REVIEW ARTICLE

Animal Genetic Resources for Sustainable Livestock Development in Nepal

Shreeram P. NEOPANE

HICAST, Purbanchal University affiliated, Kathmandu
Corresponding Author's Email: spneopane@gmail.com

ABSTRACT

Nepal is rich in animal genetic resources (AnGR) both in terms of diversity and numbers. Animal genetic resources play a key role in livestock development in the country mainly through their contribution to income generation and livelihood enhancement. They have also non-economic values (socio and cultural values) or bequest value, which doesn't seem to be valued. The diversity both species and breeds levels are enormous in the country. A total of 25 indigenous breeds from seven livestock species have been characterized so far. There are several transboundary breeds (regional and international) in the country. Despite of these several breeds, particularly indigenous breeds are declining making system non-sustainable. The major threats for animal genetic resources are genetic erosion, indiscriminate crossbreeding, low productivity, small holding size, lack of specific policies, changing production systems, lack of valuation of local breeds, increasing competition for natural resources and environmental degradation. These factors are contributing to genetic erosion of indigenous breeds in the country. Several breeds have population declined and few are about to be extinct if careful measures are not taken. Strategic actions should be undertaken in order to check genetic erosion and improve their contribution. Effective management of AnGR will address these constraints precisely. Management for AnGR includes its understanding (characterization), using (utilization), maintaining (conservation), accessing and benefit sharing.

Key Words: Animal genetic resources, Conservation and improvement, Economic and non-economic contribution, Food security and livelihood, Sustainable development

BACKGROUND

The total estimated population of large (cattle and buffaloes) and small ruminants (sheep and goats) in the country were 7.8 million and 15.0 million heads, respectively in the year 2022/23. Similarly the estimated population of pigs and poultry (non ruminants) were 1.4 million and 66.5 million heads, respectively. In 30 high hill / mountain districts, the population of Yak and Chauries (cross between Yak and hill cattle) was 53,195 heads. The estimated population of horse/asses and mules was 17,332 and rabbits (wool and meat type) was 43,192 heads (Statistical Information on Agriculture, 2024). The overall growth ranges from <1.0 to 6 % in livestock with average 4.7% (<1% in sheep and 6% in chicken) The annual growth in livetsock products ranges from 5.3% in milk to 8.0% in meat. Similarly growth ranges from 0.05 % in wool to 8.6% in eggs.

There are several others species that are being domesticated and being utilized. They are ducks, pigeons, quails, turkey, rabbits, horse and ostrich. There are several wild relatives of domestic animals such as *Arna* (wild buffaloes), *Gauri Gain* (wild cattle), Blue sheep (wild sheep), *Kalij* (wild chicken), and wild rabbits. The percentage of exotic breeds ranges from 5 to 50 (5 to 10% in sheep and goats and 50% in chicken) (AnGR, 2004) indicating chunk of contribution to the country in the form of food and agriculture comes from indigenous animal genetic resources (AnGR). Though the information has come from old data and this needs updating. It is expected that the proportion of exotic breeds (particularly in chicken and cattle) might have increased. Animal genetic resources play a key role in livestock development in the country greatly to nutritional food security in terms milk, meat and eggs. They contribute 11 % to total gross domestic product (GDP) and the contribution of livestock to total AGDP of the country is estimated to be about 24 % to agriculture GDP (MoF, 2023). AnGR are kept in the country for multipurpose uses such as food (milk, meat and eggs), transportation (draft and pack), and manure for maintaining/improving soil fertility. Apart from these they have non-economic values (socio and cultural values) or bequest value, which unfortunately don't receive appreciation in terms of value. Increased production and supply of animal source food (ASF) is important to meeting Zero Hunger (Goal #1) of UN Sustainable Development Goal by 2030.

The paper highlights on the status of the animal genetic resources in terms of conservation and utilization in the country. There will be description on their contribution to livelihood and food security. The potential and challenges for better

use of AnGR will be highlighted. The suggestive measures and strategies for better AnGR management in the country will be presented.

DIVERSITY

The diversity both species and breeds levels are enormous in the country. A total of 25 indigenous breeds from seven livestock species (7 in cattle, 3 in buffaloes, 4 in sheep, 4 in goats, 3 in pigs, 3 in chicken and 1 in horse) have been characterized so far, though the characterization at molecular level has been made for some breeds (Neopane, 2006; Gorkhali *et al.*, 2021). A wide diversity of livestock exists encompassing cattle, buffalo, sheep, goats, pigs, equines, chicken, ducks, turkey, quails, ostrich, rabbits, and pigeon (AnGR, 2004).

Table 1. Breeds of livestock in the country

Species	Local Breeds	Transboundary: International	Transboundary: Regional
Cattle	Lulu, Achhami, Siri, Terai, Pahadi, Khaila, Yak	Jersey, Holstein-Friesian, Brown Swiss, Ayrshire	Hariana, Sahiwal, Red Sindhi
Buffalo	Lime, Parkote, Gaddi	Murrah	Nili Rabi, Jaffrabadi
Goat	Terai, Khari,Chyangra and Sinhal	Saanen, Boer	Jamnapari, Barbari, Beetal, Ajmeri
Sheep	Lampuchhre, Kage, Baruwal and Bhyanglung	Polwarth, Merino, Rambouillet, Border Leicester, Romney Marsh, Corriedale	-
Pigs	Hurrah,Chwanche, Bampudke, Pakhribas	Large White Yorkshire, Landrace, Hampshire, Saddle back, Tamworth, Duroc	-
Poultry	Sakini, Pwankh Ulte, Ghanti Khuile	New Hampshire, Black Australorp, Several synthetic layers and broilers	Giriraja, Several synthetic layers and broilers
Rabbits	Wild breeds	German Angora, Russian Angora, British Angora	Chinese Angora
Horse	Jumli and several un-identified breeds	-	-

Sources: Neopane and Shrestha (2009); Gorkhali et al. (2021); Neopane et al (2023)
Note: Transboundary breeds are those available in more than one region while regional transboundary are confined to one region.

There exist a diversity at breed levels within species (Table 1). This diversity is contributing to the economy through several attributes; food production of animal source origin; livelihood enhancement; inputs for agriculture operation and transport, and several others (Neopane *et al*., 2023). There are several transboundary breeds (regional and international) in the country. Despite of these several breeds, particularly indigenous breeds are declining making system non-sustainable.

STATUS OF ANIMAL GENETIC RESOURCES (AnGR)

A total of 25 indigenous breeds has been characterized (Table 2). The characterization at molecular level has been made in some breeds. Others species available: ducks, pigeons, quails, turkey, rabbits are being domesticated and being utilized. Nepal is fortunate to having several wild relatives of domestic animals such as *Arna* (wild buffaloes), *Gauri Gain* (wild cattle), Blue sheep (wild sheep), *Kalij* (wild chicken), wild rabbits, which can be used for improvement of the livestock population.

Table 2. Characterization status of local breeds

Species/Breeds	Characterization Status	Species/Breeds	Characterization Status
Cattle		**Goats**	
Terai	Phenotypic +DNA	Terai	Phenotypic+Chromosomal+DNA
Pahadi	Phenotypic	Khari	Phenotypic+Chromosomal+DNA
Khaila	Phenotypic	Sinhal	Phenotypic+Chromosomal+DNA
Lulu	Phenotypic+Chromosomal+DNA	Chyangra	Phenotypic+Chromosomal+DNA
Achhami	Phenotypic+Chromosomal+DNA	**Sheep**	
Siri	Phenotypic +DNA	Lampuchhre	Phenotypic+Chromosomal+DNA
Yak/Nak	Phenotypic +DNA	Kage	Phenotypic+Chromosomal+DNA
Buffalo		Baruwal	Phenotypic+Chromosomal+DNA
Lime	Phenotypic+Chromosomal	Bhyanglung	Phenotypic+Chromosomal+DNA
Parkote	Phenotypic+Chromosomal		
Gaddi	Phenotypic+Chromosomal		
Pigs		**Chicken**	
Chwanche	Phenotypic+Chromosomal+DNA	Sakini	Phenotypic+Chromosomal+DNA
Hurra	Phenotypic+Chromosomal+DNA	Ghanti Khuile	Phenotypic
Bampudke	Phenotypic+Chromosomal+DNA	Pwankh Ulte	Phenotypic
Horse			
Jumli	Phenotypic		

Sources: Neopane (2006); Pokhrel *et al.* (2012); Gorkhali *et al.* ((2021)

These local breeds have wide variation in the production traits and these variations can be captured through some effective breeding methods for making improvement. Some of the local breeds that have variation are Khari goats, Chwanche and Hurrah pigs, Sakini chicken, Lime and Parkote buffaloes, Baruwal sheep, Lulu and Achhami cattle.

Positive attributes

Indigenous breeds are low producing than the exotics in terms of milk, meat, eggs and wool production. However, they have several other positive attributes such as hardiness, adaptability to local harsh conditions and can produce in low input system. It is observed that these positive attributes are not duly recognized rather exotics breeds are unnecessarily given preference over them.

Availability of livestock products for food security

The per capita availability of milk, meat and egg in the year 2023/24 for Nepal were 88.0 5 kg, 14.7 kg and 55 number respectively. The trend appears to be increasing (Table 3). The ministry of agriculture and livestock development has (in March 2021) declared the country self-reliant on poultry meat and eggs, goat, milk powder and ghee (condensed butter) (The Kathmandu Post 2021). The population of each of the livestock species is lower than human population except in fowl (chicken) where there are 2.6 fowl (chicken) for one person. The ratio for cattle, buffalo, sheep, goat and pigs for human population are 4:1, 5:1, 25:1, 2.5:1 and 20:1 respectively (MoALD, 2024).

Table 3. The per capita availability of livestock products

Products	2018/2019	2023/2024
Milk (Liters)	74.5	88.0
Meat (Kg)	12.3	14.7
Eggs (No)	53	55

Source: MoALD (2020); MoALD (2024)

ANIMAL GENETIC RESOURCES AND SUSTAINABLE LIVESTOCK DEVELOPMENT

Food, livelihood and economic outputs

The contribution of agriculture including forestry and fisheries to the national gross domestic product (GDP) is 24.1% in the country (MoF, 2023). Livestock sector being an important entity within agriculture contributes significantly to the AGDP (24.0%)

in the country through milk, meat, eggs, wool, manure/fuels. (MoALD, 2023). Livestock products are a vital source for food security and nutrition for growing population in the country. The sector contributes greatly to addressing nutritional food security and enhancing livelihoods. As can be seen from table 4, buffalo is the key livestock component contributing highest of the total livestock GDP followed by cattle, goat, poultry, sheep and duck. Amongst the products, the largest contribution comes from milk followed by meat, manure and eggs.

Table 4. Contribution of livestock to AGDP by components

SN	Species	Milk	Meat	Eggs	Wool	Manure	Total
1	Buffalo	7.282	4.233	-	-	0.8532	12.37
2	Cattle	3.950	-	-	-	0.8532	4.803
3	Goat	0.0052	3.198	-	-	0.0153	3.219
4	Sheep	0.0052	0.0815	-	0.0098	0.0001	0.097
5	Pig	-	0.4172	-	-	-	0.417
6	Poultry	-	1.4475	0.6917	-	0.0004	2.139
7	Duck	-	0.0120	0.0243	-	-	0.036
8	Others	0.0417	0.722	-	-	-	0.764
Total		11.284	10.111	0.716	0.0098	1.722	23.8

Source: Selected Indicators of Nepalese Agriculture (2023).

More than 60% workforce is employed by the sector in the country. More than 50% of the households (HHs) is being engaged with livestock (goats: 72%; buffalo: 42%; cattle: 50% and poultry: 53%) farming throughout the country (National Sample of Census of Agriculture, 2023). Substantial proportion of livelihood of the people is being addressed by the livestock sector.

Both for consumption of animal source food (ASF) and export the sector (through food production, fibres/wool) is contributing greatly. Similarly the livestock sector is contributing to the national economy through transportation and manure though the contribution of transportation (draft power, transportation) and other by-products (e.g., fuel) from livestock has not been included (Selected Indicators of Nepalese Agriculture, 2023). Animal genetic resources have been greatly contributing to food security through supply of animal source food (ASF). They provide stuff that are needed making livelihood sustained. They provide draught power and fertilizer to support agriculture production system. They support product and product related industries and contribute to enhance the economy. Livestock has been contributing to the national Agriculture GDP significantly. This can be seen from table 5 as among top 10 agricultural commodities (contributing to AGDP), there are four livestock commodities; buffalo, cattle, goat and poultry.

Table 5. Contribution of selected agricultural commodities on Agriculture GDP (2023/24)

SN	Commodities	Percent contribution
1	Vegetables	14.5
2	Rice	12.8
3	Buffalo	12.7
4	Maize	6.64
5	Potato	6.56
6	Wheat	5.87
7	Cattle	4.80
8	Goat	3.27
9	Lentil dry	1.58
10	Poultry	1.52

Sources: Statistical Information on Agriculture (2024).

Production of primary livestock products

In the year 2022/23, a total of 2.6 million MT milk was produced from about 1.77 million milking cattle and buffaloes. Around 19% of total cattle and 28 % of the total buffalo population have been estimated to be in milking stage. Of the total milk produced, 53.6 % was from buffaloes and remaining 46.4 % from the cattle (*Statistical Information on Agriculture (2024)*. The contribution of buffaloes in terms of total milk production has been gradually declining and that from cattle is increasing mainly due to initiation of dairy cattle farming at commercial scale and increase in the number of crossbred dairy animals mainly cattle with increase in artificial insemination (AI) coverage. The contribution of buffalo for total milk was 67% and that of cattle was 33% in the year 2020 (MoALD, 2020). Similarly, a total of 0.43 million MT meat was produced from buffalo, goats, pigs, fowls, ducks and sheep. The highest contribution came from chicken (46.6%), followed by buffalo (27%), goats (18%), pig (7.6%), sheep (0.43%) and duck (0.31%) (*Statistical Information on Agriculture (2024)*.

Sociocultural and ecological roles

Animal genetic resources have important role in cultural and social activities at different levels in the country. They are very important entities at households and community level. For several ceremonial activities livestock and poultry become important entity. In addition of economic importance, AnGR contribution for sociocultural values is enormous (AnGR, 2004). There are preferences over species and breeds for ceremonies and functions. For examples, black colour pigs are preferred for ethnic communities in the eastern hills of the country for their religious ceremony.

White colour pigs are preferred in the western parts of the country. Red colour cockerel (*Rato Bhale Kukhura*), Dark colour goats over light colour are preferred and have more value.

The livestock has cultural values in the country. For instances, slaughter of goats, sheep, male buffaloes, poultry, ducks and pigeon is a common feature that takes place at several religious ceremonies. Sacrificing animals to the Goddess is common features in the society. Livestock provides raw materials to the people for making clothes (*radi/pakhi*), and shoes. The number of animals reflects the status of the family. Horses are still the main means of transportation in hills and mountains. Keeping horses indicates the family status.

Grazing animals have been contributing for the maintenance and regeneration of pasture in the range and communal lands in the hills and mountains (Banstola, 2001). Animals (if kept at good size) will clear the areas which would have grown over. Migratory flocks of the animals while moving keep manuring the land and contribute to the soil fertility. AnGR contributes greatly to the transportation through pack and tracking services. Yak/chauri and horse/mules have been contributing greatly to the hills and mountains economy through transportation. Similarly Chyangra and Sinhal goats as pack animals contributes to hills and mountains economy (Neopane, 2002).

Indigenous livestock in sustainable farming system

Native livestock breeds being well adapted and environmentally effective are reared throughout the country in all ecological zones ranging from tropical/subtropical to alpine. Indigenous breeds have demonstrated their capacity to produce in low input system where the exotics can't cope with (Gorkhali *et al*., 2021; Neopane *et al*., 2023). For example Yak, Nak and Chauri utilize alpine pasture and play an important role for rural livelihood in the mountains of Nepal. Chyangra (mountain goat), Sinhal goat and Bhyanglung and Baruwal sheep are doing very good job for hilly and mountain people for their survival.

The role of native livestock breeds to the draught power has been significant. Draft animals are the major source of power for agricultural operations (Neopane, 2005). Cattle and buffaloes are the major draft animals that are used extensively for agricultural operations. Yak, sheep, goats, mules and horses are used as pack animals but these are also used for draft in high hills and mountains. Yak, nak and chauri are important sources of transportation at high altitudes. Yak and nak can survive at high

altitudes and remain important sources of transportation. Chauri (cross between yak and native cattle or nak and native cattle bull) can go down to mid hills and play important role for transportation. Similarly mules and horses as pack animals are important sources of transportation for hills. They are mostly used for transportation of food grains from lower hills to higher hills and mountains. Sheep and goats are used as pack animals in hills. They are used for transporting goods from lower place to higher hills (Neopane, 2002).

These animals are providing a substantial amount of manure that is being used for increasing/maintaining soil fertility (Neopane, 2005). Use of chemical fertilizers is not very common in hills and mountains. Animals' manure has an important contribution to this aspect. Apart from these, the livestock is important source of providing animal protein in the diet of hilly people in the form of milk, meat, and eggs.

KEY ISSUES OF THREATS TO ANIMAL GENETIC RESOURCES

The major threats for animal genetic resources are genetic erosion, indiscriminate crossbreeding, low productivity, small holding size, lack of specific policies, changing production systems, lack of valuation of local breeds, increasing competition for natural resources and environmental degradation. These factors are contributing to genetic erosion of indigenous breeds in the country. Few breeds have been extinct and some are about to be extinct if careful measures are not taken.

STRATEGY FOR ADDRESSING THESE THREATS

- Promotion of indigenous breeds
- No importation of exotic breeds at least for hills and mountains
- Strategic crossbreeding
- Value addition to indigenous breeds (both breeding and non-breeding approach)
- Reorientation of research and development programs towards optimum utilization of indigenous breeds
- Promotion of indigenous forage species (tree fodders, perennial fodder)
- Optimum utilization of natural pastureland.
- Use of suitable and combination of conservation methods
- Strategic use of crossbreeding for improvement

- Awareness about the importance of indigenous breeds at the community level

In totality effective management of AnGR will address these constraints precisely. AnGR management encompasses all technical, policy, and logistical operations involved in understanding (Characterization), using and developing (utilization), maintaining (conservation), accessing, and sharing the benefits of animal genetic resources (FAO, 2007, 2015).

OBSERVATION AND WAY FORWARD

Based on the available information and the contribution of AnGR, the following observations are made**;**
- The country is rich in biodiversity
- Great contribution from AnGR (Indigenous)
- Contribution can be enhanced if used properly
- Indigenous breeds have several positive attributes (Multipurpose uses, hardy and well suited to local conditions, can produce in low input system)
- Although low production but variation exists
- These variations could be used for improving the productivity
- Genetic erosion (More with local)
- Attention is needed for indigenous breeds
- Enabling policy for indigenous breeds and their uses
- Effective and appropriate conservation and improvement programs
- Conservation and improvement can/should go together for several cases

CONCLUSION

Animal genetic resources (AnGR) in the country have not been fully utilized. They are far from their full utilization but once it is made, there would be more prosperity through their contribution to income generation, sustainable livelihood, quality food nutrition and many more. For their effective utilization, management of AnGR is paramount and this has to be made precisely. Management for AnGR includes its understanding (characterization), using (utilization), maintaining (conservation), accessing and benefit sharing.

REFERENCES

AnGR (2004). Animal Genetic Resources. Country Report on Animal Genetic Resources of Nepal. Ministry of Agriculture and Development, Government of Nepal, Singh durbar, Kathmandu, Nepal

Banstola, B R (2001). Vegetation Composition, Carrying Capacity and Nutritional Status of

Rangelands of Rasuwa District. M Sc Ag Thesis, Institute of Agriculture and Animal Science (IAAS), Rampur, T.U., June 2001, Nepal

FAO (2007). The State of the World's Animal Genetic Resources for Food and Agriculture, 2007, Rome

FAO (2015). The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture, edited by B.D. Scherf & D. Pilling. FAO Commission on Genetic Resources for Food and Agriculture Assessments. Rome. Available at http://www.fao.org/3/a-4787e/index.html

Gorkhali, N.A., Sapkota, S., Bhattarai, N., Pokhrel, B.R., & Bhandari, S. (2021). Indigenous Livestock Breeds of Nepal: A Reference Book. Published by National Animal Breeding and Genetics Research Centre, National Animal Science Research Institute, Nepal Agricultural Research Council, Khumaltar, Lalitpur, Nepal

MoALD (2020). Ministry of Agriculture and Livestock Development. (2020). Statistical Information in agriculture. Ministry of Agricultural and Livestock Development (MoALD), Government of Nepal. Singhadarbar, Kathmandu, Nepal

MoALD (2023). Ministry of Agriculture and Livestock Development. (2023). Statistical Information in agriculture. Ministry of Agricultural and Livestock Development (MoALD), Government of Nepal. Singhadarbar, Kathmandu, Nepal

MoALD (2024). Ministry of Agriculture and Livestock Development. (2023). Statistical Information in agriculture. Ministry of Agricultural and Livestock Development (MoALD), Government of Nepal. Singhadarbar, Kathmandu, Nepal

MoF (2023). Economic Survey of Nepal (2022/23). Ministry of Finance. Government of Nepal, Singhadarbar, Kathmandu, Nepal.

Neopane, S P (2002). Prospects of Sustainable Livestock Development through Indigenous Breeds in High Altitudes and Range Lands. Paper presented at a workshop organized by the Ministry of Forestry and Soil Conservation on the occasion of International Mountain Year 2002 at Nagarkot from 1 to 2 October, 2002.

Neopane, S P (2005). Draught genetic resources of Nepal. *Proceedings of AHAT/BSAS International Conference: Integrating Livestock-Crop Systems to Meet the Challenges of Globalisation,* Volume 2. (Editors: Rowlinson, P., Wachirapakarn, P., Pakdee, P. and Wanapat, M). November 14-16, 2005, Khon Kaen, Thailand. Organised by Animal Husbandary Association of Thailand (AHAT) and British Society of Animal Sciences (BSAS). Published by British Society of Animal Sciences. ISBN: 0 906562 51 1 Pp T92.

Neopane, S P (2006). Characterization of Indigenous Animal Genetic Resources of Nepal. *Proceedings of the 6th National Workshop on Livestock and Fisheries Research*. Nepal Agricultural Research Council. Pp 1-11, 2006, Nepal.

Neopane, S. P. and Shrestha, B.S. (2009). Genetic improvement of buffalo in Nepal. *Pakistan J. Zool. Suppl. Ser., No.9, pp.459-465, 2009, Pakistan*

Neopane, S P; B S Shrestha and D Gauchan (2023). Livestock Contribution to Food and Nutrition Security in Nepal. Pp 241-258. Agriculture, Natural Resources and Food Security. Lessons from Nepal. Springer Nature. Sustainable Development Goal Series [Edited by Jagadish Timsina, Tek N Maraseni, Devendra Gauchan, Jagannath Adhikari, Hemant Ojha]

National Sample of Census of Agriculture (2023). National Statistics Office, of the Prime Minister and Council of Ministers, Government of Nepal.

Pokhrel, PK, SP Neopane, S Sapkota and R Kadel (2012). *Nepal Ka Raithane Gharpaluwa Janwarharu: Ek Parichay. Nepal Krishi Anusandhan Parisad, Pashu Prajnan Mahashakha,* Khumaltar, Lalitpur, Nepal. Pp 98

Selected Indicators of Nepalese Agriculture (2023). Statistics and Analysis Section, Planning and Development Cooperation Division, Ministry of Agriculture and Livestock Development, Singhadurbar, Kathmandu, Nepal.

Statistical Information on Nepalese Agriculture (2024). Statistical Information on Nepalese Agriculture 2079/80 (2022/23). Ministry of Agriculture and Livestock Development, Singhadurbar, Kathmandu, Nepal.

The Kathmandu Post. (2021). Nepal becomes self-sufficient in egg and meat production. https://kathmandupost.com/money/2021/03/25/nepal-becomes-self-sufficient-in-eggand-meat-production. Accessed 5 April 2021