GENETIC RESOURCES AND DIVERSITY IN PAKISTANI CATTLE

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ABSTRACT

Cattle in Pakistan have traditionally been raised for producing bullocks except breeds such as Sahiwal and Red Sindhi which are established milch breeds. General production system is low-input extensive system with crossbreds mainly raised under intensive high input system in the cattle/buffalo colonies to sustain the demand of milk especially during summer, the slump period in buffalo milk. Although, draft breeds are losing utility yet, it will take many generations before they are replaced due to mechanization. Efforts, however, are needed for their *in situ* conservation and directional selection towards beef. Institutional records indicate weak genetic control for most of the economic traits but accurate recording of performance and pedigrees can improve these estimates. Breeding policy guidelines need adoption in letter and sprit to conserve various breeds. Institutions established for breed improvement need to be restructured for achieving the goals. Adequate diversity in performance and adaptability can be exploited for actual improvement accruing to conservation and development of indigenous cattle resources.

Key words: Cattle, indigenous, diversity, conservation.

INTRODUCTION

Cattle population of Pakistan is estimated at 29.6 million heads (Fig. 1). Of the total cattle in Pakistan, 49% are present in Punjab while Sindh, NWFP and Balochistan share 23, 20 and 8% of the population, respectively (GOP, 2006). These shares are different from 1996 census. Now Punjab's share has increased by about 2.8% while Sindh's share has decreased by 3.3%. Concentration of cattle across different areas in any province is not uniform. In Punjab, for example, Jhang, Muzaffargarh and Sargodha are the most populated districts for cattle. Cattle crossbreds have emerged as a sizeable population in the recent past and are now 13% of total population in the country. Population of purebreds and non-descript is 43 and 44%, respectively (Fig. 2).

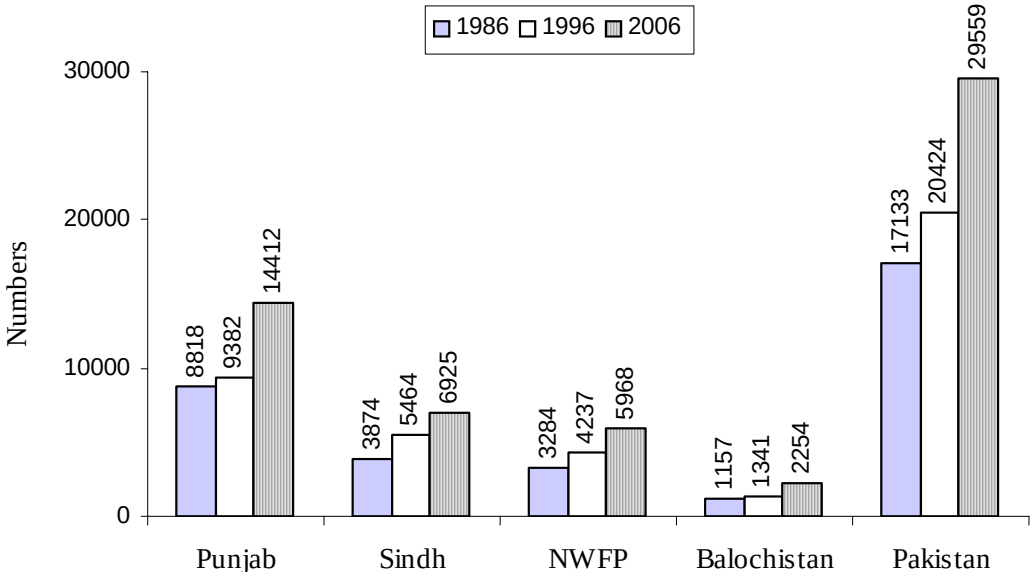

Fig. 1: Province-wise cattle population according to three livestock census.

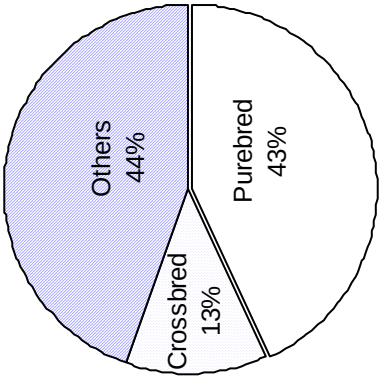

Fig. 2: Relative proportion of purebreds and crossbred cattle in Pakistan

Cattle breeds

All the indigenous cattle of Pakistan belong to zebu (humped type) cattle (*Bos indicus*). There are 15 recognized breeds of cattle in the country (Table 1) which constitute 43% of the total cattle population. Some of the breed level population estimates may not qualify to be more than guesses because ground level information and farmers' opinion do not match with the breed population trends. In the absence of any purebreeding programme (with the exception of Sahiwal conservation project), for example, population of purebreds was expected to decrease since the 1996 livestock census but it has increased by about 10%. It is interesting that purebreds of all the species have been indicated to increase at about the same rate in the 2006 livestock census. Achai, Gabrali and Cholistani are the new entries in the 2006 livestock census and are now expected to stay as breeds. An important cattle breed, Dajal is still missing in the census list because it is not available as purebred at any Government livestock farms and is likely to be vulnerable to depletion. Rojhan has the same status but it is enlisted in the livestock census.

Out of various breeds available in the country, Red Sindhi and Sahiwal are well known internationally as tropical dairy cattle breeds. Both have been used for producing new breeds. A recent FAO report indicated that Sahiwal had been taken to 12 African countries (FAO, 2007). Although population of Sahiwal in India is not very significant (restricted mainly to Government farms), aggressive marketing campaign by countries like Australia to sell Sahiwal as purebred (animals, semen and embryo) and crossbred (such as Australian Friesian Sahiwal) has been and still goes on. Kiwis have also launched campaign of selling Sahiwal crossbreds (Taurindicus) of various genetic constitution (50 and 75%) for the last many years.

Cholistani and Tharparkar are other two important breeds with dairy production potential. Both are considered to tolerate water and feed scarcity better than many other breeds. The Lohani, Achai and Gabrali are small sized breeds that can thrive and produce adequately under sub-hilly, subsistence production setups. Non-descripts are generally grouped as Desi. Draft cattle breeds include Bhagnari, Dajal, Dhanni, Kankraj and Rojhan. Population of Kankraj in the 2006 livestock census (273 thousands) is quite unusual (five times that of 1996 census). Moreover, $1/4^{th}$ of Kankraj has been reported to be present in Punjab which is not agreeable by many. Hissar and Hariana breeds have a very limited population in Pakistan (not more than few thousands). Gabrali and Achai both share home-tract with Afghanistan (Fig. 3).

Table 1: Cattle breeds of Pakistan, their utility, distribution and population size

No.	Breed	Synonym	Utility	Distribution	Pop. size*	Other countries
1.	Achai	-	Dairy & light draught	NWFP	684	Afghanistan
2.	Bhagnari	Nari	Heavy draught	Balochistan	1027	Endemic
3.	Cholistani	-	Dairy	Punjab	537	Endemic
4.	Dajal	-	Medium draught	Punjab	72	Endemic
5.	Desi	Non-descript	Draught, dairy	All over Pakistan	11752	India, Bangladesh
6.	Dhanni	Pothwari	Medium draught	Punjab	1483	Endemic
7.	Gabrali	-	Dairy & light draught	NWFP	231	Afghanistan
8.	Hariana	-	Draught	Punjab	<1	India
9.	Hissar	-	Draught	Punjab	<1	India
10.	Kankraj	-	Medium draught	Sindh & Punjab	273	India
11.	Lohani	-	Light draught	NWFP & Punjab	560	Endemic
12.	Red Sindhi	Malir, Sindhi	Dairy	Sindh & Balochistan	3032	Endemic
13.	Rojhan	-	Light draught	Punjab	376	Endemic
14.	Sahiwal	Lola, Montgomery	Dairy	Punjab	2753	India, Kenya, Australia and others
15.	Thari	Tharparkar, Grey Sindhi	Dairy & medium draught	Sindh	1783	India

*Thousand heads according to GOP (2006), if not available, estimates are given.

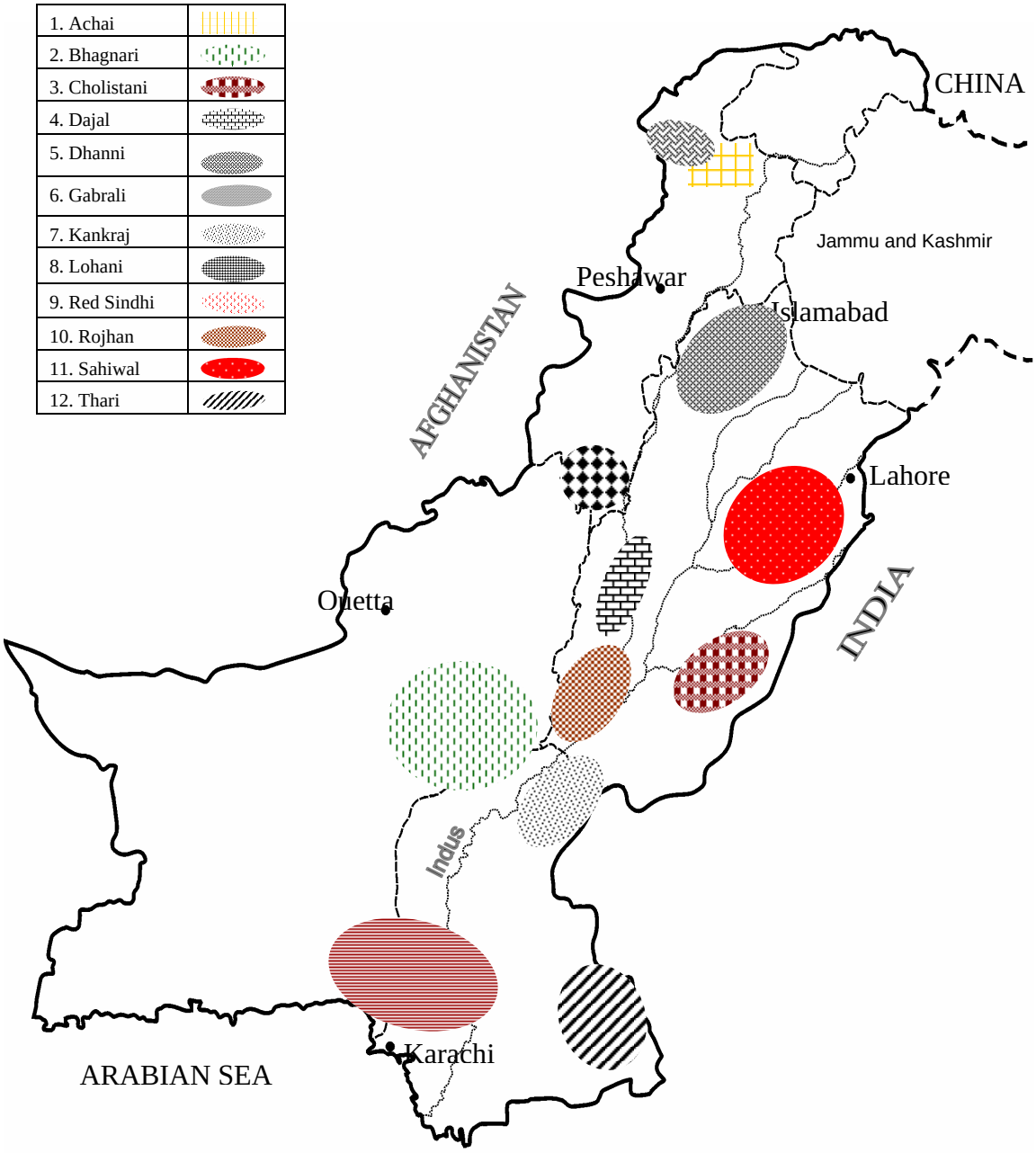

Fig. 3: Home-tracts of cattle breeds in Pakistan.

Production system

Cattle have traditionally been bred to produce bullocks for ploughing and other on-farm operations. Herd size in cattle is small, as 83% of cattle are raised in herd size of less than or equal to 10; only 6% are raised in herd size of greater than 50. Most common production system is raising for subsistence in rural irrigated areas (Qureshi *et al*., 2003)). Breeding policy allows crossbreeding of non-descript cattle with Friesian in irrigated and with Jersey in rain-fed areas and the desired level of exotic inheritance has been proposed to be between 50 and 75%. Purebreds are not allowed to crossbreed. Yet, mainly Sahiwal breed has been under pressure for the production of such crossbreds. Cholistani and Red Sindhi have also been used sporadically for this purpose. Breeds other than Holstein and Jersey have been used but general preference is for the former. Reciprocal crosses have been reported to yield results below expectations. Productivity of dairy cattle crossbreds is double than the local Sahiwal with reduced age at first calving and better calving interval but productivity is quite variable due to managemental conditions such as feed/fodder availability and health cover. Semen for the crossbreeding programmes has continuously been imported from all over the world especially from USA, Canada, Germany, Australia and The Netherlands etc. Purebred Holsteins/Friesians and Jerseys from USA, Australia, The Netherlands and New Zealand have also been imported. Government nucleus herds of exotic cattle have produced semen of Holsteins and Jerseys but to a limited extent (Khan, 1994). Three of the four provinces (except Sindh province) have nucleus herds for exotic Friesian. Attempts have also been made to distribute purebred Friesian bulls to the farmers but mortality in such cases has been high due to poor adaptability.

Cattle crossbreeding for beef has also been attempted. Semen of Charolais, Simmental and Angus breeds has been used for experimental purposes. Even semen of Brown Swiss has also been used as beef breed. The attempt to produce a local beef breed resulted in Narimaster (37.5% Bhagnari and 62.5% Australian Droughtmaster) but population of the new breed has not exceeded few hundred animals and its adoption by the farmers awaits testing. Growth rate in the synthetics has been reported to be much lower than the standards of beef breed (Khan and Khan, 1999). Recently, interest in producing beef crossbreds for special sacrificial occasions has risen. Yet, low price for beef in the local market discourages such adventures by common farmers.

Government owned livestock farms raise Sahiwal, Red Sindhi, Bhagnari and Thari breeds. Few animals of Dhanni and Lohani breeds are available at one of the research facilities in Punjab and of Achai in NWFP. Sahiwal is the most common among all the cattle breeds at the Government Farms but breedable cows are less than 3000 at these farms. Breed improvement programmes for local cattle have almost been absent in the past few decades. Earlier attempts to record and improve cattle include a herdbook scheme in Dhanni cattle breed and later to a limited extent in Sahiwal breed. Institutional recording and genetic selection is attempted for Sahiwal breed and efforts are underway to expand such a programme at farmer level after the inception of Research Centre for Conservation of Sahiwal Cattle (RCCSC) in 2004. Natural breeding is the common breeding method in cattle as artificial insemination has been available to about 10% of cattle population (Malik and Ahmad, 1997) but mainly it is directed to crossbreeding instead of pure breeding. Technologies such as embryo transfer are at experimental level only.

There are limited attempts to conserve local cattle breeds. The RCCSC is restricted to Sahiwal home-tract and a similar attempt is being launched for Cholistani cattle. Establishment of Achai nucleus is also underway in NWFP. The importance of indigenous breeds for ploughing and load-carrying is reducing due to mechanization. Unless breed-wise statistics are collected and monitored periodically, it might be too late to initiate any *in situ* conservation attempt for breeds at risk. Farmers' preference for Friesian crossbreds is generally recognized but any sustainable programme for the production of desirable crossbreds (with respect to desired level of exotic inheritance and productivity) is lacking. Even supply of semen for artificial insemination from genetically superior bulls is very limited for breeds like Sahiwal, as more than 90% of cows are bred naturally. Reasons for not using artificial insemination are many but dislikeness and unavailability are the main issues (GOP, 2006).

Utilization of cattle

Fifteen breeds of cattle (generally) have specific home-tracts with some overlapping in some cases (Fig. 3). Males of all the breeds are used for draught purpose (including ploughing), exception may be the less-thrifty Sahiwal. Dhanni is considered best of all the draught breeds, as it is taken from Punjab to NWFP for raising as purebred and even for crossing. Role of cattle to produce bullocks for work has been decreasing over the years. Cattle, however, share more than 1/3rd of the milk and about half of the red meat produced in the country, apart from pulling load and ploughing. Cow milk produced in the country (13.33 billion litres) accounts for 34.5% of the total milk (38.69 billion litres) produced (GOP, 2007). Of the 1237 thousand tonnes of beef produced in the country, share of cattle is about 45%. The 2006 livestock census indicated that there were 5 million male calves (less than 3 years old), most of which were likely to be used for beef (Table 2).

Table 2: Distribution of various classes of cattle in Pakistan

Males			Females		
Class	**Number***	**%**	**Class**	**Number***	**%**
≥3 years old	4147	43.6	≥ 3 years old	15157	75.6
i. For breeding	1573	16.5	i. In Milk	8720	43.5
ii. Others	2574	27.0	ii. Dry	4469	22.3
			iii. Not yet calved	1967	9.8
< 3 years old	5374	56.4	< 3 years old	4881	24.4
Total	9521	100.0	Total	20038	100.0

* Thousands; GOP (2006).

On the female side, proportion of young stock and calves was reported to be rather low (24%) compared to adult cows (75.6%) which needs to be thrashed. Cattle are important sacrificial animals too. Well prepared animals fetch unusually high prices at occasions such as Eid-ul-Azha. Ox races, load-pulling competitions and even cattle walks and beauty competitions are part of cattle shows, where cattle provide entertainment and honour to the farmers.

Ox as a work animal is still important and the trend is likely to continue for the near future. More than one million bullocks (GOP, 2006) indicate their use in ploughing and agricultural operations (Table 3). Although all the draft breeds are used for ploughing and other farm chores, Dhanni is famous for these purposes.

Table 3: Population* of working cattle in Pakistan

	Bullocks	**Cows**	**Total**	**%**
Ploughing	817	21	838	71.0
Agricultural purposes	195	27	222	18.8
Non-Agri purpose	77	42	120	10.2
Total	1089	90	1180	

*thousands; GOP (2006).

Cow milk is used as such for drinking and for making dairy products including various special sweets. Another important aspect of cattle utilization is its role in sustaining milk availability when buffalo milk is less available especially in the summer season. The calving pattern of two main dairy cattle type (Sahiwal and crossbreds) and Nili-Ravi buffaloes is presented in Fig. 4.

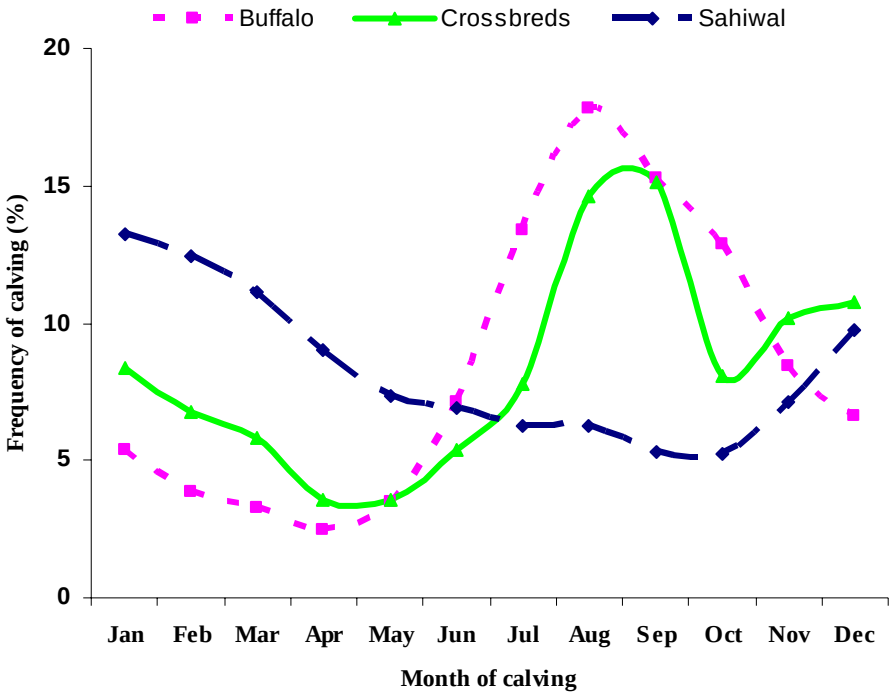

Fig. 4: Calving pattern in Sahiwal, Sahiwal-Friesian crossbreds and Nili-Ravi buffaloes (Hassan *et al.*, 2007).

It is clear that winter (January-February) is the calving season for Sahiwals and autumn (August-September) is the calving season of buffaloes. Crossbred cattle have calving pattern more similar to buffaloes rather than Sahiwal. This helps in sustaining the supply of fresh milk. Mixing of cattle milk with buffalo milk is an acceptable norm and is practised widely when milk is not tested for fat percentage or total solids.

Phenotypic diversity

Apart from the size and other attributes, colour is an important indicator of breeds. Sahiwal and Red Sindhi have solid red color but Red Sindhi has a darker shade. Lohani and Cholistani may have reddish splashes on grey or white background. Rojhan, on the other hand, has red spots of relatively bigger size. Red is also common color for Achai and Gibrali. Thari, Bhagnari, Dajal, Hissar and Hariana are grey with darker hump and hind quarters especially in males. Dhanni is mottled with black or white or red with lighter background. Variations do exist within breed as well. For example, red color of Sahiwal may be dark red getting almost black on hump, neck and hind quarters and may be very light giving a look of light brown. Brightness and dullness of red also varies; greyish tinge is also seen in males.

Variation in size is also quite apparent. Bhagnari males may weight more than 1000 kg but this may not be true for Sahiwal, where average body weight is 315 kg in females and about 400 kg in males, except in exceptional cases where males may be double of the average size. Similarly, Lohani generally weighs around 250 kg and Achai may be even less than that.

Hump is also an important attribute, as it distinguishes *Bos taurus* and *Bos indicus* species of cattle. It is huge in size (in comparison to body size) in breeds like Sahiwal, Cholistani and Dhanni and may be very nominal in Achai and Gabrali breeds. Naval flap and sheath have similar variation. Sheath in males is hanging in Sahiwal, Red Sindhi and Cholistani, while it is almost absent in Dhanni and Hissar breeds. Horns are very huge in Kankraj and Thari breeds, small and may be rudimentary in Sahiwal breed. Diversity is quite pronounced in many other physical attributes such as eye shape, tail length, switch of tail, gait, dewlap etc.

Information on performance traits is available in breeds like Sahiwal, Red Sindhi and Cholistani. Doctorate level work is available in Sahiwal only. Reports on milk yield indicate that in terms of lactation milk yield, the performance of Sahiwal is better than other breeds. Rehman (2006) reported lactation performance of the breed as 1552 ± 12 litres for an average lactation length of 235 ± 1.4 days. Performance of Red Sindhi has been reported to vary in different reports. Aslam *et al*. (2002) indicated average lactation yield of 1385 ± 46 litres, while Sarwar (1991) reported an average of 1188 litres for a lactation length of 255 days. Mustafa *et al.* (2003) however, reported a higher yield of 1531 ± 35 litres for a lactation length of 277 ± 6 days. Cholistanis has been reported to produce 1233 ± 399 litres of milk for a lactation length of 200 ± 66 days (Ashfaq, 2000). Limited data on draft breeds such as Dhanni, Dajal, Lohani and Rojhan indicate average lactation milk yield of 1121 ± 92 litres (Aslam *et al*., 2002). Performance of Sahiwal and other dairy breeds is summarized in Table 4. It is worth mentioning that breeds such as Sahiwal cows have been reported to produce 36.3 litres in a day at national competitions (Tahir, 2004) which points to the potential available in many of the indigenous breeds.

Genetic diversity

The zebu cattle (*Bos indicus*) are believed to have been domesticated in the Indus valley of Pakistan some 4000BC. MacHugh (1996) referred earlier studies which pointed to the archeological evidence from the early Neolithic site at Mehrgarh in Balochistan that zebu cattle were domesticated independently from *Bos primigenius namadicus* populations. The indigenous cattle of Pakistan are thus important international genetic resource for studying breed diversity, evolution and even for tracing back the human history.

Genetic relationships among different breeds at molecular level have been studied. Rehman (2002) employed random amplified polymorphic DNA (RAPD) analysis on total genomic DNAs from 10 cattle breeds (Sahiwal, Red Sindhi, Cholistani, Dajal, Dhanni, Rojhan, Lohani, Hissar, Hariana and Tharparkar), using 80 random decamer primers. Results indicated that at DNA level, variation was low among cattle breeds.

Table 4: Production parameters of Sahiwal, Red Sindhi, Cholistani and Thari cattle*

Performance trait	Sahiwal[1]	Red Sindhi[2]	Cholistani[3]	Thari[4]
1. Lactation milk yield (litres)	1550	1350	1235	1140
2. Average lactation length (days)	235	265	200	220
3. Age at first calving (months)	45	45	50	-
4. Service period (days)	155	210	140	-
5. Dry period (days)	205	230	225	-
6. Calving interval (days)	440	495	425	-
7. Gestation period (days)	285	-	285	-

*adapted from [1]Rehman (2006), [2]Aslam *et al.* (2002), [3]Ashfaq (2000), [2]Mustafa *et al*. (2003), [2]Sarwar (1991), [4]Ahmad *et al*. (1984)

There was a single primer OPF-07 that could identify more than one breeds without the aid of other primers, indicating that RAPD markers could be used for identification of cattle breeds. Lohani cattle produced the maximum number of DNA amplified fragments (454), while minimum number (432) was produced by Tharparkar. The genetic similarities of 10 cattle breeds were high, ranging from 83.8 to 89.6%, with Dhanni and Lohani had the greatest similarity (89.6%). The genetic similarity between Sahiwal and Red Sindhi was the second highest (89.4%), while between Cholistani and Tharparkar it was the lowest (83.8%). Hissar and Hariana clustered together with 0.8775 similarity coefficient, and Tharparkar was grouped with Hissar and Hariana. The similarity coefficient between Dajal and Rojhan was 0.8879 and these two breeds were grouped together. Dhanni clustered with Lohani and Cholistani was grouped with Dajal and Rojhan. Sahiwal clustered with Red Sindhi having 0.8944 similarity coefficient. However, the results of the cluster analysis should be interpreted with caution, as the genetic constitutions of the 10 breeds appeared to be highly similar.

Studies on genetic control of performance traits are available but data sets generally limited and methodologies compromising. Parameters presented in Table 5 are based on the results and review presented by Rehman (2006).

Table 5: Genetic control (heritability, h^2) for various economic traits in Sahiwal cattle

Traits	h^2 (%)
305-day milk yield (kg)	15
Lactation length (days)	12
Dry period (day)	10
Age at first calving (days)	12
Calving interval (days)	10
Service period (days)	15
Gestation period (days)	5
Lifetime milk yield (kg)	15
Herd life (days)	2
Productive life (days)	2

A relevant aspect of genetic diversity is genetic trend in performance traits of various breeds. Animal model estimates of breeding values for various traits are available for breeds like Sahiwal and it may be fair to conclude that Sahiwal breed in the institutional setups has not improved over the years for most of the traits of economic importance (Rehman *et al*., 2008). Test day model genetic evaluation of milk yield for Sahiwal has revealed similar conclusions (Bilal *et al*., 2008).

Loss of diversity

One of the main enemies of diversity is unplanned attempts to inbreed animals. To document the level of homozygosity, authentic pedigrees are needed. Lack of performance records has made it even more difficult to conduct inbreeding studies. This is why with the exception of Sahiwal, no other cattle breed has been studied for the effect of inbreeding. A simple regression analysis has been reported recently by Rehman (2006) for various performance traits (Table 6). Most of the traits were adversely affected by inbreeding. An animal with inbreeding level of 10%, for example, would have deterioration of the order presented in Table 6. The results indicated that a 10% inbred heifer would have calved 166-250 days later than a non-inbred heifer, produced 182-395 kg less milk and exhibited 33-81 days longer service period.

Table 6: Effect of inbreeding on first lactation traits of a cow with 10% level of inbreeding

Traits	Deterioration
305-d milk yield (kg)	288 (182-395) ↓
Total milk yield (kg)	312 (199-426) ↓
Lactation length (days)	39 (25-54) ↓
Age at first calving (days)	208 (166-250) ↑
Dry period (days)	34 (3-65) ↑
Calving interval (days)	55 (31-79) ↑
Service period (days)	57 (33-81) ↑

Wild relatives of cattle

The only wild relative of cattle in Pakistan is yak (*Bos grunniens*). It is a multi-purpose animal providing milk, meat, leather, hair and manure in the northern areas of the country. Its availability in the very cold climate is blessing for the people of the area. Survival of people otherwise might be very difficult in these hostile areas. The domestic yak is often white or piebald and more docile than the wild yak (FAO, 2003). Animals are kept for subsistence. As a pack animal it can transport heavy load, besides providing milk, meat and soft hair. Saddles, whips, boots and other articles are made from its hide. The daily production of milk by female yak is 2-5 kg per day with milk fat percentage of about 7.5%. The lactation period is 90-120 days. Its meat has a red colour with good tenderness quality. Hair are useful for making various things like carpets and ropes. Puberty starts around at the age of 3 years with most of the sexual activity occurring in mild season (July-August). Crossbreeding with cattle has been reported but information on the extent and direction is lacking.

Conclusions

Pakistan is rich in cattle genetic resources, and diversity both at phenotypic and genetic level is enormous. Efforts to manage and utilize these resources efficiently are however, lacking both due to lack of awareness as well as due to weakness of Government institutions. Most of these institutions not only lack

financial and human resources, but drive to achieve any tangible breed improvement and improved utilization is also very weak. There is a need to realize that it is our collective responsibility to leave the available genetic resources in a better form than what we inherited, to the coming generations.

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