Biotechnological Approach for the Conservation of Animal Biodiversity in Bangladesh

Mobarak Akter Md. Yahia KHANDOKER*†, Syed Sakhawat HUSAIN*, Md Shaheb ALI*, Md. Raihan ALI*, Md. Golam Mostafizur RAHMAN*, Md. Rashedul ISLAM*, Auvijit Saha APU*, A. H. M. Safiur RAHMAN*, Anupom MONDAL*, Md. Anisuzzaman MONDAL**, K. M. A. TAREQ***, Quzi Sharmin AKTER*** and Hirotada TSUJII***

*Department of Animal Breeding and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

**Department of Biotechnology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

***Faculty of Agriculture, Shinshu University, 8304 Minami-minowa, Nagano 399-4598, JAPAN

†Corresponding author : E-mail : headabg@yahoo.com

Abstract The current status of farm animal and poultry biodiversity in Bangladesh, use of biotechnology for their development and conservation, and limitations both in facility and policy frameworks on biotechnology use for conservation are discussed in this paper. Animal genetic resources (AnGRs) are still diversified in Bangladesh and concrete program is required to conserve and developed the biodiversity of these AnGRs. In particular, it is necessary to build up a National Livestock Conservation Committee (NLCC) in Bangladesh. The body must include representative from university, research institute, extension services, private entrepreneur and planning relevant expertise.

Key word : Animal, Biodiversity, Conservation, Biotechnological Approach, Bangladesh

Introduction

The animal species which are important today for food and agriculture production are a consequence of processes of domestication that have been continuing for almost 12 thousands years. The domestication of animal species involves controlled breeding and husbandry. As human beings evolved and extended the area under their control, animals were domesticated and breeds were developed to provide for human needs within these new environments. The purpose was to ensure the sustainability of human communities. The results were the development of genetically distinct breeds through the combined response of these animal populations to two interacting forces. (1) Selection pressures imposed by human communities, identifying and making greater use of preferred genetic types amongst the available animals over time. (2) The selection pressures imposed by the ruling environmental stress factors that operate through differential reproduction and survival of parent animals and their offspring to realize high adaptive fitness of the breed in the environment. The World Watch List for Domestic Animal Diversity (WWL-DAD) is the voice of the Global Early Warning System for Farm Animal Genetic Resources (AnGRs). Based on survey data, a system of monitoring has been put in place as part of FAO's Global Strategy for the Management of AnGRs. Analysis of this data, which has been collected in the Global Databank for AnGRs within the Domestic Animal Diversity Information System, enables the identification of AnGRs at risk of loss and monitoring over time of extinction rates. There are more than 40 domestic mammalian and avian species presently included in the WWL-DAD. Although small in number, their impact is substantial-they contribute directly and indirectly to some 30-40% of the total value of food and agriculture production.

Animal genetic diversity allows farmers to select stocks or to develop new breeds in response to environmental change, threats of disease, new knowledge of human nutrition requirements,

changing market conditions and societal needs, all of these are largely unpredictable. At the current rate of population growth, it is predicted that the consumption of food and agriculture products will be equivalent to that in all of the last 10 thousands years. This will be felt most acutely in developing countries where 85% of the increased food demand is expected. Given the above facts, domestic animal diversity is critical for food security. It is important not to permit the erosion of this diversity. The proportion of known threatened animal species varies on a country by country basis : according to the report of Organization for Economic Co-operation and Development (OECD) in 1999, it was found that 8% of all known mammalian and avian species are threatened in Japan ; and in the Czech Republic and Hungary almost 45% of all known mammalian and avian species are threatened. Though the exact information of Bangladesh is not available but a lot of mammalian and avian species is vanishing in our country day by day. Some of these vanishing wild species have the potential to contribute to humankind's food and agriculture by providing additional genetic diversity to that being maintained in the domestic breeds. For this reason, they are also of interest to food and agriculture for the sustainability of humankind, for which the Global Strategy for the Management of AnGRs is being developed. The imminent plight of both the domestic breed resources and of their wild relatives has not been widely recognized. Nevertheless, in 1980 a joint FAO/UNEP consultation on AnGRs held in Rome "urged all governments to give full consideration to ways and means of conserving viable populations of wild animal species, including avian, which are the ancestors or close relatives of domestic species". In the analysis of Global Databank for AnGRs, breeds are classified into one of the seven categories :

i) Extinct, ii) Critical, iii) Critical-maintained, iv) Endangered, v) Endangered-maintained, vi) Not at risk and vii) Unknown.

This categorization is based on overall population size, the number of breeding females, the number of breeding males, the percentage of females bred to males of the same breed and the trend in population size. The further consideration is given to whether active conservation programs are in place for critical or endangered populations. WWL-DAD provides an inventory and basic descriptive information on the domestic animal breeds that are at risk of extinction and those that are already extinct.

Methodology

The information cited in this paper is mainly based on our own experimental observation. In addition, relevant data of published literatures and other reports from government and non-governmental organization were also used.

Results and Discussion

The major Animal Genetic Resources of Bangladesh

Possible causes responsible for the loss of biodiversity and genetic resources

Possible causes responsible for the loss of biodiversity and genetic resources are as follows :

1. Destruction of habitat : The natural habitat may be destroyed by man for his settlement, grazing grounds for livestock, agricultural operation, establishment of industries, construction of highways, drainage, dam, or building etc. Consequently, the species either adapts in the change condition, moves elsewhere or may succumb to perdition, starvation or disease and eventually die.

2. Hunting of animals : From time immemorial, man has hunted animals for food. Commercially, wild animals are hunted for their products such as hides or skin, tusk, antlers, fur, meat, pharmaceuticals, perfumes, cosmetics and decoration purpose. Hunting for sport is also a factor for loss of animal biodiversity.

3. Over exploitation of genetic resources : This is one of the main causes of the loss of not only economic species but also biological curiosities

Table 1 Animal genetic resources (AnGRs) of Bangladesh and their present status

Species	Population (Mill)	Breed/ type	Habitat	Present status
Cattle	24.3	Red Chittagong Pabna Indigenous	Chittagong area Serajgong, Pabna All over Bangladesh	Critical-maintained Critical-maintained Critical-maintained
Gayal	–	Hill breed	Chittagong Hilltracts	Endangered
Buffalo	0.8	Indigenous	All over Bangladesh	Unknown
Goat	34.6	Black Bengal	All over Bangladesh	Not at risk
Sheep	1.1	Indigenous	All over Bangladesh	Endangered
Dog	–	Sorail	Norshingdi	Endangered
Chicken	138.2	Indigenous Assel Jungle Fowl	All over Bangladesh Brahmanbaria, Chittagong Chittagong Hilltracts	Critical-maintained Endangered Endangered
Duck	13.0	Indigenous	Kishorgong, Sylhet, Netrokona	Critical-maintained
Pigeon	–	Indigenous	All over Bangladesh	Critical
Deer	–		Sundarban	Unknown

Source : FAO, 2001

like the insectivorous and primitive species and others for teaching and laboratory works. Commercial exploitation of biodiversity has invariably meant its overuse and eventual destruction.

4. Introduction of exotic species : Native species are subjected to competition for food and space due to invasion of commercial exotic species. Unplanned introduction of exotic germplasm also dilutes the adaptive genetic materials of indigenous stock and hence threat genetic purity of local stocks.

5. Pollution of environment : Pollution of environment and consequently altered habitat threatened existence of animals.

6. Deforestation : One of the main causes for loss of biodiversity is population explosion and resultant deforestation. Deforestation mainly results from population settlement, shifting cultivation, development projects, demand for fuel-wood, demand for wood for industry and other commercial purposes.

7. Distribution range : The smaller the range of distribution, the greater the threat of extinction.

8. Degree of specialization : The more specialized organism is the more vulnerable extinct.

9. Position of organism in the food chain : Higher the preference of organism is in food chain, they are more likely to be predated and extinct.

10. Reproductive rate : Large organisms tend to produce fewer offspring at widely spaced intervals.

Biotechnology-a tool for conservation of animal genetic resources (AnGRs)

Biotechnology implies any interference with or change of genetics, function or technical use of organisms by man. In that framework biotechnology has a long history in bread, wine and cheese manufacturing. Silage for animal feed is also known since generations. Modern biotechnology is at the doorsteps to revolutionize the feed production. Apart from in situ conservation modern biotechnological approaches can supplement the conservation of AnGRs in the form of sperms, embryos, oocytes, cell lines, isolated chromosomes, genomic DNA libraries and isolated genes. Some of these technologies are still in the experimental stage but hold promise for the protracted preservation of animal germplasm and eventual resurrection of breed (Mariante, 1991). There have been several advances in biotech-

Table 2 Summarized result of Multiple Ovulation and Embryo Transfer (MOET) in cattle research in Bangladesh

A. Embryo survival rate relating to gonadotrophin used in superovulation treatment

Origin of embryo	Survival rate (%)	Level of significance
Superovulation with FSH	48.57	NS
Superovulation with PMSG	47.22	

Data were analyzed using SPSS-10 ; NS = Non-significant

B. Developmental stage of embryos and the survival rate

Developmental stage of embryos	Recovery rate (%)	Survival rate (%)
Morula	7	45.00
Compacted Morula	7	48.64
Blastocyst	7	47.82
Expanded Blastocyst	7	44.44
Hatched Blastocyst	7	10.00

C. Average survival rate and conception rate of embryos in cows and heifers

Type of recipient	Survival rate (%)	Conception rate (%)	
		Basal part or within 3-5cm from the internal bifurcation of the uterine horn	Central part or within 5-10 cm from the internal bifurcation of the uterine horn
Cows	50.00	48.64	50.00
Heifers	45.83	43.47	40.00
Level of significance	NS	NS	NS

Z-test was performed for comparing proportions according to Snedecor and Cochran 1980 ; NS = Non-significant

nological methods of reproductive technology over the past decades leading towards the realization of their enormous scope in animal agriculture. The future trends in animal production are expected to be dictated by the emerging technologies of reproduction like planed artificial insemination (AI) with frozen semen, multiple ovulation and embryo transfer (MOET), *in vitro* production (IVP) of embryos, juvenile breeding, embryo splitting and cloning, embryo and semen sexing, non-invasive early pregnancy diagnosis, marker assisted selection and transfer of gene between animals. To reduce the gap between the demand and production of animals and conserve them as well is necessary to augment the reproductive rate of low productive animals. In order to improve their genetic make up, incorporation of genetic material of elite animals is essential. The production of large number of animals of superior merit within a short period is not possible through the conventional breeding techniques. However, the recent reproductive technologies have opened up several possibilities for accelerating the genetic gain and enhancing production potential in animals in developed and many of the developing countries. Since few decades back the USA, UK, Canada, Denmark, Japan, Korea, China, Australia, Indonesia, India have been working successfully with modern reproductive technologies for increased reproductive efficiency as well as conservation of farm animals (Nicholas and Smith, 1983). In Bangladesh, these technologies are adaptable as the new option in the dimension of livestock development strategy and conservation

Table 3 Results from different research work at BAU Reproductive Biotechnology Laboratory

A. Development of Mouse Embryos

Total number of 4-cell embryos collected	Development of embryos		
	No. of 8-cell embryos (%)	No. of morula (%)	No. of blastocyst (%)
171	151 (88.30)	142 (83.04)	123 (71.92)

Figures in the parenthesis indicates the total number of embryos ; Students t-test was done using computer package SPSS-10

B. *In vitro* Production of Bovine Embryo

Grade of cumulous oocyte complexes (COCs)	Maturation rate (%)	Fertilization rate (%)	Normal zygote after 24h culture (%)
A	62.26[a]	40.98[a]	73.91[a]
B	42.50[b]	31.11[b]	62.75[b]

Students t-test was done using computer package SPSS-10 ; Means with different superscripts within the same column differ significantly ($p<0.05$)

C. Rate of development of Goat Embryo

Grade of cumulous oocyte complexes (COCs)	Maturation rate (%)	Rate of development to blastocyst (%)
A	71.70[a]	12.82[a]
B	51.52[b]	3.45[b]

Students t-test was done using computer package SPSS-10 ; Means with different superscripts within the same column differ significantly ($p<0.05$)

of AnGRs. In this context, conservation program on domestic chicken (Amin and Bhuiyan, 1995), Red Chittagong cattle (Bhuiyan, 2007) and Black Bengal goat (Khandoker, 2007) have already been undertaken.

Status of reproductive biotechnological approach for conservation of AnGRs in Bangladesh

Multiple Ovulation and Embryo Transfer (MOET)

MOET in livestock is considered as the important tool to increase the rate of genetic gain (50-100%). It is being used in various countries to introduce new breeds and multiply expensive germplasm at a faster rate. MOET can also exploit the genetic potentials of both the male and the female, and thus the population of the herd is increased quickly with the expected genetic potentialities. It is not understood as to why we are still importing elite cattle instead of going for ET. Recently we have successfully adopted this technique in Bangladesh (Ali, 2007) and the summarized result is shown in Table 2.

In vitro production (IVP) of embryos

In vitro maturation (IVM) of oocytes, *in vitro* fertilization (IVF) and *in vitro* culture (IVC) are necessary to provide the large number of embryos required for gene intrusion and cloning. The technique expected to develop is *in vitro* production (IVP) of embryos, for the purpose of making efficient utilization of a huge number of ova left in ovaries. The birth of "Dolly" by cloning was possible due to production of suitable culture condition for IVP of embryos. Fertilized ova further cultured in suitable media to obtain blastocyst, and transplanted to uterus of the recipient

females. These techniques are well established in cattle (Hanada *et al*., 1986) and are being used routinely in many laboratories engaged in molecular biology and reproduction all over the world. Though we are still in behind but recently developed the techniques of *in vitro* production of mouse (Khandoker *et al*. 2005), bovine (Rahman et al., 2003) and goat (Islam *et al*., 2007) embryos in Bangladesh. The summarized result is shown in Table 3.

Cryopreservation and AI with frozen semen

The importance of preserving biodiversity is now widely acknowledged and it is here that germplasm preservation can make a major contribution (Holt, 1997). Semen preservation enables widespread use of superior males for AI and *ex-situ* conservation of elite or endangered breeds. During short-term preservation of semen in chilled liquid state, there is a gradual decline in the motility, change in morphological integrity and rapid decline in fertility beyond 24h of storage (Maxwell and Watson, 1996). The limitation in the use of liquid semen for a longer duration has necessitated the development of a technology for long-term preservation of semen in liquid nitrogen. Several reviews have recently appeared on the progress made on the various aspects of freezing and fertility of semen (Salamon and Maxwell, 1995 ; Watson, 1995 ; Maxwell and Watson, 1996). Cryopreservation of bull semen is almost popular in Bangladesh. From the recent investigation, it was revealed that the heterozygosity of Black Bengal goat population had increased day by day through unplanned crossbreeding though FAO reported that this breed was not at risk upto 2004. This implies that this breed tends to be in risk in the near future. So we are trying to conserve this breed through cryopreservation of buck semen (Khandoker, 2007).

In order to satisfy the increasing demand by the people breed substitution and/or grading up have been replacing the indigenous bovine AnGRs in Bangladesh. Government and several non-government organizations nowadays are operating AI services to expedite the process even in the remotest villages. The status of AI services in Bangladesh is shown in Figure 2.

But we are practicing AI indiscriminately and such practices may destroy our potential genetic resources within a short period. In this context, our department took a project to conserve Red Chittagong cattle *in situ* and practicing systematic AI program with Red Chittagong bull semen (Bhuiyan, 2007). The status of conception rate by AI in Bangladesh is shown in Table 4.

The cryopreservation of mammalian oocytes will make possible random fertilization using cryopreserved bull semen regardless of generations. This promotes new aspects for breeding and genetic resources. The current procedure for bovine embryo cloning requires early stage of embryos as a source of donors. Remarkable success has been reported in mammalian oocytes and embryo cryopreservation in developed countries (Izaike *et al*., 1999) but we are still lags far behind

Figure 1 Transfer of liquid nitrogen into the cryocan

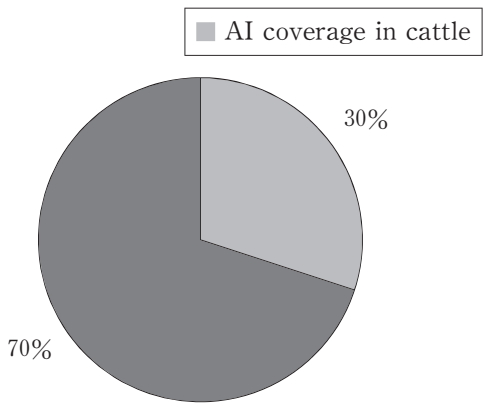

Figure 2 Status of Artificial Insemination (AI) in Bangladesh

Table 4 Conception rate of livestock by AI in Bangladesh

	Frozen semen	
	Cattle	Goat
Conception rate (%)	61.50	42.90

on it.

Concluding Remarks

The botanical community has long recognized the importance of conservation and utilization of wild plant genetic resources, but the conservation of wild animal genetic material lags far behind. The International Plant Genetic Resources Institute (IPGRI), co-ordinates the collection of wild specimens of plants, undertakes research and hold them in trust for farmers use. Research initiatives have led to improvements in crop yields and in disease and pest resistance. For animals, however, no such organization exists. The International Livestock Research Institute (ILRI) has the system-wide mandate amongst the 14 International Agricultural Research Centers for certain domestic animal species and is developing a substantial animal genetic resources component in its research program, with a second center, The International Center for Agricultural Research in the Dry Areas (ICARDA), now also contributing to this. As yet, there have been very few examples of the systematic use of genetic material from wild relatives to improve modern domestic livestock and quality of products. As such, the potential of these wild resources remains undervalued. Obviously reproductive biotechnology tool(s) would able to contribute in the conservation of farm animal biodiversity in Bangladesh but we are far behind it. Under these circumstances, skilled technical persons must be involved as the principal stakeholder in the holistic conservation program and we need care in the followings :

1) Establish a very dependable laboratory with relevant equipment and facilities.
2) Train scientist very appropriately to perform the job with expected satisfaction.
3) Breeding farm with high producing animals must be established and maintained to protect from any genetic erosion.
4) Embryo preservation for short- and long- term use.
5) Appropriate infrastructure.
6) In the beginning it could be viewed as academic and research purposes and for the reason MOET has got tremendous impetus on the livestock production technology.

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