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GENETIC RESOURCES AND DIVERSITY IN DAIRY BUFFALOES OF PAKISTAN

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ABSTRACT

Buffalo is the main dairy animal in Pakistan. There are five known buffalo breeds in the country namely: Nili, Ravi, Nili-Ravi, Kundhi and Azi Kheli (or Azakhale). Population trend is available for Nili-Ravi and Kundhi breeds and is positive. Azi-Kheli breed was included in 2006 livestock census for the first time. General production system is low-input extensive system but high input intensive system prevails around most cities in the form of buffalo colonies for supplying fresh milk. Buffaloes are seasonal breeders. Vast diversity exits both at phenotypic and genetic level. Economic traits have a wide variation and genetic control is moderate for production traits but very low for reproduction traits. Inbreeding is inimical to genetic diversity and has been reported to deteriorate productivity. Efforts to improve productivity of the species are needed alongwith sustainable utilization of existing resources.

Key words: Pakistani buffaloes, diversity, production system, sustainable utilization.

INTRODUCTION

There are approximately 27.3 million buffaloes in Pakistan (GOP, 2006) which puts Pakistan at 2nd position after India with 98 millions and before China with 23 millions (FAO, 2006). Buffalo population in 2006 was 1.6 times that of the population of 1986 (Fig. 1). Increase in buffalo population in Sindh has been 2.3 times, while in Balochistan it is 5.1 times (63 vs 320 thousands) during the last two decades. Nili-Ravi and Kundhi are the main breeds with 10.4 and 6.7 million heads, respectively. Population of non-descript buffaloes (animals that can not be ascribed to any breed) is 10.13 millions (37%) in the country. Irrigated Punjab has major concentration of buffaloes with most population in the central Punjab. Top three most populated districts are Faisalabad, Jhang and Sheikhupura.

Buffalo breeds

Pakistani buffaloes belong to river type with characteristic chromosome number of 50. The other type i.e Swamp buffaloes, found mainly in China and other South East Asian countries, have 48 chromosomes (Borghese, 2007). There are five recognized breeds of buffalo in the country (Table 1). Nili-Ravi and Kundhi are the two main breeds, while a sizeable population of Nili, Ravi and Azi Kheli (also spelled as Azakhali) breeds also exit. Nili-Ravi is breed of riverine Punjab, while Kundhi is inhabitant of irrigated Sindh province (Fig. 2). Nili and Ravi were distinguished as separate breeds until 1963 when their mixing was acknowledged officially. Nili and Ravi, however, still exist as separate breeds, also. This is true especially for the Nili breed which has a sizeable population and is being raised as a separate breed. The fifth breed is Azi-Kheli, which is mainly localized in the Swat valley in the North West Frontier Province (NWFP) (Khan, 2003). It has for the first time been included in the 2006 livestock census. It may also be recorded that a large segment of buffalo population (about 37%) in the country is considered as non-descript because animals do not fulfil the phenotypic attributes of any specific breed. Buffalo breeds are endemic to the country with the exception of Nili, which has been reported in India as well.

Production systems

Rural subsistence and rural-market oriented set ups are the most common production systems of raising buffaloes in Pakistan. Less than 3% buffaloes are also raised under commercial set up mainly around big cities to meet the demand of fresh buffalo milk. About half of the buffaloes are raised in herds without cattle, while other half are mixed with cattle. Herd size in buffaloes is small. When raised as buffaloes, 46% are raised in herds of size 1-2, while 82% in herds of size 1-10. Only 3% buffaloes are raised in herds of size greater than 50 (GOP, 2006).

Most of the buffaloes in buffalo colonies around the country belong to Nili-Ravi breed (Nili and Ravi as separate breeds as well) with the exception of colonies in Sindh province, where local Kundhi has about one fourth (or less) of the share. Kundhi is also raised in

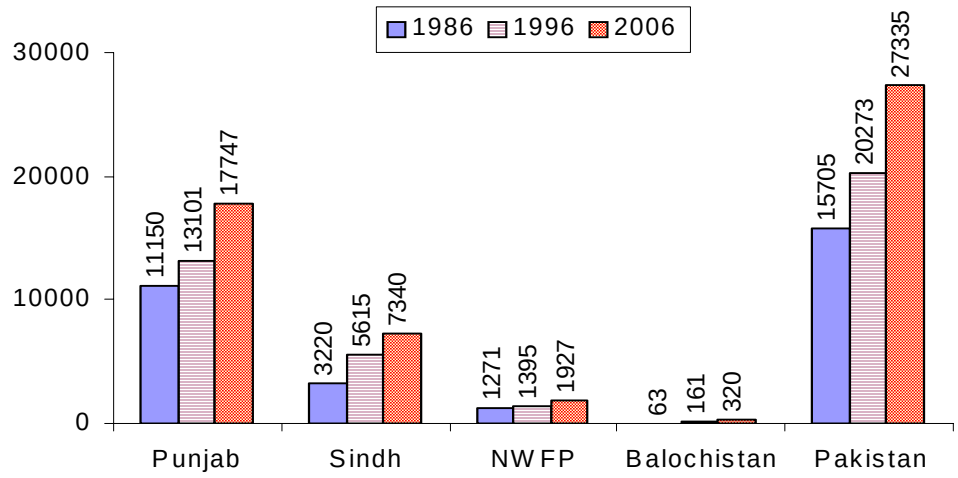

Fig. 1: Province-wise buffalo population (thousands) in Pakistan in the last three census.

Table 1: Buffalo breeds of Pakistan

	Breed	Synonym	Utility[⊥]	Geographic distribution	Population size*	Population trend	Other countries
1.	Azi-Kheli	Albino	Milk, meat	Swat valley of NWFP	107	Decreasing	Endemic
2.	Kundhi	Sindhi Murrah	Milk, meat	Mainly in Sindh, but also in Punjab & Balochistan provinces	6686	Increasing	Endemic
3.	Nili	-	Milk, meat	Mainly in Punjab but also in metro colonies of other provinces	124**	NA	India
4.	Nili-Ravi	-	Milk, meat	Mainly in Punjab but also in metro colonies of other provinces	10417	Increasing	India
5.	Ravi	Sandal Bar	Milk, meat	Mainly in Punjab	171**	Decreasing	Endemic

*Thousand heads (GOP, 2006), if not available, estimates** are given from DAD-IS [http://dad.fao.org]

[⊥] milk is the primary objective while meat is a by-product.

adjoining Balochistan but number of Kundhi buffaloes in buffalo colonies when compared to Nili-Ravi, is very small. Buffaloes in their 2nd to 5th lactation are purchased mainly from central and southern Punjab and taken to the colonies all over the country including State of Azad Jammu and Kashmir but are rarely bred for next lactation. This is because feeding for the dry period is uneconomical. In some buffalo pockets such as Districts Okara, Sahiwal, Pakpattan and Vehari, buffalo production is actually targeted for dairy colonies. It is not just for big colonies around Lahore and Faisalabad in Punjab, but they continuously produce replacements for Karachi and Hyderabad (in Sindh province) and Peshawar and other cities in NWFP. Even Pakistani controlled Kashmir gets buffaloes from Punjab on regular basis. The culled buffaloes (mainly because of low milk yield, reproductive failures and old age) and surplus males are continuously taken to NWFP from Punjab and even to Afghanistan for meat purpose. Buffaloes have very strong instinct to own their young ones and therefore weaning is difficult. Animals under commercial setups are milked using oxytocin. Use of bovine somatotropin is also very common in these colonies.

Seasonality of calving has been established in buffaloes (Hassan *et al*., 2007). Seasonality of calving index was highest (85.9) in buffaloes, followed by Sahiwal (76.6) and crossbred cattle (60.3). For any three consecutive months, highest frequency of calving (45.9%) was recorded for August-October and minimum (9.3%) for March-May.

Majority of the buffalo producers use natural methods for breeding their animals (Qureshi *et al*., 2003). Only 14% of the buffalo producers use Artificial Insemination (AI). The main sources of natural breeding include neighbours' bull (43%), own bull (33%), bull with other service provider (19%) or bull with some relatives (5%). Reasons for using natural service include AI centres being far away (3%), AI is expensive (6%), not available (18%), conceptions with AI are low (27%) or farmers perceive that their own bulls are superior (46%) to those used for AI.

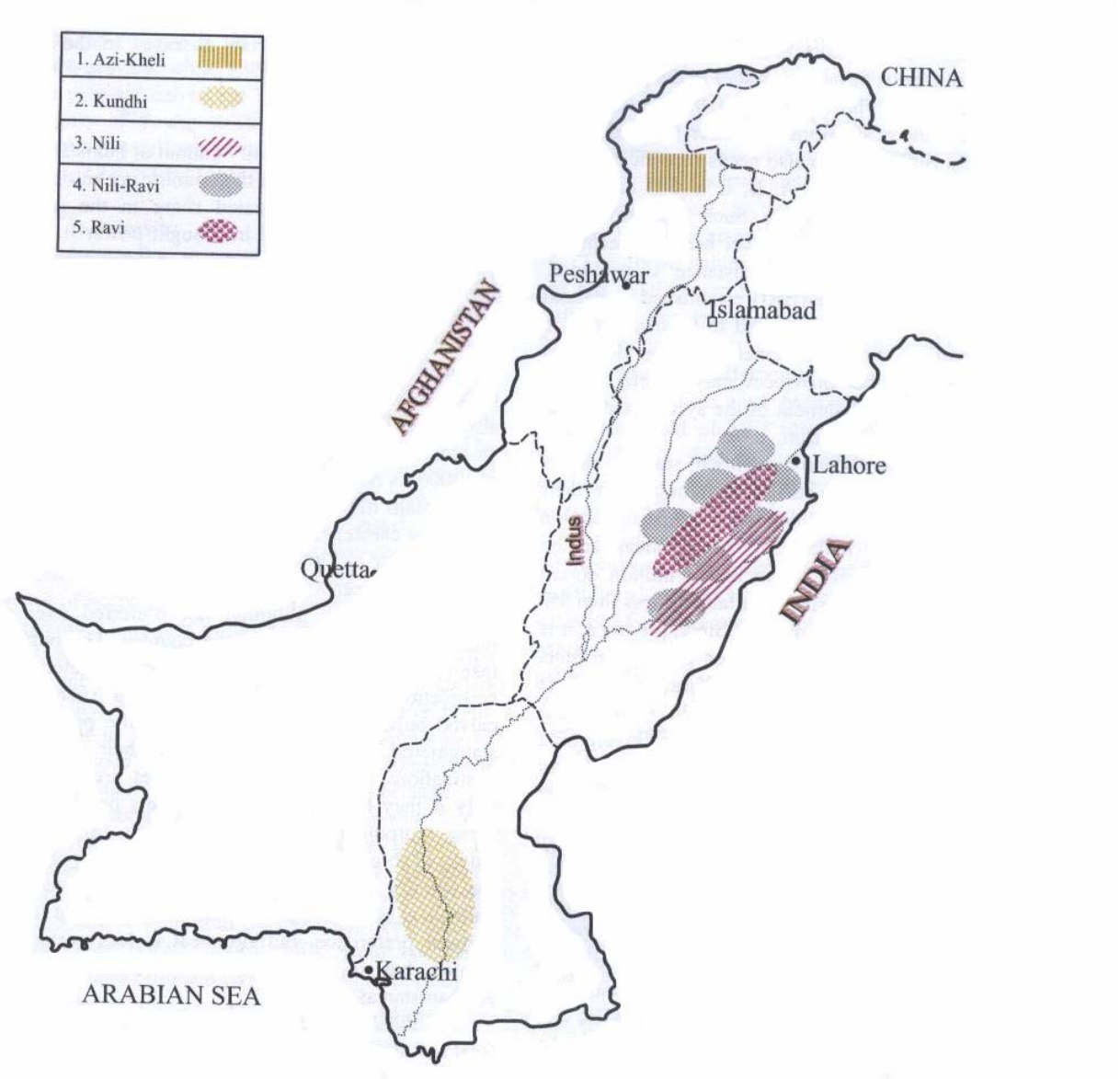

Fig. 2: Home-tracts of buffaloes breeds in Pakistan.

Buffaloes are shy in their reproductive behaviour. Homosexual behaviour in females in oestrous is almost non-existent and other oestrous symptoms are also not very pronounced. Therefore, determination of the optimum time for artificial insemination is sometimes difficult. Private semen production units have emerged in the recent past and legal framework is urgently needed before these units become source of diseases and further deterioration in productivity of buffaloes. Bulls in these units are brought on the basis of false reputation and other than the physical appearance, records are disappointingly missing.

A general perception is that buffaloes are mostly grazed on communal lands with some fodder offered in the evening. However, a recent survey in Punjab (Qureshi *et al*., 2003) has indicated that most of buffalo producers (84%) offer some form of concentrate to the buffaloes, while 16% keep them only on fodder or grazing. The households involved in buffalo rearing by stall feeding, grazing and combination of both were 68, 5 and 27%, respectively.

Organized recording and genetic evaluation programmes are not in place at field level except a

limited progeny-testing programme in Nili-Ravi buffaloes that was started in 1985 in the central Punjab. More than 300 bulls have been tested in the programme (Chaudhry, 2002). The accuracy of these evaluations has been low and evaluations have been delayed (Khan *et al*., 1999). Bull selection also needs modifications, as categorizing buffaloes into A, B, C and D categories needs changes (Parveen, 2007). Such institutionalized efforts can only be initiated in other breeds if technical and other capacity building assistance is provided. Buffalo Research Institute (BRI) established at Pattoki (Distt. Kasur) in 2005 is expected to be major step in buffalo recording and improvement, in general at least in Punjab, while other provinces may benefit from it both in terms of establishment of the system and in the form of improved germ plasm.

Government farms and experiment stations have a few thousand breeding buffaloes (along with their calves and young stocks) intended for experimentation and production of males for AI. Annual semen production in Punjab (less than half a million doses) indicates that at present, AI is available to less than 5% of buffalo population in Punjab. In Sindh province, it is much less than these figures. Semen production units (SPUs) of Qadirabad, Kalurkot and Kiraniwala collect Nili-Ravi semen and SPU at Karachi (and Rohri) collect Kundhi buffalo semen. None of the Government farms, however, has Nili, Ravi or Azi-Kheli breeds. As such, there in no conservation programme for any of these breeds. Although such efforts might be needed for Azi-Kheli, Ravi and Nili breeds in the given order of priority.

Buffaloes are affected by the same diseases that affect cattle. The control, prevention and the treatment also follow the same lines (Khan, 2002). The most important diseases include mastitis, haemorrhagic septicaemia (HS), foot-and-mouth disease (FMD) and rinderpest. Symptoms of diseases such as FMD may be less severe and recovery quicker than cattle. Buffalo vaccination is restricted to HS and FMD with restricted vaccination for anthrax and black quarters. It is estimated that 15% of the buffalo population is vaccinated against important diseases in the country (Malik and Ahmad, 1997).

Utilization of buffaloes

Buffalo is the main dairy animal of Pakistan. About 65% of milk produced in the country is contributed by this species. Their estimated share in the red meat supply is about 32% and in draught power it is about 2%. Total milk and beef produced in the country is 33.2 and 1.2 millions tonnes, respectively (GOP, 2007). Buffalo milk is more concentrated than cow milk. Higher fat (more than 6.5%) and solids-not-fat (10.5%) contents of buffalo milk are one of the major reasons for its popularity. The culture of taking tea and 'lassi' also makes buffalo milk a better choice. Cheese such as mozzarella specially made from buffalo milk (Moioli *et al*., 2006) is not a norm in Pakistan.

Buffalo milk and milk products are white because of lack of carotene. These are however, rich in vitamin A. Tradition of giving buffalo in the dowry of a daughter has been a long tradition.

Buffalo meat, although not preferred over cow meat, is also consumed in the country. The buffaloes taken from Punjab to Sindh are mostly slaughtered after completion of lactation. Calves from such freshly calved buffaloes are either left with the producers or slaughtered in the first week of their age at the destinations. Similarly, dry buffaloes are slaughtered only if they had been poor producers or if they have some reproductive or other problems. Surplus male calves (Table 2) are thus an important source of meat in the country. Young males are also used as sacrificial animals at occasions such as Eid-ul-Azha. Due to some cultural preference, buffalo meat is less preferred in Punjab but is eaten in NWFP and is taken to Afghanistan as well.

As indicated in the 2006 livestock census, of the total buffalo population of 27.3 millions, 19% are males and 81% females (Table 2). Among males, major category is less than 1 year old calves (70.5%), followed by the 1-3 years old young stock (18.0%).

Table 2: Distribution of various classes of buffaloes (thousands) in Pakistan*

Males			Females		
Class	**Number**	**%**	**Class**	**Number**	**%**
For breeding	330	6.2	In Milk	10222	46.4
< 1Year	3748	70.5	Dry	3381	15.4
1-3 years	958	18.0	Not yet calved	1959	8.9
Others	280	5.3	< 1 Year	4277	19.4
			1-3 Years	2180	9.9
Total	5316	100.0	Total	22019	100.0

*GOP (2006)

About 6% of the males are categorized as breeding males. On the other hand, 46.4% of females are in milk and 15.4% are dry, while 8.9% did not calve yet. Less than one year old calves are 19.4%, while 9.9% fall in the category of young stock (1-3 years). On overall basis, actual male:female ratio of less than 1 year category is 47 to 53% (Table 2).

Phenotypic diversity

Buffaloes in Pakistan are generally black in colour. Light and darker shades of black have also been observed. Brown (Bhoori) buffaloes are also found both in Nili-Ravi and Kundhi breeds but their percentage in the population is less than 10% and colour seems to be controlled by a single gene pair, similar to red colour in Holsteins which is recessive to the black colour. Partial albinism also exists but is not liked by the farmers. The small white patches in the forehead and lower hind limbs, alongwith white switch of tail are breed character of Nili, Ravi and Nili-Ravi breeds. Colour variation in Azi-Kheli is quite pronounced, varying from complete albino animals to piebald to even black. Presence of horns is considered important in buffaloes. Tightly curled horns are preferred in Kundhi, Nili, Ravi and Nili-Ravi breeds. Loose and hanging horns are also found in all breeds. One loose and one tightly curled horn may also be seen. Azi-Keli however, have horns more similar to Mediterranean buffaloes. Attempts to dehorn buffaloes in the 80's at Livestock Experiment Station, Bahadurnagar (Okara) failed because of farmers' perception that buffaloes should be with horns.

Performance for economic traits is limited to institutional reports. It has been reported that about 1.2% buffaloes calved under the age of 3 year, 60.9% between 3 and 4 years and 34.7% when they were 5 years or older (GOP, 2006). Milk yield has been estimated around 8 litres a day with 2.6% of population yielding 15 or more litres (Table 3). Lactation length in these buffaloes is around 10 months. Actually, 55% buffaloes have lactation of less than 10 months. The dry period has been reported to be around 6 months.

Studies on institutional herds do not tally because of differences in data sets and methodology. Average values for various parameters for Pakistani buffaloes from some recent review reports (including that of Bashir, 2006) are given in Table 4.

The above values do not mean that better animals are not available in the population. Just for lactation milk yield, for example, the average buffalo produce 2500 litres in a lactation under commercial set ups on the average but buffaloes producing more than 6000 litres per lactation have been encountered. The daily maximum yield of 38.7 litres has also been reported (Tahir, 2004). Age at first calving under improved feeding such as that of military farms has been reported to average 42 months (Naqvi and Shami, 1999), while under government livestock farms average is quite high (48 months or more). Services per conception data from institutional setups are not very reliable and average such as 1.6 services per conception is lot lower than the actual services under artificial insemination programme.

Genetic diversity

Genetic parameters of various economic traits indicate the extent to which these traits have genetic and environmental variation. Many studies exit but data sets are very limited and methodology very compromising. For generalization, report of Bashir (2006) is being used along with some adjustment based on other studies (Table 5).

The genetic control of various production traits in Table 5 may be different from or lower than the

Table 3: Performance of buffaloes for different production traits* (GOP, 2006)

Milk yield (litres)	%	Lactation length (months)	%	Age at 1st calving (years)	%	Dry period (months)	%
< 2	1.3	≤ 6	0.8	< 3	1.2	< 2	1.4
2-4	5.9	6-7	4.4	3-4	60.9	2-3	7.9
4-6	15.8	7-8	10.6	4-5	34.7	3-4	16.9
6-8	28.2	8-9	24.9	≥ 5	3.2	4-5	18.4
8-10	24.2	9-10	14.3			5-6	19.9
10-12	14.7	10-11	18.0			6-7	14.2
12-15	7.3	11-12	8.0			7-8	6.4
≥ 15	2.6	12-13	12.8			8-9	5.3
		≥ 13	6.1			9-10	3.7
						10-11	3.3
						11-12	2.8

*Upper bound means less than the value, % means percentage of buffaloes falling in the respective class interval in the left adjacent column.

expected values especially for production traits in buffaloes. But inaccurate recording and lack of authentic pedigrees may be more responsible than buffaloes themselves. In reality, production traits may be moderately controlled and reproduction traits weakly controlled by genetics, similar to cattle studies in the advanced production set ups. Accurate recording of performance and pedigree needs no emphasis for improvement of the situation (Khan, 2000).

Table 4: Production parameters of Pakistani buffaloes

Performance trait	Value
First lactation milk yield (litres)	1800
Overall lactation milk yield (litres)	2100
Average lactation length (days)	290
Age at first calving (months)	48
Service period (days)	230
Dry period (days)	250
Calving interval (days)	540
Gestation period (days)	310
Fat % in milk (%)	6.5
Total solids in milk (%)	17

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

Traits	h^2 (%)
305-day milk yield (kg)	20
Lactation length (days)	10
Dry period (day)	3
Age at first calving (days)	10
Calving interval (days)	5
Service period (days)	5
Services per conception (number)	3
Gestation period (days)	3
Lifetime milk yield (kg)	15
Herd life (days)	5
Productive life (days)	20
Breeding efficiency (%)	3

At molecular level, studies on Pakistani buffaloes are lacking except for a few preliminary studies. Sajid (2005) studied genetic relationships among Nili, Ravi and Nili-Ravi breeds using RAPD-PCR technique. The results indicated that the level of DNA variation was low among the three breeds. Nili-Ravi buffalo produced the maximum number of DNA amplified fragments (135), while minimum number (122) was recorded for Nili breed. Two primers (GLA-08 and GLA-15) were recognized as breed specific markers which could potentially identify the three breeds. Genetic distance among these breeds was very low in the range of 0.075 to 0.131. The maximum genetic distance was found between Nili and Nili-Ravi (0.1312), while minimum genetic distance was found between Ravi and Nili-Ravi (0.075). Nili-Ravi and Ravi clustered together having 0.928 similarity coefficient and Nili appeared to be distant breed with 0.877 and 0.878 similarity coefficients with Nili-Ravi and Ravi, respectively. The similarity coefficient of the Nili-Ravi and Ravi cluster with Nili was 0.8781. Recently, Azi-Kheli and Kundhi have also been included for their relationship with the breeds mentioned above (Abbas, 2007). Nili, Ravi and Nili-Ravi clustered together with 84% similarity coefficient. Kundhi was not distantly related but Azi-Kheli was quite distant genetically from these breeds.

Loss of diversity

Inbreeding, the mating of relatives, causes loss of heterogeneity. When animals are artificially bred and admired sires are a few, it is unavoidable. Yet, planned mating can help keep it to a minimum level so that economic traits are not deteriorated. A recent study in Nili-Ravi (Bashir, 2006) indicated that inbreeding adversely affected milk yield and fertility traits. Every one percent rise in inbreeding increased age at first calving by 1.13 days; first lactation milk yield decreased by 6 kg and lactation length also decreased. On the other hand, dry period and calving interval increased with increased inbreeding. Productive life decreased @ 4 days, while reduction in lifetime milk yield was @ 27 kg. For an animal (with 12.5% inbreeding), having dam and sire who were first cousins, the deterioration can be multiple of 12.5 which can cause a pronounced reduction in performance. These deleterious effects, although different in magnitude, are similar to many of the planned cattle studies. At farmer level, therefore, extension workers must be educated regarding the adverse effects of inbreeding. Farmers should also be advised to change their bulls every 2-3 years if natural mating is being practised.

Wild relatives of buffaloes

There are no wild or feral population of buffaloes in Pakistan. Yak (*Bos gruniens*) is sometimes confused with buffaloes due to its black colour and long hair but it is more relative of cattle than buffaloes. It can crossbreed with cattle as well.

Conclusions

Buffaloes are the main stay of dairy industry of Pakistan. There is lot of diversity in phenotypic and other attributes, making them survive well against high profile imports of exotic cattle but taking them guaranteed is not going to help their sustained utilization. Not only should better genetics be utilized efficiently, ability of buffaloes to produce efficiently

also needs to be improved so that poor farmers and consumers can benefit equally. We must, therefore, realize that we should leave the available buffalo genetic resources in a better form than what we inherited, to the coming generations.

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