Buffalo Genetic Improvement Programme in Nepal—Current Status and Future Prospects

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ABSTRACT

Livestock is an integral and important component of mixed farming system in Nepal. Buffalo is the most important livestock species contributing highest share in the livestock sector GDP. Buffalo alone contributes for 70\% and 60\% of national annual milk and meat production respectively. Nearly half of the households of the country keep buffaloes primarily for milk and meat and also for manure, hide, traction and ploughing agricultural land. Three native buffalo breeds, all riverine type have been identified and their production performance been documented. Selective breeding for genetic improvement of native breed in some potential pockets have been recommended owing to the variability in the performance of indigenous buffaloes. Murrah is the important buffalo breed introduced from India for upgrading indigenous buffaloes and that has led to crossbred buffalo population in the major dairy pocket areas of the country. Considering the importance of buffaloes, the Department of Livestock Services and Nepal Agricultural Research Council have jointly initiated the Buffalo Genetic Improvement Project and is being implemented in 10 districts along with 2 government buffalo farms since mid of 2010. Around 800 farm families owning buffaloes have been registered with around 1800 milking buffaloes for Pedigree and Performance Recording Scheme (PPRS). Records on monthly milk yield, milk content analysis, breeding and reproduction and health are being regularly taken and data are being managed on Microsoft Access Database specifically developed for this purpose. The process and status of implementation, challenges faced and way forward for genetic improvement of buffaloes in the country have been discussed in this paper.

Keywords: Buffaloes, Genetic improvement, Murrah, Pedigree and Performance Recording Scheme

INTRODUCTION

Buffalo is the most important livestock species among domesticated animals in Nepal in terms of its contribution in national meat and milk production, share in livestock sector gross domestic production (LGDPS) and food and nutrition security at household level. The species alone produces about 70\% and 60\% of the national milk and meat production annually whereas contributes around 53\% in the LGDP of the country. Nearly half of the households in the country keep buffaloes particularly for milk, meat, manure, traction power and hides. Most people in Nepal prefer buffalo milk over cattle due to its appealing white color and richness in fat and solid not fat (SNF) content which fetches higher price per liter of milk.

Nepal is one of the countries in Asia having highest livestock population density per unit of cultivated land, but still the country is not self-sufficient in fulfilling its internal demand for livestock products particularly meat and milk. Consequently live animals and livestock products...
worth billions of rupees are being imported annually in the country. This is because of the cumulative effects of poor genetic potential or inability to tap the existing potential of most of the livestock species including buffaloes that further aggravated by the overall poor feeding, breeding and health management. Thus, it has been felt extremely essential to have sustainable and systematic buffalo genetic improvement programme to cater the national demand especially of milk and meat in Nepal.

**Buffalo Population Distribution and Trend in Nepal**

The estimated buffalo population in the country is 4.99 million which are found across all agro-ecological regions of the country (Table 1), though the distribution is highest in the hill region (52.4% of the total population) and lowest in the mountain region (8.6%). Development region-wise, the buffalo population is highest in central (25.6%) and western development regions (25.2%) and lowest in far western development region (10.6%).

The district-wise buffalo population distribution is presented as Figure 1. Some districts have buffalo population of more than 120,000 heads, whereas there are some mountain districts which possess less than hundred heads. In general, districts in Terai and hill regions have more buffalo population, whereas mountain districts have the least. Manang and Mustang districts, also known as the districts beyond the Himalayas have almost no buffalo population.

During the last 10 years (2001-2011) period, both total buffalo population and milking buffalo heads increased steadily (Figure 2). The average annual growth rate in total buffalo population was 3.77 percent, and similar increment in the number of milking animals was also observed. The proportion of milking buffaloes to total buffalo has been found to be 25.8%.

Despite steady growth of buffalo population and total buffalo milk and meat production, the productivity (milk and meat) has not been increased tangibly during the last decade (Figure 3 and 4). Both milk and meat productivity remained more or less static during the same period. The absolute increase in buffalo population is further putting pressure on limited feeding resources; hence increasing the productivity of buffalo is even more important.

**Buffalo Breeds**

Three native buffalo breeds, namely Lime, Parkote and Gaddi have been identified and characterized in Nepal. Gaddi buffaloes are localized in the far western hills of Nepal and somewhat resembles Murrah breed, whereas Lime and Parkote are found scattered throughout the hills and Terai region of the country. Lime buffaloes resemble to Carabao in phenotypic appearance, but it has been confirmed as riverine type with 2n=50 chromosomes (Rasali et al., 1998a). The remaining two Parkote and Gaddi are also riverine type. Due to indiscriminant breeding, intermediate between Lime and Parkote are also found in the greater number. It has been also reported that population of Gaddi buffalo is declining in recent days.

Indigenous buffaloes of Nepal have the ability to adapt across different agro-ecological zones, exist in low plain of nutritional regime, possess efficient forage digestion ability and cold tolerance, and have relatively smaller body size. Therefore, they are highly suitable to thrive on narrow and steep slope of the Hills and Mountains of the country.

Murrah is the primary breed of buffalo introduced in the country to increase milk production especially in the dairy pocket areas of the country. Both milking buffaloes and breeding bulls have been introduced from India. Crossbred Murrah buffaloes (various blood levels) are found in low hills and Terai regions particularly in the areas with milk marketing potentials. Government breeding policy is to upgrade indigenous buffaloes without any restriction to Murrah blood level in the Terai region. The coverage of AI in buffaloes is quite low (<5% of the total breedable population) compared to AI in cattle, whereas distribution of Murrah breeding bulls have been the major focus of the government for cross breeding. Besides Murrah, some Surti and Jafrabadi, both
Indian breeds have also been introduced in the country directly by the farmers, but the numbers are very limited. Semen of Nili Ravi buffalo was also introduced once, but there virtually exist any Nili Ravi crossbred buffaloes in the country. It has been estimated that around 1/4th of the total buffalo population in the country are crossbreds of Murrah and a few of them are the pure Murrah (DLS, 2012).

**Existing Buffalo Production System**

The buffalo production in Nepal can be broadly categorized into following four systems:

1. Subsistence buffalo production across the country
2. Buffalo production with seasonal migration in the high hills and Terai
3. Smallholder dairying in peri urban/ urban areas
4. Semi/commercial buffalo production in major dairy pocket areas

Majority of the rural households keeping 1-2 milking buffaloes primarily for fulfilling the household need for milk across the country comes under subsistence buffalo production. The surplus milk is either converted into ghee (clarified butter) or sold in the villages if opportunity for selling exists. Ghee is mostly home consumed but the surplus is sold in the nearby market. The buffaloes under this system are mostly kept under stall feeding with cut and carry practices but grazing in the roadside, nearby forest or fallow cropland is also practiced. The system is generally low input and low output oriented.

In some parts of Terai, large number of indigenous buffaloes (about 25 or more) are owned by some farmers, are kept under minimum inputs and seasonally migrated to other places from the farmers’ homestead in search of feeding resources. Production level under this system is generally poor. Similar system, but with less number of buffaloes kept in the high hill regions of the country particularly in the mid and far western region are also seasonally migrated during wet summer months.

In the peri-urban as well as some urban areas, smallholder buffalo keeping has largely emerged in the country with opportunity to selling milk. Generally Murrah or crossbred buffaloes are kept, number of milking animals per farmer varies from 1-5 and milk is sold either directly to the consumers or to the dairy industries though milk producers’ cooperatives. Buffaloes under this system are kept under stall feeding system, sometimes as mixed herd with cattle. Disposal of male calves at early stage for saving milk is prevalent in some parts of the country. Furthermore, buying buffaloes in early stage of lactation, keeping throughout the lactation period and selling after cessation of lactation is practiced in urban areas under this system.

Medium to large scale commercial or semi commercial buffalo farming is gradually emerging in the major dairy pocket areas, but such commercial buffalo herds are minimal as compared to the emerging commercial large dairy cattle herd in the country.

**Potential and Performances of Indigenous and Exotic Buffaloes**

**Lactation Performances**

The lactation performances of indigenous buffaloes have been reported by several authors particularly through performance recording from farmers’ herds particularly from western hills of Nepal (Joshi et al., 1992; Rasali, 1998; Amatya et al., 2000; Shrestha et al., 2005; Paudel et al., 2012) conducted at different years. The mean lactation yield reported by these authors varied from 874 to 1433 lit, but there has been no significant difference between yield of Lime and Parkote buffaloes. Location variations within indigenous buffaloes have also been reported by Shrestha et al. (2005) which has been further confirmed by study of Paudel et al. (2012). Within indigenous breeds, the lactation yield varied greatly (Figure 5) and selective breeding within indigenous buffaloes for genetic improvement have been recommended (Shrestha et al., 2005).
The milk yield and milk content of indigenous and crossbred buffaloes from two western hill districts, namely Gulmi and Arghakhanchi has been presented in Table 2. The lactation milk yield of Murrah crossbred has been found to be significantly (p<0.001) higher than those of yield of Lime and Parkote buffaloes, whereas fat content of milk from indigenous Lime and Parkote buffaloes was significantly higher compared to milk from Murrah crossbred (Paudel et al., 2012). The SNF content of milk didn’t vary between breeds, but total solid content was again higher in the milk from indigenous buffaloes compared to the milk from crossbred.

The average daily milk yield of Gaddi buffaloes, another indigenous buffalo breed localized in far western hill districts, for the first three months after calving was 4.69 lit from two teats and 4.62 lit in next three months from three teats. The lactation length varied from 14 to 22 months (Paudel and Tiwary, 2007).

In another study, Rasali et al. (1998) had reported that the lactation yield of buffaloes increased with the increasing level of Murrah blood. The Murrah crossbred buffaloes with 25-49%, 50-74% and >75% Murrah blood level produced 1013 lit, 1190 lit and 1440 lit of milk per lactation respectively under farmers’ management condition.

The average lactation yield of Murrah buffaloes in Livestock Development Farm, a government owned farm has been found to be 1543 lit in a standard lactation of 305 days. The lactation performance of buffaloes in their 1st, 2nd, 3rd, 4th and 5th lactations were 1279±288 lit, 1556±318 lit, 1520±305 lit, 1562±283 lit and 1578±192 lit., respectively in 305 days (LDF, 2064/65).

In Chitwan (inner Terai), Kolachhapati et al., (1993) found the average lactation milk yield of crossbred buffaloes to be 1927.95±76.618 lit in 10.42 months. Crossbred buffaloes had nearly 50% higher milk yield and the age at 1st calving was shorter (4.69±0.07 years) when compared to local buffaloes (4.91±0.08 years).

In another study from eastern Terai region of Nepal with a limited number of animals under recording, performances of Murrah/ crossbred buffaloes have been reported to be better (Table 3). More than 60% of the animals under recording had lactation yield of more than 2100.0 lit

Reproductive Performance

The mean age at first calving of indigenous buffalo was 4.5 years which was not significantly different between Lime and Parkote buffaloes (Shrestha et al., 2005) though it was slightly higher (4.56 years) for Lime buffaloes as compared to that of Parkote (4.48 years) and Murrah cross buffaloes (4.36 years). There was significant variation (P<0.001) in age at first calving among buffaloes of different sites indicating influence of management differences. Significant effect of altitude on age at first calving in buffalo has been reported by Rasali (1996). The age at first calving in indigenous buffaloes has been reported to be 53.8 months under stall-feeding system and 59.7 moths under grazing management (Joshi et al., 2001). The authors have also reported that about 5% of the buffalo populations in the western hills calve for the first time within age of 40 months and 75% within age of 59 months.

The average calving interval of buffaloes was 600 days (20 months). The calving interval was neither significantly different for different buffalo breeds nor for the buffaloes at different sites. The average calving interval of Murrah cross buffalo was shorter (545 days) as compared to those of Lime (600 days) and Parkote (604 days) buffaloes (Shrestha et al., 2005).

Initiation of Buffalo Genetic Improvement Programme

To cater the increasing demand for milk in the formal market, government of Nepal adopted the policy of cross breeding indigenous buffaloes with Murrah bulls. The Department of Livestock Services through its network at district and village level initiated Murrah bull distribution programme for cross breeding. The government also imported Murrah buffaloes from India whereas inflow of these buffaloes also took place from the farmers initiatives from the open boarder. The
government policy has been upgrading of indigenous buffaloes to unrestricted blood level of Murrah particularly in Terai and low hills with ample milk marketing opportunities. Government farms were established as the nucleus farms to supply breeding bulls to the farming communities. However, system of distributing breeding bulls of known genetic worth did not commence in the country till the recent past, which actually represents half of the herd. External appearance and availability (only the phenotypes of the animals) were the criteria for distributing breeding bulls. Thus the efforts lag behind from the expected and potential improvement in buffalo productivity.

Later on, recording system particularly for indigenous and crossbred buffaloes at farmers herd initiated from the research centers depicted the potentiality and variability with recommendation for selective breeding within indigenous breeds in potential pockets for genetic improvement. However, such intermittent recording could not lead to concrete buffalo genetic improvement programme in the country.

Pedigree and Performance Recording Scheme (PPRS) for genetic improvement of dairy cattle initiated jointly by Nepal Agricultural Research Council (NARC) and Department of Livestock Services (DLS) in the major dairy pocket areas from July 2008 with technical and financial assistance of FAO under Technical Cooperation Programme (TCP). The project has been able to identify potential bull mothers with high estimated breeding values (EBVs) for milk and valuable solid production. The male calves born from these potential bull mothers inseminated with imported proven bull semen are being utilized for semen collection and wider scale use for dissemination of genetic progress throughout the country.

Inspired by the positive impact of dairy cattle genetic improvement programme (DCIP), the Department of Livestock Services in collaboration with NARC has started buffalo genetic improvement programme (BGIP) for genetic improvement of buffaloes since July 2010.

Implementation Status of Buffalo Genetic Improvement Programme

The buffalo genetic improvement programme has been started in 10 districts (9 in Terai and 1 in hill region) along with two government owned farms. Series of discussion with stakeholders at district level took place before selecting a total of 850 herds (farmers) registration for pedigree and performance recording scheme (PPRS) under buffalo genetic improvement programme (herd registration). All buffaloes under these registered herds have been uniquely identified with year tags and information such as date of birth, sire and dam breeds and ID (if available) have been compiled (base animal registration). In each cluster, data recorder and AI technicians have been identified and assigned for the effective implementation of the PPRS. Milk analyzers, district supervisors and the coordinators were also assigned in each district from the respective staff of the district livestock services office (DLSO). These recorders, inseminators, lab technicians, supervisors and coordinators have been intensively trained on data recording, inseminating, milk analyzing, reporting, supervising and monitoring of the PPRS works.

The recorders collect monthly production records from each registered herds. Milk production record is taken once in a month in the evening and next morning of each individual lactating buffaloes. Along with yield, the recorders take composite 40ml milk sample (20ml in evening and 20 ml in the morning) and send it with production record to the Lab where it is analyzed for fat, protein, SNF content and conductivity by lacto-scan machine. The recorders also take the record on events such as AI or natural services, calving, culling or death of animals, diseases and treatment and movement of animals that have occurred during the past one month. The monthly record format filled by the recorder and supplemented by the Lab with milk content analysis is monthly sent to the Central Data Management Unit (CPMU) at Animal Breeding Division, NARC. These data are managed in an access database specifically developed for this purpose (Figure 6). Farmers are provided with the periodic feedback as well as immediately when...
the conductivity of milk of individual buffalo crosses 6, informing the farmers that the animal might have been infected with sub clinical mastitis and to take the necessary measures to control.

The data thus obtained are analyzed and buffaloes with highest estimated breeding values in term of lactation milk production as well as total valuable solid (fat + protein) produced are identified. These animals are inseminated with the imported frozen semen (imported from India) and male calves born from these planned mating are envisioned as future breeding bulls that would be extensively utilized for semen collection and wider scale dissemination.

Constraints for Buffalo Genetic Improvement Programme

Some of the constraints (managerial and technical) that are hindering the buffalo genetic improvement programme in the country are:

1. Extremely small and scattered herd - increases recording cost
2. Disposal of buffaloes at the end of lactation
3. Lower AI success rate and low rate of adoption
4. Difficult to convince the farmers on importance of recording for genetic improvement
5. Early milking in the morning- recording inconvenience
6. Greater age at first calving and calving interval
7. Farmers’ perception- slow process
8. Limited manpower and infrastructure
9. Long term nature- lack of commitment from the related stakeholders
10. Discontinuity of work- selective breeding in indigenous buffaloes- though potential exists not initiated properly
11. Lack of assurance of fund for long term project

Initiation of 'Improving Nutrition and Productivity of Buffaloes to Adapt to the Impacts of Climate Change in Nepal'

Realizing the very high importance of buffaloes in Nepal but there exist some limitations for the improvement of their production and productivity in the context of climate change, Michigan State University (MSU), in collaboration with NARC, Agriculture and Forest University (AFU) and DLS in Nepal has been conducting collaborative research on forage crop cultivation, feeding, and reproductive management with the goal to enhance the productivity of buffaloes through improved feeding and reproduction strategies and enhance the ability of smallholder buffalo farmers to adapt to the consequences of climate change. The project has selected three pilot districts: Chitwan, Tanahun and Gorkha of the Gandaki river basin (GRB). These research sites will serve as platforms for applied research, farmer training, outreach and technology transfer. The project will collaborate with the ongoing BGIP jointly funded by the Government of Nepal (GoN) and USAID. The main objective of this collaborative research project is to study the impacts of climate change on forage cultivation, feed and forage availability, and reproductive efficiency in buffaloes in Nepal.

The specific objectives of this project are listed follows:

1. Determine climate change characteristics in Nepal that specifically affect forage production, quality, species composition, and current forage cultivation practices to develop improved practices to increase production and productivity of forage crops in the face of climate change;
2. Determine existing buffalo rearing practices in the GRB region of Nepal including feeding, breeding, housing, and animal health conditions, and record socio-economic and demographic features of buffalo rearing households in relation to climate related threats;
3. Determine factors related to buffalo rearing in relation to vulnerability to climate change and identify major risk factors for future consideration, focusing on the mid-hills of Nepal;
4. Develop low cost feeding packages for different growth stages of buffaloes using locally available nonconventional feed stuffs, and
5. Develop reproduction management strategies to improve heat detection and AI techniques to improve conception rates and reduce calving intervals.

It has been envisaged that this collaborative research support project in buffalo productivity improvement will be a milestone in the changing context of global warming and climate change in Nepal.

The Way Forward

- Implementation of selective breeding programme for genetic improvement of indigenous buffaloes-PPRS need to be initiated in some potential pockets of indigenous buffaloes in the country
- More specific research on buffalo productivity improvement in the context of climate change
- Medium to long term strategies need to be developed based on buffalo breeding policy
- Coordinated approach from all concerned stakeholders (research, extension, education, dairy farmers’ cooperatives and dairy industries)
- Consolidated efforts for continuity of PPRS in buffalo genetic improvement

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Table 1. Buffalo Population by Development and Ecological Regions (2010/11) of Nepal.

<table>
<thead>
<tr>
<th>Ecological Regions</th>
<th>Development Regions</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eastern</td>
<td>Central</td>
</tr>
<tr>
<td>Mountain</td>
<td>146,682</td>
<td>148,047</td>
</tr>
<tr>
<td>Hills</td>
<td>427,286</td>
<td>644,691</td>
</tr>
<tr>
<td>Terai</td>
<td>587,724</td>
<td>486,383</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,161,692</strong></td>
<td><strong>1,279,121</strong></td>
</tr>
<tr>
<td></td>
<td>(23.3%)</td>
<td>(25.6%)</td>
</tr>
</tbody>
</table>

Source: (MOAC, 2012)

Table 2. Lactation performance of indigenous and crossbred buffaloes.

<table>
<thead>
<tr>
<th>Breeds</th>
<th>Lactation Yield (mean± SE)</th>
<th>Fat Content (%) (mean± SE)</th>
<th>SNF Content (%) (mean± SE)</th>
<th>Total Solid (%) (mean± SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lime</td>
<td>1418.48 ± 45.56</td>
<td>8.04 ± 0.069</td>
<td>12.39 ± 0.077</td>
<td>20.57 ± 0.083</td>
</tr>
<tr>
<td>Parkote</td>
<td>1433.39 ± 45.98</td>
<td>8.17 ± 0.079</td>
<td>12.25 ± 0.082</td>
<td>20.48 ± 0.124</td>
</tr>
<tr>
<td>Murrah cross</td>
<td>1726.11 ± 45.89</td>
<td>6.83 ± 0.056</td>
<td>12.31 ± 0.056</td>
<td>19.20 ± 0.099</td>
</tr>
</tbody>
</table>

Source: Paudel et al., 2012

Table 3. Lactation Milk Yield of Murrah Buffaloes in Dhanusha District.

<table>
<thead>
<tr>
<th>Lactation Yield</th>
<th>Number of Buffaloes</th>
<th>% age</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;2400 lit</td>
<td>34</td>
<td>31.8%</td>
</tr>
<tr>
<td>&gt;2100 and &lt;2400 lit</td>
<td>34</td>
<td>31.8%</td>
</tr>
<tr>
<td>&gt;1800 and &lt;2100 lit</td>
<td>26</td>
<td>24.3%</td>
</tr>
<tr>
<td>&lt;1800 lit</td>
<td>13</td>
<td>12.1%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>107</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Source: ABD (2065/66)
Figure 1. District wise buffalo population distribution.

Figure 2. Trend of total and milking buffaloes in last decade. (Source: FAOSTAT, 2013)
Figure 3. Annual buffalo milk production and productivity.  
Source: FAOSTAT (2013)

Figure 4. Annual buffalo meat production and productivity.

Figure 5. Variation in the lactation performance of indigenous buffaloes. (Source: Shrestha et al., 2005)

Figure 6. Data management system for buffalo genetic improvement programme in Nepal.