THE SCIENCE WORLD
A Monthly e Magazine
ISSN:2583-2212
Oct, 2023; 3(10), 2698-2710

Popular Article

Strategies For Conservation of Animal Genetic Resources

Dr.Archana Kumari[1]& Dr.Alok Bharti[2]
[1]Associate Professor, Veterinary Surgery and Radiology, BASU, Patna and [2]Ph.D. Scholar, Animal Genetics and Breeding, BASU, Patna
https://doi.org/10.5281/zenodo.10058670

Biological diversity is a global asset of paramount importance for the food security and socio-economic development of mankind. The present pattern of diversity of AnGR is the result of a long and complicated history that started with animal domestication. Depending upon the species, domestication occurred 10,000 to 1000 years ago. Since then, domestic livestock have spread with human migration and trading to all inhabited continents. Local adaptation, artificial selection, mutation and genetic drift turned the genetic diversity captured with domestication into a vast array of differences in appearance, physiology and agricultural traits.

India is blessed with immense genetic resources of both agricultural and animal sector. The farm animal genetic resources in India are represented by a broad spectrum of native breeds of cattle, buffaloes, goat, sheep, swine, equine, camel and poultry. These breeds have developed during millions of years of evolution within specific ecological niche, forming and stabilizing to tropical environment besides developing genetic resistance to many diseases and adapting to native feed and fodder.

Increasing gap of demand and supply is creating immense pressure on researchers to go for intensive livestock development programmes which are promoting the universal use of very few improved breeds resulting in reduction of population of indigenous breeds as well as the genetic variability within a species. The Global Databank for Animal Genetic Resources data from 182 countries, for 38 species, the total number of mammalian national breed populations recorded in March 2018 was 11 371. The total number of avian national breed populations recorded in 2018 was 3689. With the challenges posed by climate change and emerging diseases we are now

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published: **28.10.2023**

compelled to take immediate action for systemic conservation, genetic improvement and sustainable utilization of indigenous livestock breeds.

Erosion of genetic diversity

As per the 2018 data by FAO, 59 percent are classed as being of unknown risk status, 10 percent as not at risk, 24 percent as at risk and 7 percent as extinct. There are several factors responsible for decrease in Animal genetic resources, particularly in developing countries like India, but many of these reasons apply to developed countries as well.

- Lack of appreciation of the value of indigenous breeds and their importance. More stress is given to introduce exotic and crossbreeds by AI.
- The introduction of exotic germplasm of non adapted breeds followed by rapid spread through indiscriminate cross breeding.
- Change in traditional mixed farming system and introduction of modern techniques.
- Preferential shifting to farming of other breeds because of short term social and economic influences. These may arise from agricultural policies promoting rapid solutions that are not sustainable in long term.
- Mechanization of agriculture.
- Natural disasters such as drought and diseases, and wars and other forms of political unrest and instability reducing livestock numbers.

Status of Breeds

In the analysis of the Global Databank for Farm Animal Genetic Resources, breeds are classified into one of seven categories:

- Extinct
- Critical
- Critical-maintained
- Endangered
- Endangered-maintained
- Not at risk
- Unknown

This categorization is based on overall population size, 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. Further consideration is given to whether active conservation programmes are in place for critical or endangered populations. For Domestic Animals following classification has been suggested:

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published: **28.10.2023**

Status	**Population Size**	**No. of Breeding Females and Males**
Normal	The population size is greater than 1200 and overall population size is increasing.	F: >1000 M: > 20
Endangered	greater than 1000 and less than or equal to 1200 decreasing and the percentage of females being bred to males of the same breed is below 80 %.	F: >100 & ≤1000 M: > 5 & ≤ 20
Critical	less than or equal to 120 and decreasing and the percentage of females being bred to males of the same breed is below 80 %.	F: ≤100 M: ≤ 5
Extinct	no longer possible to recreate the breed population.	F: Zero M: Zero

As per NBAGR guidelines for India:

Status	**Population Size**	**No. of Breeding Females and Males**
Not at Risk	More than 20,000 for cattle, buffalo, sheep, goat, horse and camel, yak and mithun.	F: >10000 M: > 40
	More than 10,000 for Pig and poultry.	F: >5000 M: > 40
Vulnerable	20,000 or less but more than 10,000 for cattle, buffalo, sheep, goat, horse and camel, yak and mithun.	F: >5000 & <10000 M: > 20 & < 40
	20,000 or less but more than 10,000 for Pig and poultry.	F: >2500 & < 5000 M: > 20 & < 40
Endangered	10,000 or less, but more than 1,000 for cattle, buffalo, sheep, goat, horse and camel, yak and mithun.	F: >5000 & <500 M: > 5 & < 20
	5,000 or less but more than 500 for Pig and poultry.	F: >250 & < 2500 M: > 5 & < 20
Critical	1,000 or less in cattle, buffalo, sheep, goat, horse and camel, yak and mithun.	F: < 500 M: < 5
	5,00 or less in pig and poultry	F: ≤250

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published: **28.10.2023**

		M: ≤ 5
Extinct	There is no breeding males (or stored semen) or no breeding females (or oocytes) or no embryos remaining.	F: Zero M: Zero

For their wild relatives following definitions has been suggested:

Status	**Definitions**
Commercially threatened	Taxa not currently threatened with extinction, but most or all of whose populations are threatened as a sustainable commercial resource, or will become so, unless their exploitation is regulated.
Threatened	Denote species that are endangered, vulnerable, rare, indeterminate, or insufficiently known.
Insufficiently known	Taxa that are suspected, but not definitely known, to belong to any of the above categories because of lack of information.
Indeterminate	Taxa known to be endangered, vulnerable, or rare but where there is not enough information to say which of the three categories is appropriate.
Rare	Taxa with small world populations that are not at present endangered or vulnerable, but are at risk.
Vulnerable	Taxa believed likely to move into the endangered category in the near future if the causal factors continue operating. Included are taxa of which most of all the populations are decreasing because of over-exploitation, extensive destruction of habitat or other environmental disturbance
Endangered	Taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating. Included are taxa whose numbers have been reduced to a critical level or whose habitats have been so drastically reduced that they are deemed to be in immediate danger of extinction
Extinct	Species not definitely located in the wild during the last 50 years.

Current scenario of conservation and sustainable use of AnGR in India:

Livestock and poultry population:

According to 2019 census data (20th Livestock census), the country had 536.76 million livestock population and 851.81 million poultry population. During the last seven years (2012-2019), cattle and buffalo population has increased by 1.34% and 1.06% respectively. while sheep population showed handsome increase of 14.13%, Goat population showed increase of 10.14%

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published: 28.10.2023

and total poultry population increased by 16.81% during this period. Population of pig, yak, horse, mule, donkey and camel showed a decreasing trend.

Livestock population (*20th Livestock census, 2019*)

Sl. No	Species	Number (in millions)	Ranking in the world population
01	Cattle	192.49	**Second**
02	Buffaloes	109.85	**First**
	Total (including Mithun and Yak)	**302.79**	**First**
03	Sheep	74.26	**Third**
04	Goats	148.88	**Second**
05	Pigs	9.06	-
06	Others	0.91	-
	Total livestock	**536.76**	
	Total poultry	**851.81**	**Seventh**
07	Duck	-	
08	Chicken	-	Fifth
09	Camel	0.25	Tenth

Source: Annual Report 2018-19, Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture and Farmers Welfare, Govt. of India.

Breed-wise Population:

The Government has conducted the 20th Livestock Census in 2019. It covers 184 breeds of total 16 animal species like Cattle, Buffalo, Mithun, Yak, Sheep, Goat, Pig, Horse, Pony, Mule, Donkey Camel, Dog, Rabbit and Elephant and poultry birds (Fowl, Duck, Turkeys and other poultry birds) possessed by the households, household enterprises/non-household enterprises and institutions at their site. The Department is also initiating the next Livestock Census scheduled for Year 2024. There are 38 indigenous breeds out of 184 breeds of different livestock and poultry species that are 'at risk'. (As per the Press information Bureau, GOI; posted on 28 MAR 2023 5:51PM by PIB Delhi). Breed-wise livestock census carried out at timely intervals gives information which is of paramount importance for assessing the degree of crossbreeding, preparing breed watch lists, accreditation of breeds and planning for breed conservation and genetic improvement programmes.

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published: **28.10.2023**

Livestock and Poultry Breeds:

Domesticated animals constitute an important genetic resource in the country that lends strength to the food and livelihood security in agriculture-based system. Despite contribution to the society, a large part of Animal Genetic Resources (AnGR) distributed all over the country is yet to be characterized, documented and evaluated scientifically. There are 212 registered breeds of livestock and poultry in India, which includes 53 breeds of Cattle, 20 of buffalo, 44 of sheep, 37 of goat, 7 of horses and ponies, 9 of camel, 13 of Pig, 3 of Dog, 3 of Donkey, 2 of Duck, 1 of Geese, 1 of Yak and 19 of Poultry in addition to many more not characterized and accredited so far.

Identification, characterization and documentation of AnGR

- Technical standards and protocols for breed survey and characterization is present.
- Both phenotypic and genetic characterization of more than 90% of the registered indigenous breeds.
- Molecular genotyping for diversity analysis in different livestock and chicken breeds and establishment of their phylogeny (More than 60% of the breeds have been documented).
- Information system on AnGR of India has been developed to inventorize and monitor trends.

Accreditation of Farm AnGR

- Registration of animal breeds to protect and check the bio-piracy of indigenous AnGR
- Accession numbers are given to each of extant breeds of various species of livestock and poultry.
- Publishing of Breed discriptors of extant breeds.

Conservation

Conservation of AnGR is generally defined as management of biosphere for the benefit of mankind of present generation while maintaining its potential to meet the future needs. It also refers to all human activities including strategies, plans, policies and actions undertaken to ensure that the diversity of animal genetic resources being maintained to contribute to food and agricultural production and productivity, or to maintain other values of these resources (ecological, cultural) now and in future. Three major strategies are normally followed in conservation of farm animal genetic resources. The first two i.e. *in situ* conservation as well as *ex situ* in vivo involves conservation of living population. The third, *ex situ* in vitro encompasses conservation of living

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published: **28.10.2023**

ova, embryo, semen, somatic cell or other animal tissue, DNA etc. stored cryogenically in liquid nitrogen.

As a best preferred method of conservation, *In situ* conservation of livestock through involving livestock keepers in the production system should be adopted to maintain a breed in a dynamic state. *Ex situ* in vitro (cryopreservation) should complement in- situ conservation.

In-situ Conservation

In situ conservation is the maintenance of live populations of animals in their adaptive environment or as close to it as is practically possible. For domestic species the conservation of live animals is normally taken to be synonymous with *in situ* conservation

In-situ conservation requires information on following points

1. Setting and regular review of conservation priorities and goals. Establishment of institutional structures and policies including specific measures to conserve breed at risk of extinction and to prevent breeds from becoming at risk.
2. Factors leading to erosion of animal genetic resources should be assessed for formulation of policies for breed(s) under risk.
3. Population status of the breeds in its native traits and outside the native tract. The basic population status may include the data on the year of data collection, total population size (range or exact), reliability of population data, population trend-increasing/decreasing/stable. Population basis census/estimate/survey whereas, advanced population statistics will include number of breeding males/females, percent of females bred to males of the same breed percent of males used for breeding, number of females registered in herd book/ register. AI usage and storage of semen/embryos, number of herd and average herd size.
4. The communities responsible for maintaining the breed in its natural habitat along with socio-economic status of them.
5. The breeding management of breed and the programme of government/NGOs in breeding of the animals for the genetic improvement.
6. Economic importance of the breed vis-à-vis all kind of expenditure on the maintenance of the breed.

Models for *in-situ* conservation in India:

1. Linking of genetic improvement programme for the breed with its conservation. The success of breeding programmes depends upon the responses of the animal keepers. It is better to run the genetic improvement programmes for the breeds under production so that animal keepers may get benefit by their utilization.

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published: **28.10.2023**

1. At farmer's herd/flock

Active participation of livestock owners and stakeholders is the best way to conserve the resources within their native breeding tracts. The native breeds especially those which are less productive can only be maintained as long as their minimum feed/fodder requirements are met under zero-low input system. So, the owners of the animals of the breed under risk may be give suitable incentives to save the breeds.

2. At organized government farms in their native breeding tract

In India, a large number of livestock farms under government and others are available who are concentrating on few selected breeds of livestock whereas not even a single farm are available for majority of the breeds. There is a need to earmark at least one livestock farm to each of the breeds of the livestock with fixed herd/flock strength.

The total number of government and other livestock farms in India are as follows:

SN	**Species**	**Livestock Farms**		
		Government	**Others**	**Total**
1.	Cattle	127 (+870 Gaushalas)	39 (+2215 Gaushalas)	166 (+3085 Gaushalas)
2.	Buffalo	26	2	28
3.	Goat	52	-	52
4.	Sheep	49	10	59
5.	Pig	150	-	150
6.	Camel	26	-	26
7.	Horse	17	-	17
8.	Rabbit	36	-	36
9.	Poultry	214	4355	4569
10.	Duck	57	2	59
	Total	**1343**	**6623**	**8247**

3. Research and development organizations

Many Research and development organizations like NBAGR (Karnal), specific specific ICAR institutes, SAUs, SVUs, State government Breeding units' area also maintaining the indigenous genetic resources and motivating the farmers for their adoption. The network project

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published: **28.10.2023**

on AnGR (ICAR) has already covered in-situ conservation programmes for Tharparker cattle, Nilgiri and Kilakersal sheep, Beetal and Surti goats and Spiti horse.

4. **Breeders' association and breeders' societies**

The animal keepers should be supported financially and technically for establishing breed societies so as to provide better marketing facilities. These societies should be in hands of the animal keepers under a democratic way without any political or government interventions but they should support them as and when needed. Breed societies are already running in the country for Chetak horse, Chilika buffaloes, Malaimadu, Ongole and Deoni cattle and many more.

5. **Participation of NGOs in *in-situ* conservation programmes**

The non-government institutes such as NGOs, Gaushala etc. may also play significant role in in-situ conservation of AnGR. Good NGOs involved in the conservation programmes may be invited for MOUs with the government. In rural conditions, some of the NGOs are doing commendable work like ANTHRA for Deccani sheep, SURE for Tharparkar cattle, LPPS for camels in Rajasthan and SEVA for Pullikulam cattle etc such organizations needs to be financially supported after developing a technical programme and targets to be achieved under the programme.

Ex-situ Conservation

Ex situ preservation involves the conservation of plants or animals in a situation removed from their normal habitat. It is used to refer to the collection and freezing in liquid nitrogen of animal genetic resources in the form of living semen, ova or embryos. It may also be the preservation of DNA segments in frozen blood or other tissues. Finally, it may refer to captive breeding of wild plants or animals in zoos or other situations far removed from their indigenous environment. Conservation strategies benefit from advances made in cryopreservation and reproductive technologies. Choice of types of genetic material to be preserved for different species highly depends on objectives, technical feasibility (e.g. collection, cryo-preservation), costs and practical circumstances.

Ex-situ conservation can be practiced by two ways:

In Vivo ex-situ conservation:

It requires colony relocation. The endangered AnGR are kept and bred in nucleus herds at public or private institutions or zoos, all of which house whole, protected specimens for breeding and reintroduction into wild when necessary and possible. Apart from housing, these also provide an aesthetic and educational value they inform the public of the threatened status of the species and of those factors which cause the threat, with the hope of creating public interest in stopping and reversing those factors which jeopardize a species survival.

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published: **28.10.2023**

Some special care has to be taken while allocating the animals at new place as the population becomes even more vulnerable to diseases as the animals are concentrated in only a few locations.

Ex-situ Conservation:

In Vitro ex-situ conservation:

Cryobiological principals:

Cryopreservation can involve gametes, embryos, somatic cells or primordial germ cells. The technologies for cryopreservation of different cells and tissues are at varying levels of development, cost and ease of application for different species. An assessment of the role of *in vitro* conservation in varying situations, is summarized in Table below. This assessment applies to the major mammalian livestock species. In poultry, cryopreservation of embryos and oocytes is not yet possible and somatic cell cloning has not yet been demonstrated.

Assessment of relevance and feasibility of cryopreservation for various purposes

Purpose	Semen	Embryos	Oocytes	Somatic cells	Primordial germ cells
Support breeding of small population	+++ ***	++ *	+ 0	0 0	0 0
Emergency (disease, war, natural disaster)	+++ ***	+ 0	+ 0	+ *	0 0
Breeding programmes	+++ ***	++ **	+ 0	+ 0	0 0
Backup of population in use	+++ ***	+++ **	0 0	++ *	+ 0
Trait selection	+++ ***	+++ **	+ 0	+ 0	0 0
Germplasm exchange	+++ ***	+++ ***	+ 0	0 0	+ 0
Breed reconstruction	+++ **	+++ ***	+ 0	+++ *	+ 0

+ = potential relevance of technology; * = current feasibility. A larger number of + and * indicates greater relevance or feasibility; 0 = no foreseeable relevance or not currently feasible.

Semen for Artificial Insemination:

Semen of most livestock species can be frozen adequately. Also, for a large number of birds and mammalian livestock species, dedicated freezing media and equipment for collection, packing, freezing and inseminating semen have been developed and are available commercially. Sperm cells are the endpoint of male spermatogenesis and have particular anatomic and metabolic features. Sperm cryopreservation and storage currently require liquid nitrogen or ultralow

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published: 28.10.2023

refrigeration methods for long- or short-term storage, which requires routine maintenance and extensive space requirements. Conserving sperms have several purposes apart from species conservation such as artificial reproductive technologies (ART) and clinical medicine. The present network of semen banks in India is essentially based on production, processing, storage and distribution of germplasm for those indigenous breeds which are included in breed improvement programme for milk production.

Oocyte for embryo transfer

It is done by preservation of ovarian tissue or entire ovary for transplantation, followed by oocyte harvesting or natural fertilization. The collected oocytes can be at any level of maturation including oocytes found in primordial, preantral, or antral follicles, each presenting its own special requirements and sensitivities. Remarkable progress has been made in last 20 years regarding cryopreservation of oocytes. Live born young ones from embryos produced from cryo-preserved oocytes have been reported in cattle, mouse rat, horse and human. However, the present efficiency and reliability of using frozen thawed oocytes for generating offspring is still much lower as compared to cryo preserved embroys.

Embroys or embryonic cells

In cattle, the cryo preservatin of embryos is highly successful. Both slow freezing and vitrification protocols are effective. The success of cryo preservation is dependent on the stage of the embryo; that is especially good results are obtained with blastocysts. Cryo-preservation of embryos resulting in live offspring has been reported in all important mammalian livestock species. Cryo-preservation of pig embryos is problematic, due to high lipid content of the pig embryos.

Somatic cell for reproductive cloning

In this, the nucleus of a somatic cell is removed and kept, and the host's egg cell is kept and nucleus removed and discarded. Now we have a lone nucleus and an empty (or deprogrammed) egg cell. The lone nucleus is then fused with the 'deprogrammed' egg cell. After being inserted into the egg, the lone (somatic-cell) nucleus is reprogrammed by the host egg cell. The egg, now containing the somatic cell's nucleus, is stimulated with a shock and will begin to divide. This technique is currently the basis for cloning animals (such as the famous Dolly the sheep), and in theory could be used to clone any animals. The use of nuclear transfer means that the original mitochondrial genotype of the nucleus is lost. In mammals, live offspring have been obtained from embroys generated from somatic cells in number of species, i.e. sheep, cattle, mice, pigs, goats, horse, rabbits and cats.

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published: **28.10.2023**

Cryo-preservation of important or unique genes:

Globally, the genes bank of complete genome sequence of many mammalian species is available. As per future demand the gene of interest may be introgressed in animal lacking the same using reproductive biotechnology.

Genomic DNA library

The genomic library contains DNA fragments representing entire genome of an organism. It contains large fragments of DNA in either bacteriophages or bacterial or P1-derived artificial chromosomes (BACs and PACs). The evolutionary studies can be performed using the genomic DNA library since it contains both coding and non-coding regions of DNA.

cDNA library:

cDNA libraries are made with cloned, reverse-transcribed mRNA, and therefore lack DNA sequences corresponding to genomic regions that are not expressed, such as introns and 5′ and 3′ noncoding regions. cDNA libraries generally contain much smaller fragments than genomic DNA libraries, and are usually cloned into plasmid vectors. So, the advantage is that it contains only the coding regions of DNA.

Ex situ and *in situ* conservation are not mutually exclusive. Frozen animal genetic resources or captive live zoo populations can play an important role in the support of *in situ* programmes. *In situ* conservation approaches are to be preferred as a method of conservation where maintenance and management of the AnGR is the best available livelihood option for the farmers involved. *In situ* conservation should be established as a preventive measure to protect against loss of the AnGR. The relative advantages and disadvantages of the major systems are therefore reviewed here with a view to identifying the relative strengths and areas of mutual support.

		Ex Situ	***In Situ***
i.	COST - initial set up cost	rel high	low-high
	- maintenance cost	low	rel low-high
ii.	GENETIC DRIFT - initial	rel high	low
	- annual	none	moderate-high
iii.	Applied to all species	no	yes
iv.	Safety/reliability	good-bad	moderate

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published: **28.10.2023**

v.	Local access	mod-poor	mod-good
vi.	International access	good	not good
vii.	Population Monitoring	none	good
viii.	Environmental adaptation	none	good
ix.	Selection for use	none	good

Selected Readings

Alderson L., 2009. Breeds at risk: Definition and measurement of the factors which determine endangerment. Livestock Science, 123, 23-27.

Designation of repositories under the biological diversity act, 2002. Order no.26-15/2007-csc dated 28 Aug, 2008, Ministry of environment and forests, Govt. of India.

FAO. 2021. Status and trends of animal genetic resources – 2020. Commission on Genetic Resources for Food and Agriculture. Eighteenth Regular Session, 27 September to 1 October 2021. CGRFA-18/21/10.2/Inf.6. Cited 10 October 2021. www.fao.org/3/ng620en/ ng620en.pdf

Gandini G.C:, Ollivier L., Danell B., Distl O., Georgudis A., Groeneveld E., Martiniuk E., Van Arendonk J,. Woolliams J. 2004. Criteria to assess the degree of endangerment of livestock breeds in Europe. Livestock production science 91: 173-182.

ICAR-NBAGR (2016) Guidelines for Management of Animal Genetic Resources of India. National Bureau of Animal Genetic Resources (Indian Council of Agricultural Research), Karnal (Haryana), India, 163 p.

Santiago, E. & Caballero, A. (1995). Effective size of populations under selection. genetics 139: 1013 1030.

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com

Published: **28.10.2023**