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CONSERVATION OF ANIMAL GENETIC RESOURCES: A REVIEW

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ABSTRACT

The diversity of cattle, sheep, goat, pig, poultry and other farm animal species represents an irreplaceable source of traits for livestock development in response to environmental changes and human needs. However, many of these genetic resources are being eroded as a result of certain changes in agricultural practices, economic, environmental and other factors. That of particular concern are the high rates of loss of local/indigenous breeds in developing countries, which, coupled with inadequate breeding programs for the efficient use and proper management of these genetic resources, is negatively impacting on livelihood options for the poor. Since the beginning of this century, the loss of genetic diversity within and between species have been a major concern as this could have serious consequences on the ability of these species to respond to future production constraints. Genetic diversity has traditionally been accessed from pedigree, however, with the advances in molecular genetics new opportunities have emerged. In this review, we examined different methods for accessing and conserving animal genetic diversity and as well examined current strategies for the conservation of farm animal resources.

Keywords: Animal Genetic Resources, Genetic diversity, *In Situ* Conservation, *Ex Situ* Conservation Genetic Conservation Method

INTRODUCTION

Global diversity in domestic animals is considered to be under threat. Worldwide, a large number of domestic animal breeds is endangered, in a critical status or extinct already. Out of the 6379 domestic animal breed populations, 9% is in critical condition and 39% is endangered (FAO, 2000). Furthermore, particular concern are the high rates of loss of indigenous breeds in developing countries, which, coupled with inadequate programs for the use and management of the genetic resources, is negatively impacting on livelihood options for the poor. The need to reduce the degradation of farm animal genetic resources and establish programmes for their conservation and sustainable use is well recognized (Gibson *et al.*, 2006).

Conservation means the management of the human use of the livestock so that, it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations (Buvanendran and Hodges, 1984). Conservation of animal genetic resources are human activities, including strategies, plans, policies and actions undertaken to ensure that diversity of animal genetic resources is maintained to contribute to food and agricultural productions and productivity, or to maintain values of these resources (ecological, cultural) now and in the future (Menezes *et al.*, 2015). There are several factors that place breeds at risk of extinction and threaten livestock diversity. For example, Rege and Gibson (2003) suggest that the use of exotic germplasm, changes in production systems, changes in producer preference because of socio-economic factors, and a range of disasters (drought, famine, disease epidemics, civil strife and war) are the major causes of genetic erosion. The objective of this paper is to review the various methods of conserving animal genetic resources.

ANIMAL CONSERVATION METHODS

There are basically two ways to conserve animal genetic diversity viz: *in-situ* and *ex-situ*.

***In situ* conservation:** The *in situ* in its strictest sense refers to the maintenance of living head of domestic animals mostly under the original environment (Koehler-Rollefson and Meyer, 2014). In the context of livestock diversity, *in situ* conservation is primarily the active breeding of animal



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populations for food and agricultural production such that genetic diversity is best utilized in the short term and maintained for the longer term.

Ex situ conservation: The *ex situ* conservation means conservation away from the production systems where the resource was developed or is now normally found and bred (Koehler-Rollefson and Meyer, 2014). This includes both maintenance of live animals (*ex situ in vivo*) gene banks and cryoconservation. It deals with protection of biological diversity components outside their natural habitats (Glowka *et al.*, 1994). It also provides the opportunity to study the biology of and to understand the threats to endangered species in order to eventually consider successful species recovery programs, which would involve restoration and reintroduction (Borokini, 2013).

Ex-situ in-vivo Conservation: This type of *ex situ* conservation is the maintenance of live animal populations in environments that are not their normal management conditions (e.g. in zoological parks or governmental farms) and/or outside the area in which they evolved or are now normally found. Because the animals are kept outside their normal production environments and their numbers are small, natural selection is usually no longer effective in its role of ensuring the adaptation of the population to these environments.

Cryopreservation: Cryopreservation is a technique that allows virtually indefinite storage of biological material without deterioration over a time scale of at least several thousands of years (Mazur, 1985). Important progress in cryobiology was achieved in the second half of the previous century. In this method, the biological material is cooled at a range of cooling rates that are fast enough to prevent 'slow cooling damage' but are slow enough to allow sufficient dehydration of the cells to prevent intracellular ice formation (Mazur, 1972).

Cloning

Nuclear transfer technology, popularly known as cloning is a technique whereby new individuals are created in the laboratory from the nuclear DNA of other individuals, this has a history that extends back to the late nineteenth century when Driesch (1892; cited by Di Berardino 2001) produced sea urchin larvae from isolated blastomeres.

Application of cloning technology to conservation efforts for endangered species (Ryder and Benirschke 1997) was an immediate result from Ian Wilmut's 1997 report of the cloning of Dolly (Wilmut, 1997). This cloned sheep evidenced normal reproduction capability, giving birth to six lambs. Later, it presented articulation problems and premature ageing and as a result, it was culled when it reached six years of age (Shields *et al.*, 1990 and Lanza *et al.*, 2000).

Gene banking: Gene banks are considered to be the key and most dynamic instrument for *ex situ* conservation of AnGR (Paiva *et al.*, 2014). Genome resource banking is the systematic collection, storage, and re-distribution of biomaterials in an organized, logistical, and secure manner (Agca, 2012). The ability to acquire samples cryopreserved in the past facilitates a gene bank's acquisition of additional genetic diversity (Blackburn, 2012). Its advantages includes acquiring germplasm/tissue, enhance the genetic variability for in situ populations of several rare breeds; provide breeders with larger breeds with genetic variability to use in their breeding programs, and for molecular genetics and reproductive physiology research (Blackburn, 2012).

CURRENT ANIMAL CONSERVATION STRATEGIES

Live Animals Conservation Live-animal conservation in reproducing herds is the most frequently adopted conservation method. It is an attractive method, allowing adaptation of the breed to changing production and environmental conditions and an immediate use of animals for evaluation, research and commercial breeding.

Semen Cryopreservation: Sperm is one of the most practical means of storing germplasm due to its abundance and ease of application (Rischkowsky, and Pilling, 2007). Preserved frozen-thawed semen of superior males of endangered livestock could be reintroduced into the population either through in vitro fertilization (IVF) or artificial insemination (AI). It has the potential to retain existing diversity and maintain heterozygosity while minimizing live animal transport (Johnston and Lacy, 1995). Semen from most mammalian and few avian species have proven to be successfully frozen in the past (Rischkowsky, and Pilling, 2007).



Oocytes Cryopreservation: Female gametes (ova) can be obtained through follicle puncture, ovarian tissue biopsies, unilateral or bilateral ovariectomy, or ovary collection immediately after an animal's death, irrespective of its age (Domingues, et al., 2007). In the last few decades, considerable progress has been made with cryopreservation of oocytes. Viable oocytes have been recovered after freezing and thawing in a great number of species. However, freezing oocytes of avian and fish species is not successful (Blesbois and Labbé 2003) largely because of the large size, the high lipid content, and the polar organisation (vegetal and animal pole) of bird and fish ova.

Embryo Cryopreservation: Embryo cryopreservation allows the preservation of the full genetic complement of both dam and sire and has incredible opportunities for preserving heterozygosity and population integrity. Embryos of virtually all mammals have been successfully frozen, thawed, and transferred to synchronize recipient females in the past; however, embryos from species such as swine or equine are much more sensitive to cryopreservation when compared to bovine or ovine embryos (Houmllker, 2005). Table 1 show the current status of cryopreservation in different animal species

Table 1: Current Status of Cryopreservation Techniques in Different Animal Species

Animals	SMN	OCY	EMB	SMC
Cattle	+	+	+	+
Sheep	+	0*	+	0
Goat	+	0	+	0
Horse	+	0	0	0
Pig	+	0	0	0
Rabbit	+	0	+	0
Chickens	+	-	-	-

SMN = Semen

OCY = Oocyte,

EMB = Embryo,

SMC = Somatic Cells,

+ = Routine techniques available,

0 = Positive research results,

- = not feasible in the current state of art,

* Cryopreservation of whole ovary.

(Source: Adapted from Mujitaba et al., 2020).

Somatic Cells Cloning (Somatic Cells Nuclear Transfer SCNT): Somatic cell nuclear transfer (SCNT) in mammals is an assisted reproductive technique used to produce an animal from a single cell nucleus using an enucleated oocyte as a recipient (Ogura et al., 2013). As somatic cells can be proliferated and gene-modified in vitro, this technique has been expected to contribute extensively to the farm animal production industry, drug production, regenerative medicine and conservation of invaluable genetic resources (Vajta, 2007; Oback, 2008). Besides its broad practical applications, SCNT can provide unique and interesting experimental systems for genomic research, especially in epigenetics, to learn how the somatic cell genome is reprogrammed into a state equivalent to that of the fertilized oocyte: the so-called totipotent state (Gurdon and Wilmot, 2011).

CONCLUSION

It can be concluded that, loss of farm animal genetic resources is occurring at an alarming rate across the globe. In situ and ex situ are the two major techniques that permit further conservation of animal genetic resources. Cryopreservation allows the conservation of genetic resource at seminal, oocyte, embryo and somatic cells levels. It allows for maintaining viability of the cryopreserved AnGR for an indefinite period. There are positive research results on oocytes and ovarian tissue cryopreservation and this has lead an appreciable success that warrants the establishment of gene banks across many countries.

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