DOI: https://doi.org/10.59913/dagr.2024.18009

# Biotechnology assisted approaches in the preservation of rare breeds' diversity

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## Abstract

Preservation is defined within the concept of conservation. It is an aspect of conservation, by which a sample of an animal genetic resource population is designated to an isolated process of maintenance, by providing an environment free of human forces, which might bring about genetic change. The process may be run *in situ* (*in vivo*) in natural environment; it may be run *ex situ* (*in vivo*) or cryogenic storage (*in vitro*). The *in libro* concept of preservation is the conscious "keeping alive" of the one-time presence of an already extinct domestic animal breed or all the characteristics.
When the term "biotechnology" was coined, it meant the process, by which raw materials can be biologically transformed into socially useful products with the help of living organisms (fermentation). The production of special foods that are matured in a controlled manner from the milk and meat of old domestic animals may be an area to be exploited more strongly in the future. Later, reproductive biotechnology, several biotechnical procedures have been developed, such as embryo transfer (ET) and artificial insemination (AI). There are many other reproductive techniques, ranging from cloning to sperm and embryo cryopreservation, including hormonal control of reproduction (e.g., induction of cyclicity and parturition). These biotechnological methods are already widespread in everyday animal production and have gained a reasonable right to exist in breed maintenance as well.
The applications of biotechnology are diverse, and it is necessary to use the areas of its application that result in the legal and effective preservation of genetic diversity of rare animals.

Keywords: genetic diversity, food fermentation, reproductive techniques, genetic engineering of animals

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## Introduction

The manuscript is a written version of the plenary presentation on the 8th Winter School on Animal Biotechnology 2024 with topic „Animal Biotechnology and Biodiversity” (in AgroBioTech Research Centre, Slovak University of Agriculture in Nitra, Slovakia), 1st February 2024.
Considering the title of the event, I chose the topic of my presentation. By connecting the two activities, we can review the options and procedures that can be used to bring the preservation of our old, endangered domestic animal breeds up to date.

At the beginning, I would like to briefly define the concepts of conservation and preservation.
The definition of conservation (of genetic resources) can be given as follows: The management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential in concordance with the Convention on Biological Diversity of Rio de Janeiro, 1992. It tells about the fair and equitable sharing of the benefits arising from commercial and other utilization of genetic resources. This activity includes preservation.

The preservation aspect of maintenance by which a sample of an animal genetic resource population is designated to an isolated process of maintenance, by providing an environment free of human forces which might bring about genetic change.
This may even include wild species threatened by extinction, but we are now narrowing down this definition to endangered domestic animal breeds.
At the same time, we immediately see its three versions (*in situ*, *ex situ in vivo*, and *ex situ in vitro*), in which biotechnology can play a role.

When a separate section was created in the EAAP for breed preservation first (in the 90s), the young people gave the definition of the term: a session of EAAP where old people talk. Since then, the situation has improved a lot, thanks in part to the rise of biotechnology.

When the term "biotechnology" was coined, it meant the process by which raw materials can be biologically transformed into socially useful products with the help of living organisms (fermentation).
Later, new branches of this were formed, which even lack the intermediate (micro)organism. In some of these, sub-organismal units of a living being are used, in others, it is purely about technical operations and organizational issues.

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In 1989 Robert Bud gave account of the fact that the father of the term "biotechnology" was the Hungarian agricultural engineer, Karl Ereky (1878-1952), 1919.
No such "father" has been named in the field of breed maintenance. In any case, one of its prominent representatives was Imre Bodó (1932-2023), who died in December. I would also like to project his personality, because today's generation can learn a lot from his work.
According to another funny definition, which became winged words in Hungary biotechnology is "what László Kállai (1927-2007) gives money for". He was the curator of the distribution of application resources in the 1980s, when more and more biotechnology applications were submitted from the field of agricultural science.

Biotechnology has numerous applications, particularly in medicine and agriculture. So, we can group this according to the nature of the utilization area.
This can be arranged according to the objectives to be completed (e.g., healing and production).
A reasonable resolution can be made according to the means (methodology) of the process. For example, exploring the use of microscopic equipment that can enter the human body (nanotechnology), next to embryo splitting.
In addition, the direct biotechnology processes are surrounded by ancillary scientific fields and miscellaneous supplementary tasks for the sake of completeness. Like bioinformatics. Safety precautions fall under two principal headings, occupational safety and public safety.
Finally, we must mention the consequences of biotechnology procedures. We do not yet know much about their direct and indirect forms. We have significantly different opinions on the application of biotechnology procedures. Whereas U.S. regulation of GM foods is based on the product, European Union (EU) regulations are based on the process. As a result, the EU regulates GM plants and animals more stringently, and European publics are wary of genetically engineered foods.

Today, eight branches of biotechnology are distinguished, which are also usually displayed in different colours.
Red biotechnology involves medical processes, such as using organisms to produce new drugs and stem cells to regenerate damaged human tissues and grow and regrow entire organs.
White or grey refers to industrial processes, such as the development of new chemicals or new biofuels for vehicles. Additionally, the environmental biotechnology which application is to develop sustainable environmental practices that reduce pollution and waste. (The following are its examples: phytoremediation uses genetically engineered microorganisms to purify soils of heavy metals and other pollutants. Bioremediation. Plastic-eating bacteria breaks down waste such as plastic in soils and water.

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Blue encompasses processes in marine and aquatic environments, such as converting aquatic biomass into fuels and pharmaceuticals.

The following two branches of biotechnology are related and affect us the most due to our profession.
Green covers agricultural processes, such as producing pest-resistant crops, disease-resistant animals and environmentally friendly agricultural practices.
Yellow refers to processes that aid food production. Approximately 6,000 years ago, humans began to tap the biological processes of microorganisms in order to make bread, alcoholic beverages, and cheese and to preserve dairy products.

Gold, also known as bioinformatics, is a cross between biological processes and informatics. It refers to the methods researchers (healthcare workers) use to gather, store and analyse biological data to solve problems (treat patients) and make useful products. Here we can cite the precision farming and the use of artificial intelligence. Most notably, the singularity would involve computer programs becoming so advanced that artificial intelligence transcends human intelligence, potentially erasing the boundary between humanity and computers.
Legislation in violet ensures the practice of biotechnology is in compliance with laws and ethical standards governing each field.
Biotechnology also comes with misuse and disadvantages. The former one is shown in dark or black which is the use of biotechnology for weapons or warfare.

The next slide, partly as a continuation of the previous one, presents the main disadvantages of biotechnology, which are as follows: biological warfare, high costs, safety questions, ethical considerations.
Concerns about biotechnology's disadvantages have led to efforts to enact legislation restricting or banning certain processes or programs, such as human cloning, GMOs and embryonic stem-cell research.
The disadvantages include the reduction of soil fertility and biodiversity.
Seeing this, one can question whether we can really use biotechnology to preserve genetic diversity and old domestic animal breeds.

If the answer is “yes”, it is obvious that the application area of biotechnology in the preservation of old breeds is the agriculture, including animal husbandry.

When the term "biotechnology" was coined, it meant the fermentation. The production of special foods that are matured in a controlled manner from the milk and meat of old domestic animals may be an area to be exploited more strongly in the future.
Biotechnology gradually gained appreciation in the reproduction of our old rare breeds as well.

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Several biotechnical procedures have been developed for both the female and male side. Such as embryo production (ET) and artificial insemination (AI). There are many other reproductive techniques, ranging from cloning to sperm and embryo cryopreservation, including hormonal control of reproduction (e.g., induction of cyclicity and parturition). These are the biotechnological methods that are already widespread in everyday animal production and have gained a reasonable right to exist in breed maintenance as well.

In-depth characterization of a breed now undoubtedly includes direct DNA testing by use of microsatellites, SNPs, longer and shorter DNA segments- and whole genome sequencing. Moreover, in some cases, QTL association analyses and gene expression studies. Soon, genomial breeding value will also be estimated in the old breeds. The molecular genetic screening of monogenic defects is also spreading in these breeds. It is important to check pedigree data, paternal lines and maternal families with molecular genetic tools. It is urgent to introduce molecular genetic control of parentage and individual identity and food chain, to calculate coefficients of molecular inbreeding and degree of kinship.

Well, now let's take a look at the preservation variants which can now be considered crystallized. Certain biotechnological methods or biotechnical procedures have already been used, or may be used in the future in these. The variant may be in situ whereby the pool consists of live animals (*in vivo in situ*) in natural environment. During the maintenance of endangered animals in situ, we must pay attention to the regular, original use (in traction, and raw material and food production), breeding, feeding, and housing of the animals.

It may be ex situ, whereby the sample is placed, for example in rescue station (*in vivo ex situ*, this is called as the "necessary but wrong solution" in quotation marks, but not at all (test station, centralized sire rearing, zoos etc.) or cryogenic storage (*in vitro ex situ*). The *in libro* concept of preservation is the conscious "keeping alive" of the one-time presence of an already extinct domestic animal breed or characteristics lost by today and remaining knowledge of a still living rare breed in our common knowledge.

Looking back from today's time, it is very interesting that the preservation of *tissues and genes* separately was envisioned decades ago among in vitro methods.

I note that the concept of breed preservation is often replaced by gene conservation in public life. In any case, if we indicated the preservation of separated genes in this form, then this already gained the right to exist. Genes are transferred from one breed to another with traditional crossing in vivo (*gene introgression*) and preserved in the recipient breed with accelerated back-crossing (MAS – *marker assisted selection*). An example is the creation of genetically hornless Limousine cattle in the practical breeding or congenic strains in the laboratory animal science.

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The *gene rescue*, an additional, novel element of domestic breed maintenance program, is based on this principle. Which is strongly connected with the *in libro* version. In other words, if we find a trait believed to have disappeared in an individual of a country herd, we can return it to the breed in question, from which this trait has disappeared (example: winter hair coat whitening of horse).

Another important technique used in biotechnology includes *tissue culture*, which allows us to grow cells and tissues in a laboratory for research and medical purposes. From the point of view of breed maintenance, it can be an interesting, sub-organismal unit for the storage of genetic resources (gene conservation). If necessary, these (embryonic) cells merged (blastocyst fusion) can develop into an organism (a breed identical chimera). *Mitochondrial replacement therapy* (MRT) and *three-parent in vitro fertilization* (IVF) introduce more genetic information. It draws attention to the special treatment of multiparental inheritance (crossed maternal lines, *heteroplasmy*) and *epigenetic effects*.
Most novel, and at the same time in the animal production most critical key technique of biotechnology is *genetic engineering* allowing us to alter the genetic makeup of organisms to realize the requested properties.

At the very theoretical level of breed maintenance, it is possible to consider the precise introduction of the desired allele of a genetically healthy breed mate into another one which requires modification of its dysfunctional or harmful allele (breed identical transgenic animal).
Melioration may include insertion/replacement of genes responsible for resistance (heat, parasites etc.).
Possibly applying techniques of stem cell research and cloning to replace dead or defective cells and tissues (regenerative medicine).
Genetically modified organism (GMO) foods of plant origin (e.g. tomato) stay fresher longer and reduce food waste.

## Conclusion and recommendation

Today's opportunities and needs result in a certain amount of change. The applications of biotechnology are diverse, and it is necessary to use the areas of its application that result in the legal and effective preservation of genetic diversity of rare animals.

References are available at the Author.