi

*3: Pakistan Sugar Mills Association 2008-2009

(b) Farmers know how to effectively use feed that are locally available, and they have practiced with intensive use of land by cut and carry and grazing. Thus, the following can be considered as potentials:

- Simultaneous production system of rice for soiling herbage for animals and after the regrowth of grain for both human beings and animals, as suggested by some farmers in Badin.
- Intensive forage production technologies using paddy of levee *Sesbania spp.* can be introduced for this purpose.
- Camels and sheep can be grazed on the land that is unsuited to agriculture, where there are saline tolerant woody plants such as *Salvadora persica., Tamarix sarenesis, Suaeda fruticosa*, etc.
- Weeds are grown widely under fruits trees such as mango, guava, and dates palm. These weeds can be shifted to the grasses which are suitable for the land for repeated cutting and grazing. Furthermore, berseem and lucerne can be planted in the field under these fruits trees as green fodder in Rabi season.
- Fodder trees can be planted in a line so that farmers including women in the landless households are able to collect forage when they come back home from their agricultural jobs.
- Babal (*Acacia nilotica*) and native grasses along the watercourses can be used as fodder.
- Stubble and fallow can be used for grazing and cutting in the pasture land as the regulation is quite loose.

(c) Cut and carry system is taken root as a foundation for fodder development in Sindh.

(d) There are unused agricultural lands which are salt affected. Edible salt tolerant plants such as Kallar Mar grass (*Leptochloafusca*), *Panicum antidotale,Atriplex spp*., etc. exist in Sindh and Punjab provinces, which can be utilized. Growth characteristics and feed value of salt tolerant crops have been evaluated by domestic research institutions, and there are efforts to encourage farm uptake of these salt tolerant species.

(iii) Limiting factors

(a) Livestock farmers who are landless or tenants with small farming have limited access to quality feed, and therefore they are forced to use low quality feed.

(b) Sharing of technical information is limited. Even though multi-cut high yielding fodder crops and pasture seeds are available at the market, only a small number of farmers can cultivate them since the information is not much shared. Also, even if farmers cultivate them, they have little knowledge on the cultivation such as appropriate density of planting (spacing), proper cutting time, and height of fodder.

(c) Nutritious management including standard feed composition, feed requirements of dairy buffalo, dairy Zebu, and crosses with European breeds, etc. has not been established. Hence, the livestock farmers are not aware of it.

(iv) Countermeasures

(a) A participatory field evaluation is needed to assess animal feeding management for milk and meat production based on locally available resources and technologies.

(b) The meadow and the grazing land needs to be improved quantitatively and qualitatively by introducing high yielding multi-cut pastures and leguminous fodder trees. Introduction of low-cost technology to improve nutrition of animals will be needed for small scale livestock farmers who are interested to increase milk production, but not increase the number of animals raised. An example for this measure is the introduction of Mott grass that has relatively higher yield and nutritive values. An important point to note for this grass is the timing of cutting. Also, one can observe the utilization of Luecaena which is long-lived and highly productive in this area. This can be grown at the backyard plots along the watercourse and at the edge of crop fields, so it can be extended widely.

(c) Introduction of high yielding fodder crops would be another countermeasure. Suitable crop should be prompted to be planted with the appropriate technologies. The difference of productivity between Sadda Bahar (Sorghum-Sudan-Cross hybrid) and local Jowar (*Sorghum bicolor*) is seemingly large, and the planting of the latter should be encouraged.

(d) The improvement of nutrition in the crop residues can be made with the supplementation of molasses, urea, oil seed cake, and mineral (e.g. molasses-urea block).

(e) Self-sufficiency of coarse feed can be enhanced by the improvement of soil of the salt affected land.

(f) Salt tolerant forage crops should be identified: As mentioned earlier, the relative salinity of surface soil, based on EC values, has been classified into 4 categories; salt free (less than 4 ds/m), slightly saline (4-8 ds/m), moderately saline (8-15ds/m) and strongly saline (more than 15ds/m). Damage due to salt build up in soil in Sindh is outlined in Table 7-3-6. A total of 20.3% (2,855,168 ha) of the land area of Sindh is classified into the most severe class of "strongly saline". Most of this farmland is left fallowed or abandoned as unfit for agricultural purposes. In the irrigated areas as the growing of food and cash crops receives a priority (see Figure 7-4-1), it is difficult to expand the cultivation of forage crops. As a result, growing forage crops on saline damaged land is receiving attention. In Punjab province they have already succeeded in growing salt tolerant forage crops. Depending on the degree of salt accumulation in the soil, salt tolerant species are being selected to be grown for forage. One such example is as in Table 7-4-14.

Table 7-4-14 Salt Tolerance of Selected Plants for Forage

	Common name	Scientific name
Tolerant	Alkali grass	Puccinellia airoides
(Strongly saline)	Bermuda grass	Cynodon dactylon
	Kallar grass	Leptochloa fusca
	Salt grass	Distichlis stricta
	Wheat grass	Agropyron cristatum
	Wheat grass, tall	Elytrigia elongata
	Wildrye	Leymus angustus
	Barley	Hordeum vulgare
	Mesquite	Prosopis juliflora
	River saltbush	Atriplex aminicola
		Acacia ampliceps
Moderately	Sorghum	Sorghum bicolor
tolerant	Sudan grass	Sorghum sudanense
(Moderately saline)	Rhodes grass	Chloris gayana
	Wheat grass	Agropyron sibiricum
	Wildrye	Elymus triticoides
	Guar	Cyamopsis tetragonoloba
	Rape	Brassica napus
		Acacia nilotica
		Sesbania sesban

Source: R.H. Qureshi and E.G. Barrett-Lennard 1998, Saline Agriculture for Irrigated Land in Pakistan: A handbook, Australian Centre for International Agricultural Research, Canberra, Australia

(g) An efficient feeding method by designing the feeding standard based on existing feeding environment needs to be promoted.

(2) Non-irrigated Area (Open range land grazing type)

(i) Feed resources and feeding management

- Thar Desert Zone: Residues from drought resistant crops are stored, and during the driest part of the season when forage is insufficient, it is used together with the shoots of Kandi (*Prosopis cineraris*) along with fruits. The remaining branches are used as fuel wood. The goat favors fruits of Devi (*Prosopis juliflora*), being supplemented with crop residue feed during the dry period. When all available feed sources run out in the area, dry crop residues such as straw are purchased from small markets.

  Livestock are mainly raised by grazing throughout the year. During the rainy season from July to November when farming takes place, livestock return daily to the homestead. As there is no drinking water in the grazing lands, the livestock herds are brought back to the village between 12 and 14 o'clock. After the midday watering, the animals are taken back out to the grazing lands and brought back in the evenings and stayed in the night inside of paddocks set up in the village. However, after the harvest, during the dry season from December to June when there is a lack of feed, sheep and goats are left to range on the grazing lands (open areas) both day and night in order to find enough feed. Since in the grazing lands there is no drinking water, once a day between 14 to 15 o'clock the herd is brought back to the village for watering. The herd must then return back to the grazing lands. For the large animals grazing occurs as per the rainy season, when they are brought back to the village on a daily basis.

Over the years, this efficient means of utilizing the range lands seems to have been established through repeated experiences of droughts and infectious diseases as a subsistence means of livestock management that is in harmony with the harsh environment in this region. Due to the unpredictably of rainfed agriculture in this arid area to supply sufficient grain, there is inevitably a tendency to be highly dependent on pastoralism. During years with poor crop harvests, livestock are sold in order to buy food. Thus there is a need to maintain the appropriate number of livestock. According to the staff of the district office of the livestock department, there is a sense that for small sized farmers a herd size of about 20 goats and sheep and a few large animals needs to be kept. In this arid area, a herd size of this scale is required in order to ensure a stable livelihood.

- Kohistan Zone: Main livestock species are sheep, goats, and horses that graze basically year-round. In the range lands during the dry season when there is a shortage of feed, lactating cows are preferentially fed cut grasses that are grown in the evergreen forests. In Jamshoro, the livestock population being raised is 414,191 goats, 171,748 sheep and 163,732 cattle. Compared to the other districts, this is a low number of livestock that is being kept[16]. These stocking density (LSU[17]/ ha) is also low even compared to the arid area of Tharparkar and Umerkot that have stocking densities of 0.62LSU/ha, and 0.69LSU/ha compared to 0.26LSU/ha for Jamshoro.

  Examining the salinity of groundwater used for human and livestock consumption in both areas, the depth of the groundwater in the village of Ali Murad Bareso, Thano Bula khan is 105 to 120 meters and the salinity 0.01% (EC value 0.41ms/cm), in Mithrio Bhatti village near Mithi the groundwater is drawn from a depth of 75 meters and has a salinity of 0.24% (EC value 4.38ms/cm). In general, irrigation water with a salinity of below 0.075% does not harm crops. Thus the groundwater near Thano Bula khan is close to fresh water and can be used to irrigate crops. On the other hand, the groundwater near Mithi, which has salinity as 24 times high as that from Thano Bulakhan, cannot be used to irrigate crops.

Table 7-4-15 Availability of Crop Residue in Non-irrigated Area of Sindh (2008/09)

	Millet stover	Sorghum stover	Cluster bean haulms	Chickpea haulms	Green gram haulms	Black gram haulms	Kharif pulse haulms	Groundnut haulms
Agro-ecological zone	'000t	'000t	'000t	'000t	'000t	'000t	'000t	'000t
Thar desert	160.00	0.00	51.92	0.00	17.55	0.30	1.18	7.15
Kohistan	3.60	3.60	0.25	3.20	0.19	0.11	0.08	0.00

Source: Crop Area and Production (By District) 2007-08 & 2008-09, GOP, Ministry of Food and Agriculture (Economic Wing) 2010

(ii) Potentials

(a) Farmers know the value of and how to effectively use indigenous feed resources (Grasses, Shrubs, trees, etc.): In this harsh arid environment, the local people have gained a vast wealth of experience on living in a sustainable and harmonious way with the land, by controlling livestock population levels and raising a diversity of livestock species. This type of dry land livestock management can be said to have

[16] Pakistan Livestock Census 2006, Agricultural Census Organization, Statistics Division

[17] The Livestock Unit (LSU) is calculated with a conversion rate of 1.0 for buffalo, 0.8 for cattle, 0.1 for sheep and goats, 0.4 for donkeys, 0.8 for mules, 1.0 for horses and 1.1 for camels.

high potential. To cite one example which the Project Team heard when visiting the Mithrio Bhatti village, Mithi taluka, this village cultivates 1,500 acres of arable land (the slopes and ridges are used for grazing). There is 2,000 acres of open grazing land where 3,000 goats and sheep are grazed, and 200 cattle, 130 camels, 60 donkeys, and 2 horses are kept without the need to migrate to other areas. When the Livestock Unit (LSU) is divided by the combined total area of arable and grazed land, a value of 2.2ha/1LSU is obtained. This is a high holding capacity in such an environment. This is prerequisite on there always being drinking water available in the village for the livestock. In this arid area, maintaining a livelihood with such a high holding capacity is a fine balancing act between arable and grazing land allocation, and raising a diversity of animal species at the appropriate grazing pressure.

(b) There is open access to vast grazing land (range land) under the control of the provincial government.

(c) The self-sufficient subsistence (mixed farming of agriculture and livestock) which cope rainfall fluctuation and drought occurred frequently is taken root in the dry area.

(d) Drinking water of livestock from a well are available each village.

(e) There are edible draught and saline tolerant plants as follows:

- Annual grasses: Cenchrus1 biflorus, Elionurushirsutus, Aristida adscenscionis, etc.
- Perennial grasses: Panicum antidotale, Panicum turgidum, etc.
- Forbs: Indigofera cordifolia(Leguminosae), Lycium europium, Euphoria candicifolia, Leptidinia phrotechnica, Blepharis linariofolia, etc.
- Woody plants: Acacia senegal, Prosopis cineraris, Ziziphas nummularia, Salvadora oleoides, Grewia tenax, etc.
- Crops: Bajra, Jowar, Guar, Mung, Moth, Til, Water melon, etc.

(f) Rainfall fluctuation is coped by transhumance to irrigated area of large animals

(iii) Limiting factors

(a) Rainfall fluctuate considerably.

(b) Water holding capacity is low due to sandy soil in Tharparkar

(c) Rain-fed cultivation cause unstable crop yields

(d) Sharing of technical information on how to maintenance of range land and soil conservation and edible saline tolerant plants are weak.

(e) Some wells decrease water levels during May to June. The shortage of stock drinking water arises since domestic use of water is higher priority over livestock.

(f) Stock drinking points exist only in the village despite the existence of the vast grazing land.

(iv) Countermeasures

(a) A participatory field evaluation is needed to assess animal feeding management for milk and meat production based on locally available resources and technologies.

(b) Establishment of water harvesting technology.

(c) Establishment of rotational cultivation patterns combined cereal crops edible green manure and leguminous fodder tree.

(d) Establishment of the vegetation bunds using multi-purpose leguminous trees in the cultivated valley between the sand ridges for the control of erosion and soil improvement through the reduction of organic matter.

(e) Rotational grazing: to delineate areas, suspend grazing for 3 to 5 years for spreading seeds of useful grasses, forbs, and woody plats so that grazing area may be maintained and expanded.

(f) Providing more stock drinking points in grazing lands: even though the limiting value of salt concentration in human drinking water is 0.3%, in case of livestock the limiting value is 1.4%[18]. Water from well at Mithrio Bhatti village in Tharparkar district was 0.24%. Although it was close to limiting value of human drinking water, salt concentration of this water pose little problem for livestock. With this situation in mind the possibility of water development for livestock is suggested.

7.5 Livestock Promotion and Processing

7.5.1 Dairy Production and Farm Management

(1) Dairy Production

(i) Current situations and potentials

(a) Sindh is the origin of a number of famous tropical dairy livestock breeds of cattle and buffalo. The population of buffaloes is more than 7.34 million heads in the province, and they are the main resources for the dairy industry. The custom of dairy product consumption has a very long history, resulting in strong demand for both buffalo and cattle milk. The main dairy breeds of buffalo are Kundhi, Nili-Ravi, and their crosses. Regarding daily production of milk in Sindh, cattle produce much smaller portion than buffalo. Among the tropical cattle breeds, there are Red Sindhi, Tharparkar, Kankrej and crosses with European cattle. The dairy sector provides small and landless farmers with both a source of income and nutrients. According to the survey conducted at the cattle colony in Hyderabad, the ratio of buffalo and cattle was 9:1[19].

(b) When considering this sector, supply of feed, feeding management, livestock and related product sales, livestock disease prevention and treatment, and other associated dairy chain activities, this industry provides large employment opportunities. With a long history, traditional knowledge about animal husbandry is enormous and commonly shared among people, and therefore anyone can become involved in dairy production with relative ease.

(c) For cows to be milked, a continuous pregnancy and giving birth to calves is essential. Among the newly born calves, statistically about 50% of the total new born calves are males, which have high potential as meat resource.

[18] Barrett M.A, Larkin P.J. 1974. Milk and Beef Production in the Tropics, Oxford University Press

[19] The details are shown in Appendix G.

Small scale buffalo farm, stall feeding

Bathing buffalo

(d) Regarding milk production, the following shows the results of the household survey. The analysis of the survey was made according to the classifications of the areas and the farmers[20].

As shown in Table 7-5-1, the average milk production per head a day (cattle and buffaloes) is about 8 litters for colonies and about 4 liters for other areas ("Non-colonies" in the table). There is a significant difference in the per head milk production among colonies, irrigated area, and non-irrigated area.

Table 7-5-1 Daily per Head Milk Production (liter)

	Sample HH	Milk Production/head /day(liter)
Colonies	**45**	**8.01**
Irrigated Area	**399**	**4.26**
Large Dairy Farmers	41	4.76
Medium Dairy Farmers	58	4.13
Small Dairy Farmers	300	4.22
Non-irrigated Dairy Areas	**40**	**5.87**
Large Dairy Farmers	10	6.01
Medium Dairy Farmers	12	6.20
Small Dairy Farmers	18	5.58
Other Non-irrigated Areas	**73**	**2.66**
Large Dairy Farmers	10	2.05
Medium Dairy Farmers	14	2.55
Small Dairy Farmers	49	2.83
Non-colonies	**512**	**4.16**
Irrigated Area and Other Non-irrigated Areas	**472**	**4.01**
Total	**557**	**4.46**

As indicated in Figure 7-5-1, there is no clear difference in milk production among large, medium, and small dairy farmers.

[20] Refer to Appendix D for the details of the household survey

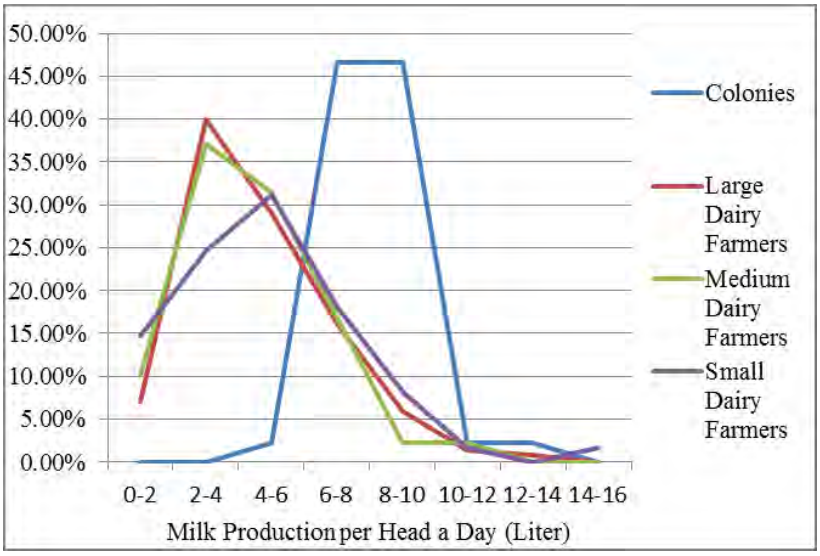


Figure 7-5-1 Distribution of Milk Production Volume for Each Type of Dairy Farmers

Figure 7-5-2 depicts the distribution of milk production for each area. Most of the farmers in the "Other Non-irrigated" areas[21] are distributed in the lower levels of milk production.

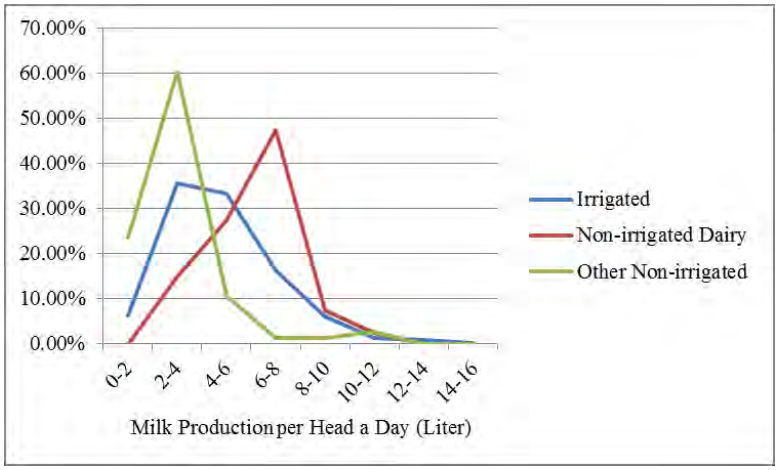


Figure 7-5-2 Distribution of Milk Production by Area

As shown in Table 7-5-2 and Figure 7-5-3, when the milk production of those who sell milk and those who self-consume milk are compared, the milk production of the former is larger. It may indicate that the opportunity to sell milk motivates the farmers to produce more milk and thus leads to the greater per head milk production.

[21] In the first household survey, the villages located in the non-irrigated areas are groups into two; areas the villages which are close to Karachi and Hyderabad are classified as "Non-irrigated dairy areas" where the dairy farming is practiced extensively for these areas. The other villages located in the non-irrigated areas are grouped into "Other non-irrigated areas"

Table 7-5-2 Milk Production of Milk Selling HH and Self-consuming HH

	Sample HH	Milk Production /head/day
Irrigated Area	**407**	**4.26**
Milk Selling HH	208	4.96
Self Consuming HH	199	3.54
Non-irrigated Dairy	**40**	**5.87**
Milk Selling HH	35	6.14
Self Consuming HH	5	4.00
Other Non-irrigated	**76**	**2.66**
Milk Selling HH	13	3.30
Self Consuming HH	63	2.53
Total	**523**	**4.16**

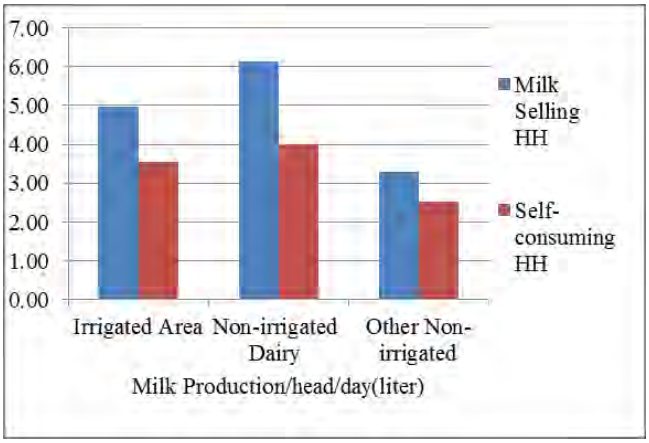


Figure 7-5-3 Milk Production of Milk Selling HH and Self-consuming HH

To compare the difference in milk production between buffalo and cattle, the milk production of households who hold only adult female buffaloes and those who hold only cattle are compared (Table 7-5-3). It is confirmed that the milk production of adult female buffaloes is much larger than the one of cattle.

The ratio of adult female buffaloes to total number of cattle and adult female buffaloes are depicted in Table 7-5-4. It is shown that the ratios are lower in other non-irrigated area. The regional difference in milk production can be partly explained by the difference in its ratio.

Table 7-5-3 Difference in Milk Production of Buffalo and Cattle

	Sample HH	Milk Production/head/day
Buffalo Only	269	4.76
Cattle Only	124	2.88
Total	**393**	**4.18**

Table 7-5-4 Ratio of Adult Female Buffaloes to Total Number of Cattle and Adult Female Buffaloes

	Ratio of buffaloes to total holdings
Colony	82%
Irrigated Area	65%
Non-irrigated Dairy Areas	73%
Other Non-irrigated Areas	39%
Total	75%

(e) The household survey reveals that, as shown in Table 7-5-5, the main contributor of livestock management is house owners, and his spouse and son also play important roles. As the size of livestock holdings becomes larger, the roles of spouse become smaller, and in turn the role of permanent workers become larger. Table 7-5-6 indicates that the roles of women become significant in milking for small size farmers.

Table 7-5-5 Persons in Charge of Livestock Management (Multiple Answers)

	House Owner	Father	Son	Mother	Spouse	Daughter	Daughter in Law	Permanent Worker	Temporary Worker	Other
Large Dariy Farmers	51%	0%	8%	5%	7%	0%	1%	69%	7%	3%
Medium Dairy Farmers	60%	3%	41%	5%	29%	3%	7%	12%	2%	1%
Small Dairy Farmers	61%	2%	29%	4%	34%	4%	3%	7%	5%	4%
Total	**60%**	**2%**	**27%**	**4%**	**29%**	**3%**	**3%**	**19%**	**5%**	**4%**

Table 7-5-6 Persons in Charge of Milking Cows and Buffaloes (Multiple Answers)

	House Owner	Father	Son	Mother	Spouse	Daughter	Daughter in Law	Permanent Worker	Temporary Worker	Other
Large Dariy Farmers	31%	0%	6%	3%	12%	0%	10%	58%	1%	0%
Medium Dairy Farmers	37%	2%	22%	7%	37%	5%	1%	5%	0%	3%
Small Dairy Farmers	34%	2%	13%	6%	34%	5%	0%	4%	0%	2%
Total	**34%**	**1%**	**13%**	**6%**	**31%**	**5%**	**2%**	**13%**	**0%**	**2%**

(ii) Limiting factors

Some development potentials are described above. There are limiting factors that hinder their realization. The following outlines main limiting factors:

(a) Problems with fodder acquisition: particularly for small to medium landless dairy farmers obtaining adequate fodder is a difficult task. It is limiting the enlargement of herd sizes. Especially fodder shortages arises during changing of weather for example from 15th of October to 15th of December and in summer from 15th of April to 15th of June.

(b) Supply of high quality feed: for dairy farmers who have lands, improvements in quality of self-supplying feed such as pasture and green fodder through fertilization and improvement of cutting practice (plant height), etc. are possible. However, for the landless dairy farmers who depend on grazing after harvesting, grazing in orchards and on grasses beside the road side, selection of high quality roughage is not possible.

(c) Hygienic milking: in order to obtain milk with the lowest possible bacterial count, milking conditions (the floors, roofing and wind proofing of milking sheds) need to be improved, and also hygienic milking practices (cleaning udder and other milking techniques) need to be encouraged. Most of farmers are currently do not practice the above.

(d) High subclinical mastitis: there are many dairy farms that do not clean teats at the time of milking. According to the observation by the Project Team, the infection rate of subclinical mastitis was 70% in milking cows and 30% in the total teat numbers. The infection rate in the small scale farmers was comparatively low (California Mastitis Test (CMT) was carried out on a few samples, but all were negative). However, the Project Team conducted CMT for 13 heads of milking buffaloes in the Old Cattle Colony and found that 9 heads (69%) and 17 teat numbers (33%) were infected by subclinical mastitis.

(e) Low conception rates: buffaloes generally become capable for reproduction (first parturition) between the ages of three to five years at the latest. In the developed countries, the target of the calving interval of the cattle is one calf per year, and the average of the Japanese Holstein is about 14 months. The calving interval of buffalo and Red Sindhi is two to two and a half years, which is a relatively long period.

(f) Milk production capability: difference of milk production capability among individuals is large.

Moreover, the average milk production per head of buffaloes is only 4 liters/day for small landholding farmers.

(g) Late maturation: both buffalo and Red Sindhi cattle are coming into maturity late, compared to the European cattle such as Holstein breed, etc.

(h) Low productivity and commercialization: for those farmers who are situated away from the major markets, there is generally little motivation to increase the production or commercialization of their operations.

(iii) Countermeasures

To overcome the above limiting factors, the following countermeasures are needed:

(a) Demonstration of appropriate technology: appropriate technology should be tried in a selected location, the experiences and lessons learned are extracted and consolidated into a manual, and then need to be spread to other targeted Sindh farmers. This manual will need to be visually based (photos and illustrations) to make it as easily understandable as possible. Appropriate technology is i) cheap, ii) high effect, iii) simple, and iv) proven (risk free) technology.

(b) Establishment of an institution for sustainable extension services: extension service providers that are self-sustaining and capable of continuous provision of services need to be instituted.

(c) Establishment of an appropriate extension methodology for Sindh: there are numerous examples of good extension services throughout Sindh and Punjab provinces. These examples will need to be adapted to the current situation and tried, and the lessons learned are extracted into a manual in order to provide sustainable and effective extension services for Sindh.

(d) Strengthening collaboration with other institutions: although Sindh is talked about as a whole, the situation varies significantly between areas within Sindh for various criteria. Each area has its own distinctive livestock management regime. Many different public and private institutions including NGOs will need to form partnerships if appropriate and effective livestock extension services are to be provided throughout Sindh. This will also need to include the effective use of mass media, such as radio and television.

(2) Dairy Farm Management

(i) Current situations and potentials

In the economic point of view, dairy farm management in Sindh are composed of the following four components: milk production, calf production (reproduction, calf suckling, and husbandry), meat production (fattening and sales of non-milking animals and male calves), and waste disposal (incorporation of manure into soil and distribution of commercial products). Milk production is regarded as most important among them. With the long history of this industry in Sindh, specialization of activities has been come up adapting to local needs. This includes such traditional practices as small farmers being commissioned to raise buffalo; cattle colonies that bring in heavily pregnant buffalo or ones that have just given birth to be milked and then sold when the milking period ends; raising of calves for subsequent replacement of non-lactating animals; and large commercial farms. In this way, the history has provided many farmers with a role to play in the dairy production industry through calf production and the raising of non-lactating animals.

(ii) Limiting factors

Significant wastage: the cost of moving livestock throughout Sindh is estimated to be extremely large. Moreover, the stress (transport, changing environment and management) due to movement from place to place is thought to be very significant.

(iii) Countermeasures

(a) Survey and recommendations: all the above 4 components should be examined, and recommendations including pricing need to be made.

(b) Information sharing: for the promotion of the regional dairy industry, accurate information sharing among landowners, large commercial farmers and small scale farmers needs to be encouraged for better consciousness.

7.5.2 Meat Production and Farm Management

(1) Meat Production

(i) Current situations and potentials

(a) With such a long history of livestock production in Pakistan, anybody can become involved in meat production. If the conditions related to the capital needs for the purchase of animals, nutrition/ fodder requirements, etc. can be met, meat production will generate relatively high incomes.

(b) In the case of Halal meat exports, if less than two year old animals weighing approximately 400 kg are raised with nutritious feeding management, then tender and juicy meat can be produced. With this ideal Halal meat, there is a high potential to earn valuable foreign exchange from this export.

(c) Farmers, particularly commercial farmers suggest that the profit margin on beef farming is 18 to 20%, whereas in goat farming that is above 40% per year. The main reasons indicated by farmers are that goats give birth 3 times in 2 years, and out of 3 times one time she produces twins. As a result 4 kids are obtained during 2 years. The price of goat meat is about Rs. 400/kg and beef is Rs. 220/kg, which shows the high profitability of goat farming.

(ii) Limiting factors

(a) Slaughter of young calves: Table 7-5-7 shows the number of households that responded yes to the question in the household survey if they slaughter calves and/or young buffaloes right after their birth. Forty two households out of 45 sample households in the colonies say that they slaughter calves and/or young buffaloes. No households in other areas say yes to it.

Table 7-5-7 Slaughter of Calves and Young Buffaloes (Number of HH)

	Total Dairy HH	HH Who Say Yes
Landhi Cattle colony	15	15
Nagori Cattle Colony	15	13
Qureshi Cattle Colony	15	14
Other (Non-colony)	573	0
Total	**618**	**42**

(b) Large feed requirements: compared to goats, the large feed requirements of cattle result in higher management, transportation, and time costs.

(c) Beef prices: the price of beef is relatively cheap compared to that of mutton, so generally farmers are not motivated to produce beef.

(d) Animal Health: as the mobility and morality rate of goats are higher than cattle, the risk of economic loss of goats is higher than that of cattle.

(iii) Countermeasures

(a) Awareness Campaign: conduct an awareness creation campaign to encourage farmers to go for fattening of young calves, rather than slaughtering them.

(b) Improve feeding management: increase production efficiency through advising appropriate technologies.

(c) Animal Health: decrease mortality and morbidity (diseases) rates through introducing an appropriate health calendar and preventive activities.

(d) New technologies: develop technologies of fattening and early weaning by using milk replacer (liquid and solid form)

(2) Cattle and Goat Fattening for Eid-ul-Azha

(i) Current situations and potentials

In Pakistan during the period prior to Eid-ul-Azha (the Festival of Sacrifice) the demand for livestock, particularly those of good appearance, becomes higher. Accordingly, the prices of those livestock rise sharply during this period. Most farmers aim to manage the fattening of their livestock so as to sell them at prime rates. During this period prior to Eid-ul-Azha, prices become nearly doubled as compare to other times and on occasions even more.

Cattle fattening in Sanghar. The main breeds are Cholistani and Tharparkar.

Goat fattening in Sanghar. The main breed is Pateri.

(ii) Limiting factors

Festival of Sacrifice (Eid-ul-Azha): this religious festival has a very old tradition that encourages Muslims to scarify best animals. The male goats (Buck) and sheep (Ram) are most preferred. That's why the bucks and ram achieve high prices. The basic order of preference after male goats and sheep is female

goats, female sheep (ewes), male cattle, female cattle (especially heifers), buffalo and camel. As these animals are intended for use during the festival, well-manicured animals are particularly desired. And as the period of sales is limited, the number of animals that can be processed during this time is limited. Most of fattening is being carried out by large scale farmers who can afford the capital investment in these animals.

(iii) Countermeasures

(a) Awareness campaign: conduct an awareness creation campaign to encourage farmers to go for fattening of young calves at the age of one year after weaning, rather than slaughtering them.

(b) Advice to small and medium size farmers: fatten livestock for sale just prior to Eid-ul-Azha as a group or individual.

(3) Sheep and Goat Production in Arid Regions

(i) Current situations and potentials

(a) The earning opportunity of farmers in arid and environmentally harsh districts like Tharparkar is very limited. For the people of this area, the indigenous sheep and goats of Sindh that can endure this environment, they are one of their few sources of income.

(b) Goats in particular, have the capability of traveling for long periods of time with relatively less drinking water. They also have the ability to browse on thorny shrubs, plants with high salt content and reach up on their hind legs to feed on the leaves of higher shrubs. Moreover they are tolerant of heat and highly resistant to endemic diseases. Compared to goats, sheep are relatively less heat tolerant and less adapted to browsing in this harsh environment, though they can be shorn for wool twice a year. This wool supports the needs of traditional crafts and cottage industries such as spinning in the surrounding villages.

(c) Milking and selling of sheep and goats: As depicted in Table 7-5-8, there are 95 households among 717 sample households keep sheep according to the results of the household survey. Most of them milk sheep but very few of them sell that milk.

Table 7-5-8 Number of Households that Keep Sheep and Milk Them

	Sheep Holding HH	HH that milk sheep	HH that sell sheep milk	HH that sell milk to middlemen	Selling Price/Litre to middlemen	HH that sell milk at Town	Selling Price/Litre
Colony	2	2					
Irrigated	35	30	2	1	27	1	27
Non-irrigated	58	56					
Total	**95**	**88**	**2**	**1**	**27**	**1**	**27**

As shown in Table 7-5-9, 440 households among 717 sample households keep goats. All of the goat holding households milk them but very few of them sell the milk.

Table 7-5-9 Number of Households that Keep Goats and Milk Them

	Goat Holding HH	HH that milk goat	HH that sell goat milk	HH that sell milk to middlemen	Selling Price/Litre to Middlemen	HH that sell milk at Village	Selling Price/Litre at Village	HH that sell milk at shop	Selling Price/Litre at shop
Colony	4	4	1	1	40				
Irrigated	268	268	9	5	27	1	40		
Non-irrigated	168	168	21	7	22	4	31	4	35
Total	**440**	**440**	**31**	**13**	**25**	**5**	**33**	**4**	**35**

Table 7-5-10 shows the milk production of sheep and goats. There is a slight regional difference in the milk production for sheep between the irrigated and non-irrigated areas. As to the milk production of goats, the average milk production per head a day is much higher in non-irrigated area than that in irrigated area. With the sample of only one household, the milk production of goats in colonies is twice as much as the average of irrigated area.

Table 7-5-10 Milk Production per Head a Day for Sheep and Goats (Liter)

	Number of Sample HH	Sheep Milk Production /head/day	Number of Sample HH	Goat Milk Production/ head/day
Colony			**1**	**2.00**
Irrigated	**12**	**0.92**	**145**	**1.03**
Non-irrigated	**12**	**0.75**	**105**	**1.58**
Total	**24**	**0.83**	**251**	**1.26**

Sheep and goats in Tharpakar. The main breeds of goat are Tharri and their crosses. The main breed of sheep is Kachhi.

Goats can reach up on their hind legs to feed on the leaves of higher shrubs.

(ii) Limiting factors

(a) Limited feed supply: in the low rainfall savannah, forage supplies are limited.

(b) Lower heat tolerance of sheep: in direct sunlight (38°C) the respiration rates of goats and sheep were measured by the Project Team. The average respiration rate for 3 animals of each type was 147/min and 62/min for sheep (Kachhi breed) and goats respectively.

(c) Shrubs represent limited fodder potential for sheep: sheep cannot reach up into higher shrubs to eat the leaves.

(d) Low price of wool: for example, the price of wool is Rs.30/kg in Tharparkar that is very low.

(e) Mortality and morbidity (disease) rates: higher in small ruminants compared to large animals.

(f) Diseases have more profound effects on goats than sheep, for example peste des petits ruminants "PPR" (a viral disease) and contagious caprine pleuropneumonia "CCPP" kills more goats than sheep.

(iii) Countermeasures

(a) Efficient production needs to be improved through development and provision of the following appropriate technologies:

- Decrease of grazing intensity.

  The grazing intensity is the strength of pasturage for the grass land of constant area, which is measured by pasturage head count per fixed period of time and per area. Grazing pressure seems to be high at present, so it is necessary to conduct investigation to find out the reasonable grazing intensity.
- Stockpile fodder for the dry season.
- Efficient use of salt tolerant plants.
- Re-vegetation with appropriate drought resistant plants
- Establish a rotating free range system: to allow pastures to have a fallow period for recovery.

(b) Animal health: through disease prevention activities with an appropriate calendar, decrease disease and mortality rates.

(4) Camel Production in Arid Regions

(i) Current situations and potentials

(a) Camel ownership: by owning a camel, the owner can obtain work to transport, etc., or in arid regions they can borrow land from landowners to cultivate crops with camel and take a share in the harvest. The needs for raising camels are high.

(b) Important source of nutrients: in a harsh arid environment, the camel acts as an important source of nutrients through supply of milk.

(c) Carpet industry and export: The camels' hair is also utilized in traditional carpet making and as a raw material for making bags. In addition, there is a high potential for the farmers to export live camels to neighboring countries, such as Saudi Arabia, where they fetch a high price and gain valuable foreign currency exchange.

(d) Dhatti and other unique camel breeds of Pakistan: these breeds have the ability to endure a harsh arid environment with little available fodder. Moreover, they do not directly compete with cattle or sheep for fodder, as they eat the leaves and small branches of tall trees and shrubs, and are capable of eating plants with a high salt content.

Camel in pasturage of Tharparkar, Breed of Dahtti

Camel drawing well water.

(ii) Limiting factors

(a) Animal Health: pneumonia is prevalent among camels during recent years. Mortality rates are leading to miscarriage problems. Trypanosomias that is pathogenic protozoal disease and very common in camels causes decrease in growth and production and also causes mortality if not treated timely.

(b) High investment cost: the purchasing price of a camel is high, making it extremely difficult for the poor farmers to invest in a camel.

(c) Limited fodder supply: in arid regions, fodder is chronically in short supply, making any significant increases in numbers of camels.

(iii) Countermeasures

Animal health: through disease prevention activities with an appropriate calendar, decrease disease and mortality rates.

(5) Poultry (Eggs and Meat)

This discussion focuses on small and medium farmers who keep poultry in their backyards.

(i) Current situations and potentials

(a) The Desi breed is highly resistant to disease: this breed is able to endure severe environmental conditions and minimal management input. Moreover, their production costs are relatively low in comparison with other types of livestock, well within the range of poor farming households. They can be raised on the seed of wild grasses, insects, and leftovers. The eggs and white meat are an important source of protein for the household.

(b) Eggs and meat of the Desi breed is preferred in Pakistan and can be marketed at high prices.

(ii) Limiting factors

(a) Low productivity: Compared to imported breeds the Desi breed is late to mature and slow to grow. Thus egg production starts late and the time taken to produce marketable meat is long.

(b) Inadequate disease prevention: although the native Desi breed is strong, there are examples in villages where the birds have not been vaccinated against Newcastle disease, of all the birds dying.

(iii) Countermeasures

Poultry health: through disease prevention activities with an appropriate calendar, decrease disease and mortality rates.

7.5.3 Genetic Improvement

(1) Breeding Improvement

(i) Current situations and potentials

(a) Husbandry of buffalo (Kundhi breed), Zebu cattle (Red Sindhi, Tharparkar and Kankrej), sheep, goats and camels has a very long history: during this long history many native breeds have evolved to be adapted to the harsh environmental conditions to feed in Sindh. As these breeds have also received the attention of other breeders throughout the world, this genetic resource has a very high potential.

Dairy buffalos, Kundhi Breed

Dairy tropical cattle, Red Sindhi Breed

Multi-purpose breed of tropical cattle being used for both meat and milk and as a draft animal, Breed of Tharpakar

Multi-purpose breed of tropical cattle being used for both meat and milk and as a draft animal, Breed of Kankrej.

(b) Sindh Livestock Breeders Association Pakistan (SLBAP): this is the leading livestock breeding association in Sindh. This association was established in December 2009. A total of 12 members of Executive Committee have been selected, a President, General Secretary and Vice President for each breed; cattle, buffalo, sheep and goat. The association office is based in Hyderabad. If this association is able to function effectively and develop an independent breeding program, then the future for improved breeds looks bright in Sindh.

(ii) Limiting factors

(a) Inadequate breeding improvement institution: SLBAP has just been established and has not yet had time to function properly.

(b) Most breeders are small scale farmers: the fundamental principle for breeding improvement is the implementation of strict selection and culling of animals. And even the parents are good, their offspring

are not always good. Thus strict selection and culling of offspring is vital. However, in the case of Kundhi buffalo and Red Sindh cattle, most breeding take place at the small or medium sized farms where there are not many offspring to select from, resulting in low selection pressures in their breeding efforts. This creates problems of slow breeding development.

(c) Identification card is not used. To carry out the correct selection and culling, the collection of data on their capacities such as production (milk and weight), reproduction, and pedigree are necessary. However, this practice is not used widely.

(d) The capability of livestock types and the direction of their improvement are unclear.

(iii) Countermeasures

(a) Breeding improvement program: provide guidance to SLBAP, during this early stage of their development, on the livestock types likely to have high potential, such as Kundhi buffalo, and use this as a trial model for other breeding efforts.

(b) The extension of artificial insemination is essential to produce the dairy cross breed between European dairy and zebu cattle.

(c) Small scale breeders: most of the holders of pure breed animals are small scale farmers. Breeding technologies suitable for them to use need to be developed and proven.

(d) Baseline survey: conduct a baseline survey of the livestock breeds in Sindh, analyze the results and identify the direction for future improvement.

(e) Embryo transfer: when high-capacity female buffaloes and cows can be certified by capable institutions, breeding improvement of females by embryo transfer may be considered. Such improvement includes technical guidance on conducting embryo transfer for properly freezing and transplanting embryos of Sindh-genetic resources and important breeds of buffalo and cattle.

(2) Artificial Insemination

(i) Current situations and potentials

(a) Artificial insemination: the most effective means for breeding improvements is through the male side by collecting semen from genetically guaranteed bulls, and freezing it. In Sindh at the moment, there is little artificial insemination (AI) of cattle being carried out properly and the conception rate for buffalo is exceedingly low, thus there is not much motivation on the ground to conduct AI services. There is however a high potential to improve the capability of native breeds through AI.

Semen laboratory under construction (co-funding between LDDB and private breeder.)

(b) Semen technology: An AI center in Kot Ali Haider Shah village, Matiari District is currently being constructed with 50:50 funding between LDDB and private breeders. Construction is to be completed around February 2011. Equipment for the center will be funded 80% by LDDB and 20% privately. Normally, sustainable management would be performed more easily by the private sector rather than by

a public organization, and expected to supply frozen semen guaranteed for: (1) Genetic capability, (2) good motility, and (3) free of disease.

(ii) Limiting factors

(a) Low motivation to provide AI service: an artificial insemination program where semen is collected from certified breeder bulls which have undergone strict selection for capability is just getting underway, and the number of cattle that have received AI is still small. For buffaloes, the conception rate is still very poor and AI is still yet to make much of an impression on the ground.

(b) Problems with frozen semen production: in the publicly run semen collection center there is no equipment to make sperm counts. Thus a specified number of sperm cannot be placed into straws. Moreover, printing equipment is not being used to label the straws, thus there is no data about lot number, date of collection, breed, or the bulls name on the straw that contain the frozen semen. For this reason data is not recorded at time of semen collection. In such conditions, planned breed improvements cannot be implemented. In addition, because the laboratories do not have any records, all the semen is mixed up, evaluation of semen activity, selection of the best and disposal of the worst lots is not taking place.

(c) Only few trained AI technicians and there is no proper institute for AI training, hence the above trend will continue in future.

(iii) Countermeasures

(a) Improvement of basic artificial insemination procedures: as the tropical cattle and buffalo of Sindh are native breeds, the establishment of a system of breed improvement is necessary. A survey needs to be undertaken for each region in each season regarding feeding management of cattle when in heat, period of heat, etc. With this, appropriate technologies for high conception rates can be confirmed and advice given.

(b) High quality frozen semen technology: when certified breeder bulls which have undergone strict selection for capability have been obtained, then advice on high quality semen collection can get underway. This will include proper sperm counts, strict selection and evaluation for motility of semen, and records of collection date, and name of bull on the straw of frozen semen.

(c) Natural mating is the prime method until the conception rate of artificial insemination of buffalo will improve.

(d) As artificial insemination of buffalo is essential to genetic improvement, necessary technical guidance will be conducted.

(3) Kundhi Buffalo

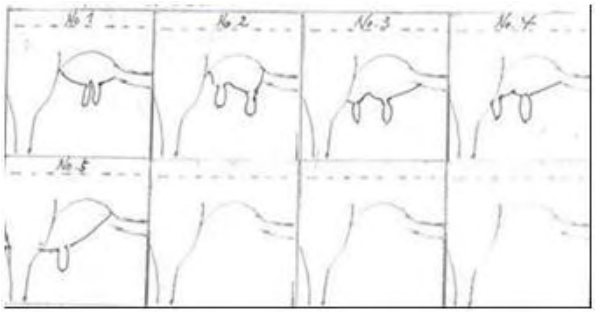
(i) Current situation and potential

(a) In Sindh large numbers of Kundhi buffalo are raised. This breed is, compared to the Nili-Ravi breed of Punjab Province, more compact, produces slightly less milk and requires less feed. The milk produced contains about 6% fat, and individual animals can produce up to 21 liters per day. Moreover it is docile and does not require careful management.

(b) Using the Holstein liner classification procedure, the legs of buffalo are sturdy, straight and well formed (in order to support their heavy weight).

(c) On the other hand, udders and body size vary considerably between individuals leaving much room for breed improvement.

(d) Kundhi buffalo have a large lumen supported by a large body size and depth. Probably for this reason buffalo have a hardy appetite and unlike cattle are able to eat hard grasses and those with high salt content, as well as the unopened cotton buds on cotton plants. This breed can be thought to be well adapted to the harsh environment of Sindh.



Various udder forms

Kundhi buffalos with wide body show a hearty appetite.

(ii) Limiting factors

(a) Scale of Kundhi breeding: when LDDB was asked to provide a list of Kundhi buffalo breeders in Sindh, they provided a list of 182 households that kept 9,394 adult females from a total of 8 districts. A figure was less than expected. When they were classified according to herd size: 1~50 head, 51~100 head, 101~150 head, 151~200 head, and 201~250 head, the percentage of animals in each class respectively was 38%, 18%, 12%, 10%, and 17%. Thus 51.6% of the total number of animals is kept by the breeders that have less than 100 head, and 87% of breeders maintain herds of less than 100 head. Of the remainder, 9 households (26.5%) were commercial cattle colony farmers who only milked cattle for one lactation period and thus unable to breed them for improvements. The improvement of this breed depends on the strong interest and endeavors of a group of breeders who love this breed. When the animals from the cattle colony are removed from the LDDB data, 173 households remain that maintain 6,905 head of cattle for breeding improvement purposes.

(b) A suitable feed standard and feed conversion rate are unclear. A feed standard in Pakistan and feed conversion of proper breed such as indigenous buffalo, tropical cattle, and crosses with European daily are not completely established.

(*Feed standard: The feed standard which is most frequently used in the world is NRC standard made in the U.S.A. This standard lists a table of ingredient and the necessary nutrition quantity depending on the quality and quantity of milk or category of the cattle such as milking cow, dry cow, young, etc. Based on this standard, one can decide the types of feed to give cattle and calculate nutritive value, and then a feed plan can be made.

*Feed conversion: It shows the quantity (kg) of the feed required for producing 1 kg of product.)

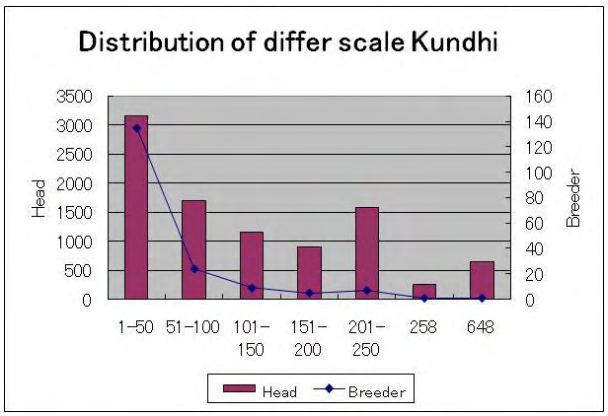


Figure 7-5-4 Number of Animal and Breeder Differ Herd Size (Kundhi)

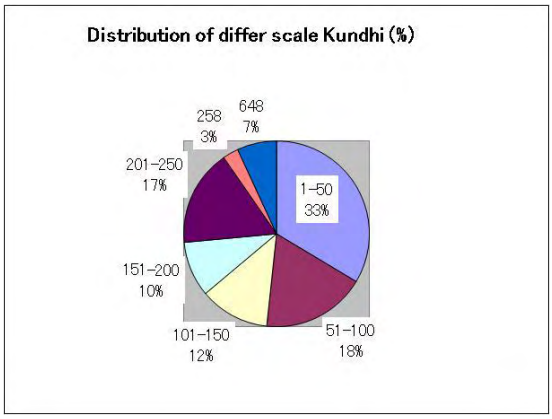


Figure 7-5-5 Ratio of Animal Differ Herd Size (Kundhi)

(c) Selection and culling of animal criteria and direction of improvement are undefined. (The selection and culling is the key for animal improvement. It is to choose the fitting animal and culling the breeding stock which does not fit to the standard. The standard is the target value for improvement that includes the body type, trait**,** and productive capacity (milk production, weight gain, etc.).)

(d) Low conception rate, the AI technology especially needs to be improved.

(iii) Countermeasures

(a) Support for Sindh Livestock Breeders Association Pakistan: provide support and guidance to the association to become self-reliant and identify the most appropriate and effective means of improving the Kundhi buffalo in Sindh.

(b) Implement baseline survey: conduct a survey to establish the most appropriate means of breeding, selection and culling criteria, and direction of improvement.

(c) A research is necessary for the improvement of conception rate of artificial insemination.

(4) Red Sindhi: A Tropical Cattle Breed

(i) Current situations and potentials

(a) This breed has its origins in the Thatta, Matiari, Karachi, Jamshoro, Tando Muhammad Khan districts of Sindh Province and Lasbela region of Balochistan Province. Its name reflects the deep dark red color of its skin. There are also cinnamon, dark brown and other colored animals as well.

(b) It is a medium sized cattle breed, with a body height of 124~145 cm for males, and 102~127 cm for females. It is well known as a milking breed, that is able to endure the heat of the tropics and requires minimal management. In addition, it has a strong resistance to diseases, and endo- and ecto-parasites. For these reasons it is widely utilized in other countries.

(ii) Limiting factors

(a) Scale of Red Sindhi breeding: when LDDB was asked to produce a list of breeders having Red Sindhi cattle in Sindh, they provided a list of 106 households that kept 1,044 adult females from a total of 5 districts. When looking at these figures in terms of the herd size of the breeders, it has been uncovered that 80.5% of Red Sindhi are raised by the breeders that have less than 20 head of cattle. Since selection pressures in such small herds are low, there is concern about the effectiveness of this breeding effort.

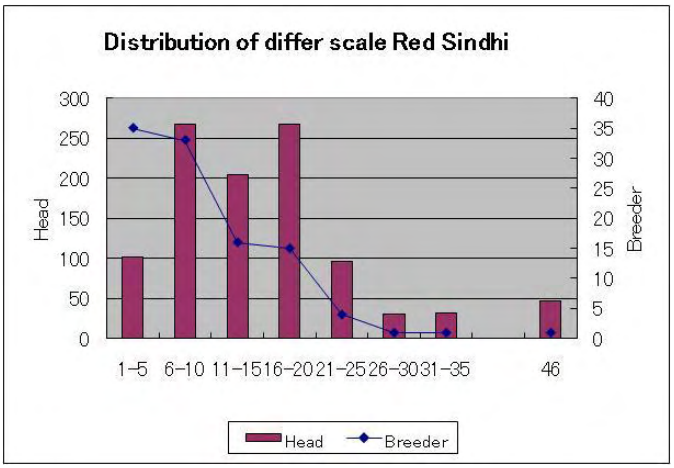


Figure 7-5-6 Number of Animal and Breeder differ Herd Size (Red Sindhi)

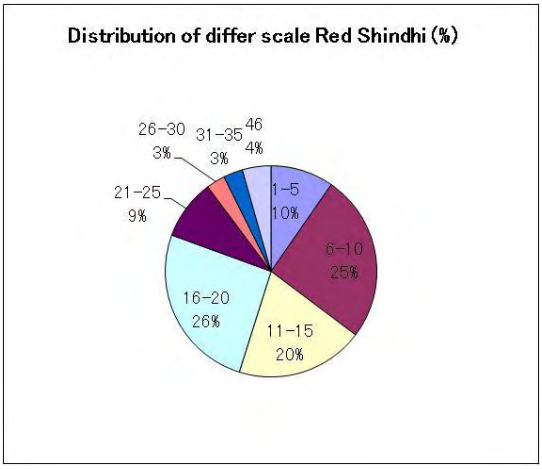


Figure 7-5-7 Ratio of Animal differ Herd Size (Red Sindhi)

(b) Selection and culling animal criteria and direction of improvement is undefined. Please refer to item in the above (3) Kundhi buffalo (ii) (c) for the details of "selection and culling animal criteria".

(iii) Countermeasures

(a) Support for Sindh Livestock Breeders Association Pakistan: provide support and guidance to the association to become self-reliant and identify the most appropriate and effective means of improving the Red Sindhi cattle in Sindh.

(b) Implement baseline survey: conduct a survey to establish the most appropriate means of breeding, selection and culling criteria, and the direction of improvement.

7.5.4 Processing

(1) Milk Processing

(i) Current situations and potentials

Various dairy products have been developed during Pakistan's long history of its custom in daily product consumption. The main products are cream, khoya, mava, ghee, lassi, yoghurt, butter and ice cream. These products are very popular amongst the people and there is a high demand for them.

Table 7-5-11 depicts the number of households that produce and sell dairy products according to the household survey. There are a number of household that produce variety of dairy products, but very few of them sell the products.

Table 7-5-11 Number of Households that Produce and Sell Dairy Products

	Dairy HH	Mave Produce	Mava Sale	Ghee Produce	Ghee Sale	Lassi Produce	Lassi Sale	Yogurt Produce	Yogurt Sale	Butter Produce	Butter Sale
Colony	**45**										
Irrigated	**444**	**2**		**192**	**8**	**312**	**1**	**273**		**303**	**2**
Landowner	301	1		150	3	228	1	202		223	2
Tenant	116	1		34	3	72		62		68	
Non Farm	27			8	2	12		9		12	
Non-irrigated	**129**			**35**	**9**	**69**	**1**	**57**		**66**	**4**
Large LO	3			1		3		3		3	
Landowner	80			27	6	52	1	43		48	3
Tenant	13			3	1	7		4		7	1
Non Farm	33			4	2	7		7		8	
Total	**618**	**2**		**227**	**17**	**381**	**2**	**330**		**369**	**6**

Yoghurt, as raw materials for butter and ghee

Production of butter, stirring yogurt

After having hardened, take out butter (left), liquid left in a pot is lassi (right)

Production of ghee, boiling butter

Ghee

Production of mava, boiling milk

(ii) Limiting factors

(a) Consumers basically have a preference for fresh milk rather than processed milk.

(b) For most small farmers, self-consumption or small-scale processing and distribution in the local area are the main channels for the dairy products.

(c) There are few households that produce preserved processed products for distribution due to lack of means to preserve milk and the distance from the market.

(iii) Countermeasures

Group production and marketing: products like khoya, mava and butter have a comparatively longer shelf life, and there is a considerable demand on these products. It should be considered whether production and marketing can be done collectively at the village level, which requires further study.

(2) Meat Processing

(i) Current situations and potentials

As large numbers of livestock is being raised, there is a large reserve of meat products. If the processing of the meat will be carried out qualitatively then there will be a huge potential of exporting Halal meat.

(ii) Limiting factor

There is a strong preference for fresh meat: the demand for processed meat products is low.

7.6 Animal Health

(i) Current situations

(a) Non-contagious Diseases: The numbers of the treated animals are monthly reported from the district offices to the provincial office. Table 7-6-1 shows the total of those in the year of 2009/2010. As it is shown, nearly 90% of the reported cases are non-contagious diseases.

Table 7-6-1 Number of the Treated and Reported Cases in 2009/2010

Number of animals	Non-Contagious Disease occurance	Contagious Diseases Occurance
	655,102	81,861

Source: the Livestock and Fisheries Department

In 2009/2010, the Central Veterinary Diagnostic Laboratory (CVDL) of the department received 8,620 specimens, and out of which 2,964 specimens (34%) were positive for parasitic disease, while 727 specimens (8%) were positive for other diseases. In addition, through the survey on animal diseases conducted by the Project Team at 10 farms in various parts of the province, parasites were detected in most of the inspected animals.

(b) Contagious Diseases: In the province, the occurrence of the following bacterial and viral diseases has been reported.

FMD: Foot-and-Mouth Disease (Vaccination to Buffalo, Cattle, Sheep & Goats)

HS: Haemorrhagic Septicaemia (Vaccination to Buffalo, Cattle)

BQ: Blackquarter (Vaccination to Buffalo, Cattle, Sheep & Goats)

ETV: Enterotoxaemia (Vaccination to Sheep & Goats: Small ruminants)

PPR: Peste des Petits Ruminants (Vaccination to Sheep & Goats: Small ruminants)

CCPP: Contagious caprine pleuropnemonia (Vaccination to Sheep & Goats: Small ruminants)

Anthrax (vaccination to Buffalo, Cattle, Sheep & Goats)

The department has been vaccinating animals every year for preventing those diseases as shown in Table 7-6-2. Among them, the control of HS is the highest priority over the other diseases, and therefore the rate of the HS vaccination is high.

Table 7-6-2 Numbers of the Animals Vaccinated in 2009/2010

Large animals(Vaccinated)			Small animals(Vaccinated)			Small & Large animals
FMD	HS	BQ	ETV	PPR	CCPP	Anthrax
193,052	2,259,393	222,588	1,674,923	977,434	753,999	185,431

Source: the Livestock and Fisheries Department

(c) Zoonosis: There are the occurrences of brucella and bovine tuberculosis. Brucella is excreted in genital secretion including semen, milk including colostrum, etc. It can be easily transmitted among animals including cattle, goats, and sheep, and human beings are also infected through occupational or domestic contact with the infected animals or with environment contaminated by their discharges. Brucella survives in water at 25°C for 50 days, meat for 65 days, and cheese at 4°C for 180 days. Veterinarians, livestock farmers, abattoir workers, butchers, and consumers are all at risk in this regard.

The department has been conducting surveillance on brucella through the CVDL. The samples were collected from milk and male serum, and as shown in Table 7-6-3, the high positive cases have been reported.

Table 7-6-3 Results of Surveillance on Brucella

District	No. of farms visited	Milk			Male serum		
		No. of samples collected	No. of samples positive	% of positive	No. of samples collected	No. of samples positive	% of positive
Hyderabad	101	506	149	29	53	7	13
Karachi (colonies)	118	506	153	30	51	17	33
Larkana	100	594	121	20	36	18	50
Sukkur	102	507	96	19	-	-	-
N. Feroz	128	506	118	23	-	-	-
Dadu	103	546	146	27	-	-	-

T. Allahyar	107	517	164	32	47	8	17
Tarparkar	103	543	116	21	-	-	-

Source: CVDL

Bovine tuberculosis is also transmitted from livestock to human beings, and vice versa. It is transmitted through respiration, saliva, and other discharges of the infected animals. It is particularly serious in the countries where milk is not pasteurized. The result of the surveillance of the department on bovine tuberculosis at the same districts as above is shown in Table 7-6-4.

Table 7-6-4 Results of Surveillance on Bovine Tuberculosis

District	No. of samples collected	No. of samples positive	% of positive
Hyderabad	128	16	13
Karachi	197	19	10
Larkana	100	11	11
Sukkur	50	4	8
N. Feroz	50	5	10
Dadu	50	7	14
T. Allahyar	132	9	7
Tarparkar	99	17	17

Source: CVDL

(d) Animal disease prevention network: Farmers suffer huge economical losses from the outbreak of bacterial and viral diseases. Those diseases occur seasonally, and therefore early detection and reporting are important for preventing them. In Sindh, the CVDL and six sub-centers cover the whole province for diagnosing livestock. The situations related to disease and clinical activities are informed to the Director General (DG)'s office and the CVDL through those sub-centers and the district offices of the department. The clinical staff are allocated to the district offices, hospitals, dispensaries, and veterinary centers at each district for treating livestock. Figure 7-6-1 shows the allocation of those facilities.

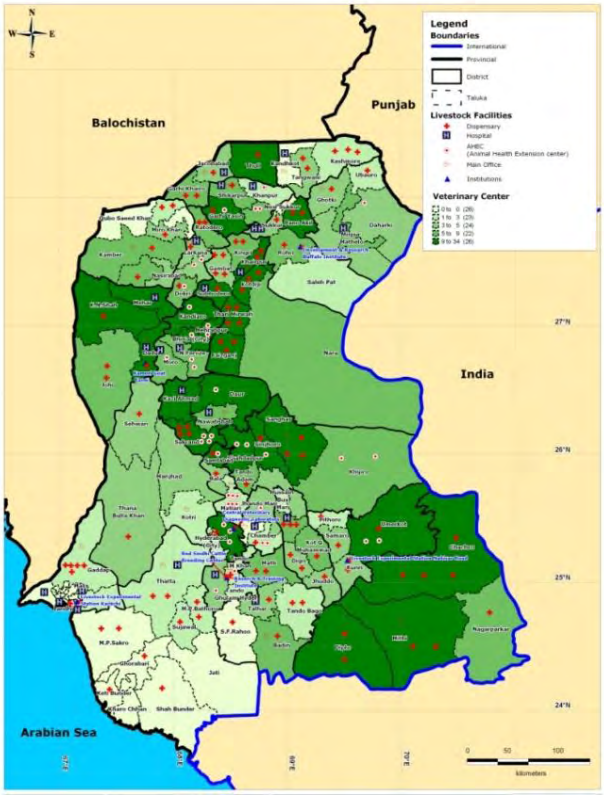
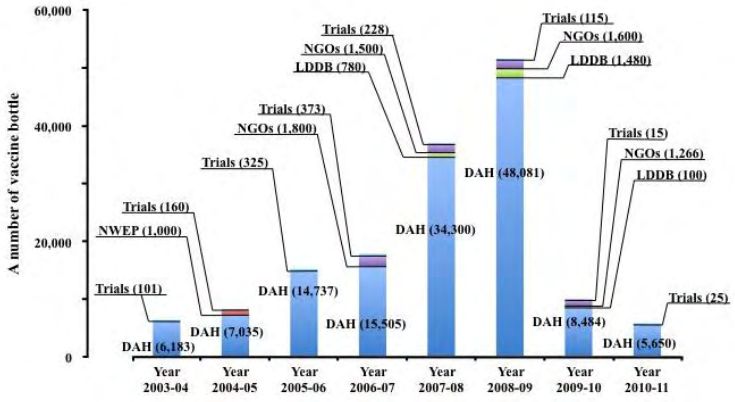


Figure 7-6-1 Distribution of Livestock Facilities

(e) Vaccines

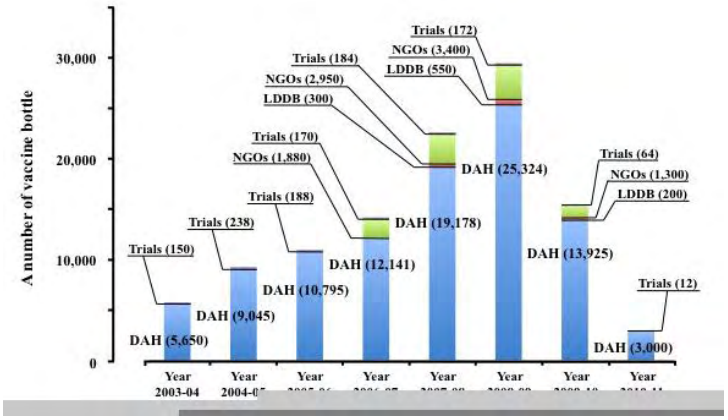
- Production: In the department, there are one

vaccine production unit for ruminant animals and one vaccine production center for poultry producing vaccines. The vaccine production unit and the CVDL are located under the directorate of Veterinary Research and Diagnosis. The unit has been producing HS and ETV vaccines since 2003. The production volumes and destinations of both vaccines in each year are shown in Figures 7-6-2 and 7-6-3. Every year a portion of the products has been used for the trials in quality control. The maximum annual productions were 51,276 bottles for HS vaccine and 29,446 bottles for ETV vaccine in the year 2008-2009. Since then the production has been temporarily reduced due to expansion of the vaccine production unit. The unit is preparing to start vaccine production for Anthrax and Black Quarter.



Note: DAH=Directorate of Animal Husbandry, NWEP=North-West Frontier Province, Trials= used for quality-control

Figure 7-6-2 HS Vaccine Bottle Produced at the Vaccine Production Unit



Note: DAH=Directorate of Animal Husbandry, NWEP=North-West Frontier Province, Trials= used for quality-control

Figure 7-6-3 ETV Vaccine Bottle Produced at the Vaccine Production Unit

- Supplies: The vaccines produced by the unit are usually sold to the directorate of Animal Husbandry. Also, the unit sells the vaccines to NGOs with lower price than the cost of production. One bottle of HS vaccine containing 60 doses is sold at Rs.90 to LDDB and NGOs, but the unit does not sell the vaccines to private companies. On the national network, the vaccines have been exchanged between the unit and

the VRIs (Veterinary Research Institutes) in the other provinces. For example, in the year 2004-2005, 1,000 bottles of HS vaccine were sold to North-West Frontier Province (NWEP) for emergency. The directorate of Animal Husbandry supplies vaccines to farmers with Rs.2/dose even though some vaccines are purchased from VRIs or pharmaceutical companies.

- Demands: The amount of vaccines produced by the unit is insufficient for meeting the demand of farmers. The director of the CVDL mentioned that the unit can supply for only 20% of the demand on HS vaccine in Sindh and therefore HS vaccines are purchased from the VRIs in the other provinces and pharmaceutical companies every year.

  The result of the household survey on FMD vaccination is shown in Table 7-6-5. Ninety eight percent of the respondents in the colony answered that they vaccinate their animals against FMD, but 77% of them did not purchase the vaccine from the department. By contrast, only 25% of the farmers in the non-irrigated areas vaccinated for FMD, and 67% of them purchased vaccines form the department with Rs.2/dose.

Table 7-6-5 Percentage of Farms Conducting FMD Vaccination, and its Service Providers

Zones	FMD vaccinated	Who provided the services?		
		Public	Private	Self
Colony	98%	22%	38%	39%
Irrigated area	41%	48%	41%	10%
Non-irrigated area	25%	67%	14%	19%

Source: Household survey

(ii) Potentials

(a) Network in the Department: The department has the network for disease prevention and the reporting system of epidemic disease through laboratories, animal hospitals, dispensaries, and veterinary centers as explained above. The department also has its own facilities for producing vaccines.

(b) Unemployed veterinarians by the department of livestock: There are about 2,000 employed and unemployed veterinarians in Sindh. A part of them are working as private veterinarians, but many of them are out of the network of the department. Their human resources should be exploited for livestock development.

(c) Pharmaceutical Companies: Twenty-five pharmaceutical companies are supplying veterinary medicines to farmers. As the volume of vaccines produced at the vaccine production unit is insufficient for meeting the demand of farmers in Sindh, the pharmaceutical companies play the complementary role for the vaccine supply. Pharmaceutical companies would be useful resources and play a more significant role in animal disease prevention and treatments.

(d) According to the previous project named “Control on Endo & Ecto Parasites in Livestock”, deworming of infested livestock animals partly contributed to improve animal production. The project was continued for 72 months after 2003, and drenched 410 thousand buffaloes and cattle and 1.698 million sheep and goats. In the last year of the project, the project probed that 164 million liters of milk, 6

million kg of beef and 6 million kg of mutton were increased partly as the result of the deworming. This indicates effectiveness of deworming on increasing animal production.

(iii) Limiting factors

(a) Unused resources: Although the department has good human resources, networks, and facilities for disease prevention, they are not fully utilized. One of the main reasons could be insufficient budget for vaccine production and staff mobilization. However, most importantly, public veterinarians are not allocated properly since there is neither livestock development strategy, nor human resource development plan.

(b) A lack of farmers' awareness: In general, livestock farmers in Sindh do not pay much for the services on productivity improvement and disease prevention. For example, as mentioned above, parasites reduce animal productivity, but farmers may not feel the importance of deworming animals, thus do not pay for its service, because of low mortality of the affected animals.

(c) Lack of equipment: For animal disease prevention, the CVDL should play the leading role in Sindh, but is not sufficiently equipped for the latest analysis. For detecting and identifying pathogen, the high-level analyses such as Enzyme-linked immunosorbent assay (ELISA) and Polymerase chain reaction (PCR) methods are often used recently for especially virus diseases. It is difficult to prevent contagious diseases at the early stage of expansion without such high-level analyses. However, ELISA is not ordinarily applied because of expensive reagents.

(iv) Countermeasures

(a) Awareness building of the farmers: To be able to charge the appropriate fees of animal health related services and vaccinations to the farmers, they should become aware that they can be benefited from the services and vaccinations. Thus, awareness building of the farmers is important. At the same time, the quality of the services and vaccination should be maintained good so that farmers may see the value for pay. Through building the farmers' awareness, the demand for private veterinarians will also be increased.

(b) Independence of the vaccine production unit: The vaccine production unit could be partly independent on the operating budgets from the department. The poultry vaccine production center in Karachi has been established as a self-financing institute. As vaccines are indispensable for poultry farming and there are many commercial poultry farmers exist as customers, independent production would be appropriate for the stable supply of vaccines.

In Sindh, there are still many poor farmers who own large ruminant animals. They may not always afford to pay vaccines, and therefore the role of the vaccine production unit is important for supplying vaccines for them at the subsidized rate. On the other hand, for the farmers in the other categories, the vaccine costs should be charged appropriately.

(c) Vaccine production by private sector: The volume of vaccine production by the unit is insufficient to meet the demand of farmers in Sindh. The department should facilitate pharmaceutical companies to produce and directly supply vaccines to farmers, and the role of the department should gradually be shifted from production to inspection, permission, and licensing to the companies. Investment in vaccine production by the private sector should be promoted.