Buffalo Genetic Resources of India and Their Conservation

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ABSTRACT

The contribution of buffalo (Bubalus bubalis) to the Indian agrarian economy is considerable by way of milk, meat and draught power production and as a source of security that requires minimum inputs. The domesticated buffaloes in Indian are mainly of river type with small number of swamp buffaloes present mainly in north-eastern part of India. India is having 56.70 percent of the world buffalo population and they supply 68.21 percent of the total milk produced around the world. The river buffaloes of the Indian sub-continent are maintained chiefly for milk production, but all of them are also dual purpose animals, exhibiting good meat characteristics. The swamp buffalo is more or less a permanent denizen of marshy lands, where it wallows in mud and feed on coarse marsh grass. India has rich repository of buffalo breeds with 13 recognized breeds and the best known breeds of buffaloes are Murrah, Nili-Ravi, Jaffarabadi, Surti and Mehsana. The germplasm of such well-defined breeds constitute a valuable genetic resource which needs to be conserved on priority basis. The rich biological diversity of this species is progressively being eroded due to unplanned breeding. Except in few organized farms which maintain small herds of pure breed, there is almost unrestricted interbreeding among different breeds and there is a marked decline in the availability of unique animals conforming to the attributes of defined breeds, particularly in their native breeding tracts. The situation is further complicated by the fact that there exists no breed societies or breed registration/ improvement societies to register animals of specific breeds, maintain herd books and ensure the purity of the breeds. Hence, proper conservation measures have to make to preserve the valuable buffalo genetic resources of India for the sustainable utilization.

Keywords: breeds, buffalo, conservation, India

INTRODUCTION

Livestock sector plays a vital role in the economy of many developing countries including India. It provides food (more specifically animal protein in human diets), income, employment opportunity, draught power, means of transport and organic fertilizer for crop production. In fact, livestock are considered as financial assets to farmers, since they serve as an insurance against the risk of crop failure due to drought and other unfavourable climatic conditions. Dairy industry in India has made significant progress in the last few decades. Today, India is the largest producer of milk in the world and the India’s contribution to the total world milk production is about 15.8 percent. In India, the buffalo is the principal dairy animal and occupy an important place in the agricultural economy of India because of their adaptability to harsh climatic conditions, tolerance to tropical diseases and survival under poor feeding and management practices. Although, the breedable buffaloes are almost one-third in number as compared to cattle, buffaloes contribute in

Accepted April 10, 2013; Online November 11, 2013.
BUFFALO POPULATION AND PRODUCTION DETAILS IN INDIA AND THE WORLD

The number of the world buffalo population is estimated to be approximately 185 million spread in some 42 countries around the world (FAO, 2008), of which 97 per cent of them are found in Asia and the remaining are found in rest of the continents. India has over 105 million buffaloes, which is 56.7 percent of the total world buffalo population (Table 1). India is the highest producer of buffalo milk in world with the total share of 68.21 per cent. Among the different countries, a total of 91.72 per cent of the milk is obtained from India and Pakistan alone. The milk production particulars of major buffalo rearing countries are as follows in Table 2.

BUFFALO GERMPLASM OF INDIA

The buffaloes are normally classified into river (2N=50) and swamp (2N=48) types though both are called Bubalus bubalis. Most of the animals in India are river type and are found throughout India where clean water of rivers, irrigation canals and ponds are available to wallow. The swamp buffaloes are found only in small areas in the north-eastern part of the country. Swamp buffaloes are used mainly for work and a very small amount of milk. Swamp buffalo is more or less a permanent denizen of marshy lands, where it wallows in mud and feeds on coarse marshy grass. There are no distinguished breeds in swamp buffaloes.

India possesses the richest source of germplasm of buffalo with 13 recognised breeds of riverine buffaloes. These include breeds like Murrah, Nili-Ravi, Jaffarabadi, Marathwadi, Mehsana, Nagpuri, Pandharpuri, Bhadawari, Surti, Banni, Kalahandi, Toda and Chilka. There also exist a number of buffalo populations, known for their adaptability to harsh climatic conditions, tolerance to tropical diseases and survival under meager feeding and poor management practices. These local varieties have not been defined as breeds and hence they have to be assessed, defined and recognized. The buffalo breeds habituated in different agroclimatic zones of India have evolved themselves more through genetic isolation and natural selection than through deliberate intervention by man. They have been distributed in extremes of climates i.e., from saline condition (i.e., Chilka buffalo of Orissa) to high altitude mountain areas up to 2,000 m.s.l (i.e., Toda buffaloes). Besides the cultural and religious considerations, buffaloes are contributing significantly to food and agriculture in terms of milk, meat, manure, fuel and draft power. Variations in regional demand for...
animal products have influenced the use of different buffalo genetic resources. The major buffalo breeds are classified into five distinct groups according to their phenotypic similarity and the breeding tract and are as follows:

- **Murrah group:** Murrah, Nili – Ravi, Kundi
- **Gujarat group:** Jaffarabadi, Surti, Mehsana, Banni
- **Uttar Pradesh breeds:** Bhadawari, Tarai
- **Central India group:** Nagpuri, Pandharpuri, Kalahandi, Manda, Jerangi, Sambalpur
- **South India group:** Toda and South Kanara

The breeding tract, morphological characters and performance of important breeds of buffaloes are presented in Table 3. The buffalo breeds and their home tracts are stable, have a well-defined place in the local natural cycles; consume the remnants of the crops, yet produce valuable milk and provide draft-power and dung/urine as organic manure. With excellent ability to convert poor quality feed to fodder, buffaloes provide milk that is rich in nutrition and quality, meat that is known for flavor and marbling and steady but sure-footed draft power in rural/remote areas and a host of other services, including Mozzarella cheese. All the recognized breeds and local populations have unique qualities for meeting local requirements of food, energy and livelihoods in an environmentally suitable manner.

The number of purebred animals of above specified breeds and lesser known breeds is expected to be about 25 to 30 per cent of the total buffalo population in the country. Rest of the buffaloes are non–descript in type and have extremely variable composition being either non-descript or crosses among various breeds and cannot be categorized in any other well-established breed. There is general concern that the genetic variation within the few domestic animal species is disappearing through breed substitution and inter-breed crossing. Any reduction in the diversity of genetic resource narrows the scope to respond to selective breeding (Sethi and Kala, 2005).

**INTERVENTIONS TOWARDS GENETIC IMPROVEMENT**

All types of breeding structures are being used in India for genetic improvement of buffalo population. Selective breeding is the main program for recognized breeds of buffaloes and the non-descript buffaloes are improved through grading up program with Murrah and Surti breeds to augment the milk production potential. Under the various schemes of ICAR [Indian Council of Agricultural Research] and SAUs [State Agricultural Universities], improvement of defined breeds and also some of the strains has been taken up in the recent past. Progeny-testing scheme was started in the Third Five-Year Plan to ensure identification of superior Murrah bulls tested on the basis of performance of their progeny rather than only the dam’s yield. The tested bulls were used through AI for achieving higher genetic gain. Subsequently, field progeny testing programs for Murrah and other indigenous breeds of buffaloes supported by the Government, Cooperatives dairies, Research Institutes and NGOs have also been made to select the superior bulls for the production and supply of semen throughout India. Under the AICRP/Network Project approach, genetic improvement and conservation of indigenous AnGR is being undertaken at a number of species specific institutes of ICAR and in collaboration with the SAUs. Such activities have also been taken up by State and Central Government Farms, NDDB and some NGOs including Gaushalas. Recently a state sponsored scheme ‘National Project on Cattle and Buffalo Breeding’ envisaged raising AI facilities for buffalo breeding in the country. A field oriented approach ‘Central Herd Registration Scheme’ implemented at some of the locations undertook earmarking of elite buffaloes at the farmers level with regular recording and genetic selection.
APPROACH TO CONSERVATION OF BUFFALO BREEDS IN INDIA

Conservation is the act or process of protection, preservation, management or restoration of wildlife, livestock and natural and cultural resources and management of human use of bio-sphere so that it may yield the greatest sustainable benefit to present generation. Conservation of live specimens of buffaloes consumes sizable manpower, valuable space and costs besides demanding proper planning skills. However, the buffalo needs to be conserved for the following reasons in brief:

1. They possess adaptive characteristics to thrive in the stressful environment which could be lost through dilution and intensive selection for production traits.
2. They also possess the ability of converting poor quality feed resources into meat, milk and working capacity in the field.
3. The genetic variability should be maintained which is the basis for genetic improvement for the future.
4. The future expectations of our buffaloes are unknown or unknowable. Selection goals in cattle breeding in the past have changed. From single trait selection, we have turned to selection on total merit, when we may have lost some of the negatively correlated valuable genes. Selection for conformation traits are beginning to show their importance in relation to lifetime stability and production. With raising production costs, we are now looking at yield per unit dry matter or energy input. In this respect the buffalo has an important role. The future spectrum of diseases and feed availability is unknown. Therefore we need to maintain the present variability or even increase it.
5. Finally, we ask ourselves, do we have the right to destroy or even neglect our indigenous germplasm collection which rightfully belongs to our children and grandchildren who may find greater uses for them.

The general approach to be followed for conservation of buffalo genetic resources is Live animals

An actively breeding population should be maintained, perhaps, each line or variety in a different farm to reduce costs. The major advantages of live animal conservation are:

1. They are always available for immediate utilization in the event of any setbacks in the upgraded population;
2. They are constantly exposed to new strains of diseases and their resistance evaluated.
3. Such live animals would also contribute to education and to community awareness of the indigenous fauna. Cost of maintenance is often argued to be high. This may be an exaggeration overlooking their cheap maintenance costs, better longevity, lower veterinary costs besides revenue from milk and meat.

A major problem that needs to be defined is the type of selection to be practiced without altering the genetic variability. It is suggested here that both random selection as well as overall merit (with equal weighting for each trait) should be practiced with minimum intensity.

Cryogenic storage

This is convenient and cheap and further work needs to be done. Another advantage is that the genotype will not be subjected to genetic drift. A disadvantage is that the animals, especially in the case of females, have a time lag when live adults are urgently required.

DNA genetic material storage

This is a useful tool but certainly not an immediate task (FAO, 1987).

CHARACTERIZATION OF INDIAN BUFFALO BREEDS AND POPULATIONS

The buffaloes of India have evolved within their ecosystem over several centuries and have thus acquired adaptive characteristics and still remain useful in food production.
However, they have been subjected to genetic manipulation such as selection and crossbreeding only during recent decades. By virtue of the fact that it is often considered a neglected species, much of its genetic variation may not have been lost except through natural selection in the domestic environment. However, the main areas of concern are that a complete documentation and evaluation of the variability and characterization of the various breeds and strains are lacking. Such information is vital in agricultural planning strategies and allocation of animals and breeding programs to various farmers and farming systems. Hence, phenotypic and molecular characterization of the recognized and lesser known buffalo breeds have been taken up and the breed descriptors have been in the recent past prepared. The breed descriptors contain detailed information on the geographic distribution, population status, morphological characters, physical traits and production and reproduction performances. At present, most of the breeds have been identified on the basis of morphological characters; information on genetic architecture is available for few breeds. The molecular characterization of AnGR for establishing genetic distances among various breeds has been undertaken using microsatellite based DNA markers.

CONSERVATION MEASURES ADOPTED IN INDIA
The rich biological diversity of this species is progressively being eroded due to unplanned breeding. Except in few organized farms which maintain small herds of pure breed, there is almost unrestricted interbreeding among different breeds and there is a marked decline in the availability of unique animals conforming to the attributes of defined breeds, particularly in their native breeding tracts. There has been a non-judicious utilization of buffalo genetic resources in the country. The males are only partially utilized in the form of bulls and bullocks. There is always a scarcity of breeding bulls of superior genetic merit. Above all, the high producing milk buffaloes from the breeding tract, representing the best germplams, are taken to metropolitan cities in large numbers for milk production. After completion of lactation, these buffaloes are slaughtered, causing a serious erosion of elite germplasm. Based on the population the major breeds are classified into two groups and the group-1 comprises of stable breeds viz. Murrah, Mehsana, Jaffarabadi, Nagpuri and Pandharpuri, since they do not face reduction in their numbers over the decades. The group-2 comprises of the breeds facing dilution and reduction in numbers; the breeds are Nili-Ravi, Bhadawari, Surti, Marathwadi and Toda.

Both in-situ and ex-situ conservation efforts have been made under different schemes at the institutional level to conserve these breeds for sustainable utilization. Conserving the live animals that exist in nature is in-situ conservation. The animals are maintained in their original habitats under native conditions with no interference in their mode of management, feeding and other conditions. The main problem of in-situ conservation is inbreeding and genetic drift typical of small populations. The ex-situ conservation is used when the endangered population is distantly low in numbers, as this process has its own innate problems. It may suffer from spread of disease or neglect during periods of institutional weakness, besides being costly in long term preservations and losing the relatedness of current genotype with environment, when one of these is preserved for long time (Singh et al., 2004).

Under the in-situ conservation scheme, a set of 150 buffaloes have been identified on the basis of their peak yield and then the milk production is recorded at monthly interval. The owners are provided an incentive for two years so that the animals are retained and kept in good health. The tagged females are inseminated with the semen/bull of the same breed of higher genetic merit. The farmers rear the male progeny from these females up to six months; incentives are provided to retain the calf. As these calves grow, a total of 50 unrelated males are selected as future bulls. Under the ex-situ conservation program, live
animals are maintained at the different government institutional farms and semen samples of the superior bulls (3000 doses/animal) are collected and stored in the liquid nitrogen container for future revival (Sadana, 2010).

CONCLUSIONS

It is evident that the buffalo plays an integral part of our farming system and its numbers have been maintained or increased in some breeds and erosion is observed in some breeds. As a part of conservation measures, various river breeds have been documented and evaluated. Strains of swamp buffalo have been observed but attempts to characterize them genetically have yet to be made. Conservation measures should begin with a proper sampling technique to represent the existing variability and in sufficient numbers. In these populations for conservation, selection should be minimal and to maintain population size constant, either random culling or culling based on total merit should be practiced. However, for the national herds, genetic improvement could be achieved through selection and grading up with Murrah and Surti breeds. For both, germplasm collection and national herd, data banks are essential to monitor their genetic progress.

REFERENCES


Table 1. Buffalo population (millions) of India and the world (FAO, 2008).

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Population</th>
<th>Per cent to world population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>India</td>
<td>105</td>
<td>56.7</td>
</tr>
<tr>
<td>2</td>
<td>Pakistan</td>
<td>29</td>
<td>15.7</td>
</tr>
<tr>
<td>3</td>
<td>China</td>
<td>23</td>
<td>12.6</td>
</tr>
<tr>
<td>4</td>
<td>Nepal</td>
<td>4.5</td>
<td>2.4</td>
</tr>
<tr>
<td>5</td>
<td>Egypt</td>
<td>4.1</td>
<td>2.2</td>
</tr>
<tr>
<td>6</td>
<td>Philippines</td>
<td>3.3</td>
<td>1.8</td>
</tr>
<tr>
<td>7</td>
<td>Myanmar</td>
<td>2.9</td>
<td>1.6</td>
</tr>
<tr>
<td>8</td>
<td>Vietnam</td>
<td>2.9</td>
<td>1.6</td>
</tr>
<tr>
<td>9</td>
<td>Indonesia</td>
<td>1.9</td>
<td>1.0</td>
</tr>
<tr>
<td>10</td>
<td>Thailand</td>
<td>1.7</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Total world population 185

Table 2. Production of buffalo milk (million tonnes) by major countries (FAO, 2008).

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Milk production</th>
<th>Per cent to world production</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>India</td>
<td>60.90</td>
<td>68.21</td>
</tr>
<tr>
<td>2</td>
<td>Pakistan</td>
<td>20.99</td>
<td>23.51</td>
</tr>
<tr>
<td>3</td>
<td>China</td>
<td>2.90</td>
<td>3.25</td>
</tr>
<tr>
<td>4</td>
<td>Egypt</td>
<td>2.64</td>
<td>2.96</td>
</tr>
<tr>
<td>5</td>
<td>Nepal</td>
<td>0.99</td>
<td>1.11</td>
</tr>
<tr>
<td>6</td>
<td>Iran</td>
<td>0.25</td>
<td>0.27</td>
</tr>
<tr>
<td>7</td>
<td>Myanmar</td>
<td>0.22</td>
<td>0.25</td>
</tr>
<tr>
<td>8</td>
<td>Iraq</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>Other countries</td>
<td>0.15</td>
<td>0.16</td>
</tr>
</tbody>
</table>

Total world production 89.28 100
Table 3. Description of important buffalo breeds of India (Source: http://www.cirb.res.in/).

<table>
<thead>
<tr>
<th>Buffalo breeds</th>
<th>Home tract (Name of the State)</th>
<th>Morphological characters</th>
<th>Production and reproduction performances</th>
</tr>
</thead>
</table>
| Murrah         | Central Haryana & Delhi        | • Large sized animal and Jet-black in colour with white markings on tail.  
• Horns are short and tightly curved in a spiral form.  
• Tail is long reaching up to the fetlocks with white switch | Average 305-day milk yield (kg): 2000  
Age at first calving: 44  
Calving Interval: 453  
Fat percent: 7.3 |
| Nili-Ravi      | Western Punjab                 | • Medium sized animal.  
• Colour is black-brown or fawn with white markings on forehead, face, muzzle, legs and tail and the peculiarity of the breed is the *valleyses*.  
• Horns are small, tightly curved and circular in cross section. | Average 305-day milk yield (kg): 1950  
Age at first calving (months): 45.3  
Calving Interval (days): 487  
Fat percent: 6.8 |
| Jaffarabadi    | Southern Gujarat               | • Large sized and heaviest Indian buffalo and the colour is usually black.  
• Horns are heavy, emerge out by compressing the head, inclined to droop at each side of the neck and then turning up at points (ring-like).  
• Forehead is very prominent, broad and convex. | Average 305-day milk yield (kg): 1850  
Age at first calving: 50.7  
Calving Interval: 440  
Fat percent: 7.7  
• Bullocks are heavy and are used for ploughing and carting |
| Mehsana        | Northern Gujarat               | • Developed by crossing Murrah and Surti breeds of buffaloes  
• Medium sized animal and the colour is usually black  
• Horns usually sickle shaped with curve more upward than in Surti breed and less curved than in Murrah breed but are longer and could be of irregular shape. | Average 305-day milk yield (kg): 1700  
Age at first calving (months): 42.2  
Calving Interval (days): 476  
Fat percent: 7.0 |
| Surti          | South Western Gujarat          | • Medium sized and the oat colour is rusty brown to silver-grey.  
• Peculiarity of the breed is that there are two white collars, one around the jaw and the other at the brisket.  
• Horns are sickle shaped, moderately long and flat. | Average 305-day milk yield (kg): 1400  
Age at first calving (months): 56.4  
Calving Interval (days): 535  
Fat percent: 7.5-8.3 |
Table 3. Description of important buffalo breeds of India (Source: http://www.cirb.res.in/) (Continue).

<table>
<thead>
<tr>
<th>Buffalo breeds</th>
<th>Home tract (Name of the State)</th>
<th>Morphological characters</th>
<th>Production and reproduction performances</th>
</tr>
</thead>
</table>
| Bhadawari      | Uttar Pradesh and Madhya Pradesh | • Medium sized with wedge shaped body  
• Body is light or copper coloured  
• Tail is thin, long with black or white markings | Average 305-day milk yield (kg) : 1100  
Age at first calving (months) : 50  
Calving Interval (days) : 478  
• Bullocks are reputed good draught animals. |
| Nagpuri        | Vidarbha region of Maharashtra. | • Horns are long, flat, curved and carried backwards on each side of the neck nearly to shoulders.  
• Coat colour is black with white patches on face, legs and tail tip. | Average 305-day milk yield (kg) : 1200  
Age at first calving (months) : 55.8  
Calving Interval (days) : 430  
Fat percent : 7.0-8.5 |
| Toda           | Western Tamil Nadu             | • Medium sized animal and the colour is fawn and ash-grey in adults and the calves are usually fawn and rarely grey.  
• Horns: typical, set wide apart, curving outward, slightly downward and upward with the points being recurved inward, forming a crescent shape. | Average 305-day milk yield (kg) : 700  
Age at first calving (months) : 47  
Calving Interval (days) : 480 |