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**EVOLUTION OF THEORY AND METHODOLOGY  
OF PRESERVATION OF FARM ANIMAL BIODIVERSITY AS  
BASIS FOR DEVELOPMENT OF UKRAINIAN ANIMAL  
SCIENCE**

*The author has demonstrated the global nature of the problem of domesticated animal gene pool preservation caused by intensive using some transboundary breeds and reduction in the number of aborigin and local ones. Ignoring this problem leads to loss of biodiversity, the restoration of which with traditional methods of breeding work is not possible. The main aim of the article to highlight the key milestones of forming of the theory and methodology of farm animal gene pool preservation, contribute of Ukrainian scientists to the development of the some specific approaches. The author has proved they have developed evolutionary, anthropological, ecological, synergistic, cultural approaches for stabilization the number of the domestic aborigin and local breeds. The problem solution is based on a combination of the whole complex of factors: theoretical and methodical, organizational, economic and technological. Nowadays cryopreservation of biomaterials is the dominant form of farm animal gene pool preservation. The article shows development of modern strategies of farm animal gene pool preservation should be based on the use of the most effective methods have proposed and verified by some scientists in the last century. The author used the special historical and scientific methods of research.*

**Key words:** farm animals, animal science, animal husbandry, gene pool, preservation, crioconservation, gene bank.

# **ЕВОЛЮЦІЯ ТЕОРІЇ ТА МЕТОДОЛОГІЇ ЗБЕРЕЖЕННЯ БІОРІЗНОМАНІТТЯ СІЛЬСЬКОГОСПОДАРСЬКИХ ТВАРИН ЯК ОСНОВА РОЗВИТКУ УКРАЇНСЬКОЇ ЗООТЕХНІЧНОЇ НАУКИ**

*Авторка продемонструвала, що глобальна сутність проблеми збереження генофонду домашніх тварин зумовлена інтенсивним використанням транскордонних порід і зменшенням кількості аборигенних і локальних порід. Ігнорування цієї проблеми призводить до втрати біорізноманіття, відновлення якого традиційними методами селекції є неможливим. Основна мета статті – висвітлити ключові віхи становлення теорії і методології збереження генофонду сільськогосподарських тварин, внесок українських учених у розвиток окремих наукових підходів. Автор довів, що вони розвинули еволюційний, антропологічний, екологічний, синергетичний, культурологічний підходи стабілізації кількості вітчизняних аборигенних і локальних порід. Вирішення цієї проблеми ґрунтується на поєднанні всього комплексу факторів: теоретичних і методологічних, організаційних, економічних і технологічних. На сучасному етапі кріоконсервація біоматеріалу є домінуючою формою збереження генофонду сільськогосподарських тварин. Стаття показує, що розроблення сучасної стратегії збереження сільськогосподарських тварин повинно ґрунтуватися на використанні найбільш ефективних методів, які були запропоновані і випробувані деякими вченими в минулому столітті. Автор використав історичні та наукові методи дослідження.*

**Ключові слова:** сільськогосподарські тварини, зоотехнічна наука, тваринництво, генофонд, збереження, кріоконсервація, генофондовий банк.

# **ЭВОЛЮЦИЯ ТЕОРИИ И МЕТОДОЛОГИИ СОХРАНЕНИЯ БИОРАЗНООБРАЗИЯ СЕЛЬСКОХОЗЯЙСТВЕННЫХ ЖИВОТНЫХ КАК ОСНОВА РАЗВИТИЯ УКРАИНСКОЙ ЗООТЕХНИЧЕСКОЙ НАУКИ**

*Автор продемонстрировала, что глобальная суть проблемы сохранения генофонда домашних животных обусловлена интенсивным использованием трансграничных пород и сокращением количества аборигенных и локальных пород. Игнорирование этой проблемы приводит к утрате биоразнообразия, восстановление которого традиционными методами селекции является невозможным. Основная цель статьи – осветить ключевые вехи становления теории и методологии сохранения генофонда сельскохозяйственных животных, вклад украинских ученых в развитие отдельных научных подходов. Автор доказала, что они развили эволюционный, антропологический, экологический, синергетический, культурологический подходы стабилизации количества отечественных аборигенных и локальных пород. Решение этой проблемы основывается на объединении всего комплекса факторов: теоретических и методологических, организационных, экономических и технологических. На современном этапе кріоконсервація біоматеріала*

*является доминирующей формой сохранения генофонда сельскохозяйственных животных. Статья показывает, что разработка современной стратегии сохранения сельскохозяйственных животных должна основываться на использовании наиболее эффективных методов, которые были предложены и апробированы некоторыми учеными в прошлом столетии. Автор использовала исторические и научные методы исследования.*

**Ключевые слова:** сельскохозяйственные животные, зоотехническая наука, животноводство, генофонд, сохранение, криоконсервация, генофондовый банк.

One of the global problems is biodiversity preservation including gene pool of the farm animals. Animal husbandry development is accompanied by processes intensive using some commercial breeds that leads to reducing of populations of the aborigen and local breeds which have highly adaptive and resistant properties, constitutive durability, vitality, simplicity to feed, reproductive and maternal quality, long period of productive exploitation and so on.

Breeding of the commercial transboundary cattle breeds such as Holstein does not always lead to the expected results. The local breeds are dominated by transboundary ones in terms of their fertility, resistance to certain infectious diseases and adaptation to extreme environmental conditions. Therefore, the disappearance of the original breeds may become irreversible loss of the genes and irreparable damage for further breeding work. As is known, gene pool of the aborigen and local breeds successfully have used for creation of the new breeds and it is the only reserve of genes to correct possible threshold selection.

Nowadays White-Head and Gray Ukrainian, Lebedynska cattle breeds have almost disappeared in Ukraine. Simmental, Red Steppe and Brown Carpathian breeds have included in the category of local breeds. Similar situation is typical for animal husbandry of other countries. In particular Italy, France, Holland, Great Britain, Hungary, Romania, Czech Republic, Slovenia, Poland, Russia and others have developed programs for domestic breed preservation.

In 1946 according to the decision of the Advisory Committee on Agriculture of International Food Organization (FAO) is responsible for plant and animal gene pool evaluation and preservation. A number of international and regional forums and

conferences have taken place at its support. Working group for evaluation, rational using and conservation of genetic resources was formed in 1966 by decision of the 13<sup>th</sup> session.

To support *in situ* and *ex situ* preservation and rational using of farm animal genetic resources the European Regional Focal Point for Animal Genetic Resources (ERFP) was established in 2001. ERFP facilitates the collaboration, coordination of work and exchange of information and experience between different European countries and governmental and non-governmental organizations.

The author suggests it is necessary to explore the most effective scientific approaches to biodiversity preservation have been proposed by some scientists in the XX century for development of modern strategy of evaluation, management and preservation of gene pool of the domesticated animals.

The aim of this research is updating problems of farm animal gene pool preservation as part of biodiversity, synthesis of the scientific developments of Ukrainian scientists applied for the rational using and preservation of main cattle breeds at different periods of breeding work. The main attention was focused on highlighting of the scientific approaches, which should be use in developing a modern strategy of domesticated animal gene pool preservation. The author used the special historical and scientific methods of research. Research methodology is based on using a systematic approach.

Scientists of classical period of animal science have used evolutionary theory as the basis for forming of the doctrine of gene pool preservation, because objective analysis and scientific study of the selection and genetic processes are impossible without knowledge of breed evolution. The fundamentals of evolutionary theory have formulated by Charles Darwin on base a synthesis of biological sciences. Scientist has applied the fundamentals of ecology as a science studying the relationship between organisms and the environment during its life.

M. Vavilov, N. Kolesnik, Yu. Lyskun, A. Serebrovsky, A. Filipchenko, I. Shmal'gauzen and other Soviet scientists have made a significant contribution to the evolutionary theory. In particular, A. Filipchenko has coined the term

«microevolution» in 1927 to identify a number of issues concerning the variability occurring in plants and animals as a result of divergence from population to specie level. Volatility is especially important in domestication and different from macroevolution.

The particularly important issues of establishing of farm animal geographical distribution, frequency of alleles that determine the main features and properties within the area of investigated species or their part were considered by A. Serebrovsky. He is founder of a new scientific direction – genetic geography, its practical significance is to establish of gene pools of the farm animals and crops as one of the foundations of the waste zoning and breeding. The scientists has introduced the term «gene pool» to scientific use, raised the issue of organization of the special farms for farm animal preservation.

Methodological basis of biodiversity of domesticated animal preservation is M. Vavilov's doctrine of centers of cultivated plant and domestic animal origin that promotes the rational using and preservation of the world's genetic resources. Significant scientific M. Vavilov's achievement is also law of the evolutionary stages. The foundation of the homologous series is parallelism of genotypic variability of individuals with a similar gene placement. This law explains polymorphism of the species and its integrity, reflects the overall pattern of mutation process and shaping of organisms. It is a biological basis of the methods for targeted obtain the desired genetic changes and further breed improving [3, 4].

The Ukrainian scientists have used craniology as basis of the farm animal preservation. In particular, Yu. Lyskun first researched craniological types of the farm animals, identified centers of breed origin including six European and three Asian. In the same time M. Kolesnik has prepared a map of the world centers of origin, evolution and ecology-geographical differentiation of the farm animals [7].

S. Chetverykov also has made a important contribution in the development of evolutionary theory, substantiated a number of conceptual scientific statements. In particular, he has proved that the mutation process in natural populations is constantly, most of the mutations reduce animal viability. At a free mating specie

keeps ratio of gene frequency, each recessive mutation is «absorbed by specie» in the heterozygous state and in the case absence of selection can be stored indefinitely. He has explained that numerous specie splits into isolated colonies; isolation is a major factor intra- and inter-specific differentiation in the same time with the genetic variation. According to the findings of the scientist, adaptive evolution without isolation leads to the transformation of species; panmixia leads to an increasing specie polymorphism, etc [12].

I. Shmal'gauzen in the late 30s of the XX century has formulated the theory of stabilizing of selection, which explains the existence of specie stability, the role of mutations as the basic foundations of evolution. He has proved important modifications to the evolutionary process and made interpretation of the evolution as independent system, in this case the role of the main way takes natural selection. Using materials of genetics, zoogeography, ecology and embryology, scientist has substantiated that evolution is based on sophisticated combinations of minor mutations determining organism changes. Both the hereditary and non-hereditary change provide by the same mechanism of shaping of the reactions, which appear as a result of a long historical development. The adaptive modifications cause genotype restructuring at new stable environmental conditions, which include the loss of the reactions having no previous role under these conditions and stabilization of new ones [13].

A. Browner has researched of origin, evolution and conservation of the farm animal breeds. He has proposed classification of process of breed creation and formulated the basics of zoological animal science using osteology and osteometry methods. His classification of cattle is a fundamental generalization of historical connection of the geographical species and breeds. The researcher has explained the importance of cultural and economic factors of farm animal evolution [1].

The scientific researches of some Ukrainian scientists is based on the problem of preserving the breed gene pool as a result of anthropological factors. The methodological basis of this approach is A. Vernadsky biosphere doctrine, his new interpretation of noosphere. His noospheric concept bases on the fact that human is

not only a logical evolutionary link aimed cephalization and improvement of higher nervous activity, but primarily an intelligent and energetic force with creative conscious of organizer of biosphere process, able to assume the function of managing of environmental sphere planet. A. Vernadsky doctrine of biosphere and its transition into the noosphere is the theoretical basis for environmental protection, breed gene pool preservation as an important component of the biosphere [5].

The law of symmetry in animal husbandry is also significant scientific heritage of A. Vernadsky. Its use in the selection process makes it possible to determine the population status of breed and features chosen for this evaluation; compare various options of crossing foreign and domestic breeds and determine the optimal combination; create model animal type for each breed. Assessment of farm animal constitution, the rate of reaction in relationship «genotype – environment» is impossible without studding of symmetry of the indexes.

In 30-70s of the XX century scientific research of Ukrainian scientists based on study of genotypic and paratypic factors of farm animal breeding. Thus, M. Ivanov's fundamental strategic approach on local cattle breeding was not only in its improvement on base of improved methods of feeding and keeping, acclimatization the best foreign breeds and its reconstruction through complex reproductive crossbreeding with more productive breeds of foreign selection, interspecies and intergeneric hybridization, acclimatization and domestication of the wild species. He has proposed classification of the constitution types, complemented with strong type, that is desirable in farm animal breeding.

M. Potemkin has considered the biological relationship of form and function, offered selection of animals with a strong constitution as the basis for cattle breed preservation. He has outlined the program of domestic Simmental valuable property improvement and preservation. Among the planned measures he has considered as priorities: systematic inspection and examination, testing lines, pedigree books, regular exhibitions, instructions to assess the farm animals by a special scale for simultaneous use in farms and its examination at exhibitions, preparation of

perspective plans etc. Yu. Ruban has also developed a method of gene pool preservation that is based on the use of animal constitution indexes.

Special contribution to the development of the main provisions of the aboriginal and local cattle breed preservation was made by M. Kravchenko. As the main ways of increasing the efficiency of animal pure breeding he considered the optimization of line breeding, introduction of modified methods for assessing of farm animal herd value. His developments of the methodical bases of breed genealogy control, methods of cross-group pedigrees for gene pool herds are a priority in the world animal science. Scientists have substantiated inbreeding as a reliable source of creation animal with a record performance. M. Kravchenko has identified six its main types at line breeding, proved the most efficiency of complex one (per group of ancestors). He has proposed a model to calculate genetic similarity of an animal and its common ancestor at the inbreeding, as well as method of assessing its coefficient and ancestor part in the pedigrees. He has developed the measures to extend the productive use of farm animals, actualized the problem of its lifelong productivity.

F. Eisner is the creator of the original method of preservation of Ukrainian Gray Breed and increasing its variability in a closed herd. Applying inbreeding he formed a related group and used line breeding for two or three generations. In the second stage he used crossing of the related groups [14].

I. Smyrnov has developed a general biological theory of anabiosis, as well as the theory of spermatozoon cold shock, which were important to find further solution of the problem of domesticated animal gene pool preservation. In 1949 he has developed a method of mammal sperm physical hibernation from based on its glassy freezing at low temperatures ( $-78^{\circ}$ ,  $-183^{\circ}$ ,  $-196^{\circ}\text{C}$ ). The method of long term storage mammal sperm was the theoretical basis for the reorganization of breeding work through extensive introduction of artificial insemination, a radical improvement of the domestic farm animal gene pool through involvement of genetic resources of foreign selection in the selection process. This method provided the possibility of cryopreservation of genetic information, reclamation of lost life forms, creation new genetically modified objects. I. Smirnov has created the basis for the development of

a new scientific direction – farm animal reproductive biotechnology. Nowadays Ukrainian scientists have achieved success on the freezing of different species of farm animal sperm.

Culturological approach to farm animal gene pool preservation was developed by I. Huziev. He has formulated its basic postulate: to save all breeds as cultural and intellectual heritage. This applies to local and newly created commercial breeds, as well as purebred reserve of gene pool of the domestic micro populations of world's best genetic resources, which are necessary for subsequent use in breed creation process and different breed crossing.

In the second half of the XX century ecological approach to biodiversity preservation has also used in Ukrainian animal science. We recognize the famous American scientist E. Odum as its founder. He has grounded in the monograph «Ecology» (1968) that biological diversity as a whole and its some components are closely linked with the organization of ecosystems advantage of different genotypes is increasing of its stability. Subsequently, environmental and synergistic methods have developed by M. Zubets. He has noted that the basis of breed preservation and intensifying of breeding work – one of the law of uneven development of biological systems. In relation to the different breeds its effect is caused by different intellectual and material human contribution to its improving.

Nowadays cryoconservation of biomaterials is the dominant form of farm animal gene pool preservation. The problem of sperm banks organization was first discussed at the European Conference of FAO in 1972. Background its organization is rapid development of reproductive and cryo-biology in the second half of the XX century. One of the first banks of the valuable sire sperm organized in 1955 in Bavaria. The international corporation «Frisian sperm bank» opened in the Netherlands in the next year. In the second half of the 50s sperm sire bank established in Canada at the University of Guelph (Ontario). In the next decade a number of sperm banks have operated in the USA and UK, its activities was mostly commercial. In particular, in 1960 the company «British sperm export» sold more than 1,000 doses of bull semen [10].

In the USSR the first sperm banks have opened at Union and regional field research institutions and public associations, stations of farm animal artificial insemination. Its activities were aimed at finding famous bulls of different breeds and lines, creating sufficient semen resources, participate in intra- and inter-republican exchange of genetic material. In addition, they have developed the technologies of semen freezing and thawing, investigated the effects of various synthetic environments on its quality characteristics and so on. The first sire sperm bank in the Soviet Union was established in 1959 at the Central Station of Farm Animal Artificial Insemination by Academician V. Milovanov. It has a unique collection of semen of the outstanding sires of the domestic and foreign breeds of different species of farm animals, particularly they save more than 1.14 million of semen doses in 1972. Sperm bank of the outstanding sires was also established at the Central Experimental Station of Artificial Insemination of the Ukrainian SSR in 1965 [11].

Today Ukrainian scientists apply methods of biotechnology and genetic engineering including the transplantation of embryos, creating interbreed aggregate and injecting chimeras that can be used to save genetic information and its transmission to future generations, especially in cases where the use of traditional breeding techniques for some reason is difficult.

However, solving of problem of farm animal gene pool preservation only by cryoconservation of semen, ova and embryos is impossible. Breeding of female populations is also an essential element of this process. For this purpose they keep two or three gene pool herds in each breed to be protected from the effects of factors that can affect the frequency of genes (selection, mutation, migration). Under the conditions of market economy the preservation each of breeds is economically impossible, so the population must be minimal and genetically resistant [6].

Obviously, solving of problem of farm animal gene pool preservation should be based on a combination of the whole complex of factors: theoretical and methodical, organizational, economic and technological. In the last decades Ukrainian scientists have developed organizational foundations of farm animal gene pool preservation; its basic principle is breed adaptation to the certain climatic zones. They have introduced

the seven main organizational forms of the domesticated animal preservation including gene pool population, gene pool herd, selected animal farm, collections' nursery, farm of gene pool reserve, gene pool reproducer, bank of animal gene pool resources and other banks. They have initiated the development of the concept of creation and placement gene pool objects, its main link is bank of animal gene pool resources [8].

Twelve research institutes of National Academy of Agrarian Sciences of Ukraine carry out scientific program «Preservation of biodiversity and research of the farm animal minority populations and its use in the breeding process». The Institute of Animal Breeding and Genetics (IABG) is main institution that coordinates its activities. Bank of Animal Gene Pool Resources of IABG has been recognized as a national treasure in 1986. Today the gene bank has 145.5 thousand semen doses of the bulls of 30 breeds, 1.5 thousand semen doses of boars of 3 breeds, 1.5 thousand semen doses of the roosters of 3 breeds, 60 cattle embryos of 2 breeds, 80 oocytes of pigs. Since 2009 Ukraine is a member of the European Regional Focal Point for Animal Genetic Resources at FAO [8].

IABG has developed a methodology for integrated assessment, management and long-term storage of gene pool resources. The scientists of the institute have introduced methods of genetic and population monitoring of the gene pool herds and systems of regulation and optimization of the number of the gene pool populations through a combination of biotechnological and genetic technologies of cryopreservation of sperm, embryos, oocytes, primary germ cells and DNA, directed selection and creation of virtual cryopreserved gene pool herds. They have identified categories of the gene pool objects for storage and optimal size of deposit, developed requirements for genetic material of each gene pool object of the different species of farm animals, as well as standards of main parameters of the gene pool micropopulations for the some species [2].

Thus, V. Burkat, B. Vernadsky, I. Huziev, F. Eisner, M. Zubets, M. Ivanov, N. Kolesnik, M. Kravchenko, Yu. Lyskun, Yu. Ruban, A. Serebrovsky, I. Smyrnov, I. Shmal'gauzen and other Ukrainian scientists have made a significant contribution

to solving global problems of preservation of domesticated animal gene pool. They have developed evolutionary, anthropological, ecological, synergistic, cultural approaches for stabilization the number of the aborigen and local breeds of farm animals. Ukrainian researches solve this problem on base of combination of the whole complex of factors: theoretical and methodical, organizational, economic and technological. In the last decades the method *ex situ* based on genetic material preservation in the artificial environment (gene pool herds, relicted animal farms, collections' nurseries, cryopreservation of gametes, embryos, etc.) is prevalent in developing programs for farm animal genetic resources preservation. Scientific heritage of famous Ukrainian scientists is a theoretical and methodological basis of modern strategy of farm animal gene pool preservation.

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