

AGRARIAN SCIENCE DEVELOPMENT TO INCREASE THE EFFICIENCY OF IMPLEMENTATION OF ORGANIC AGRICULTURE TECHNOLOGY IN UKRAINE (1990–2015)

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INTRODUCTION

At the beginning of the XXI century intensive use of irrigation, chemistry, mechanization with its harmful effect on soil structure, scientific breeding, including the creation of genetically modified varieties of crops, allowed to reach a new level of development of the agricultural sector, which provided a solution to the food problem in Ukraine¹. At the same time, the introduction of intensive technologies increased the technogenic impact on the soil cover and caused the spread of erosion, dehumidification and agrophysical degradation of soils in one third of arable lands of Ukraine². The negative impact of these factors of intensification on the environment has developed the formation of new approaches to agricultural management, which are embodied in the introduction of organic technologies³. It became urgent to use rational land use in different soil and climatic zones of Ukraine, which was based on scientific technologies of organic agriculture and provided for the increase of soil fertility, production of ecologically clean production and restoration of the natural state of the environment in the country⁴.

Theoretical, methodological and practical foundations of organic farming technology were based on the use of rational structure of acreage and specialized crop rotation with alternation of different biological groups of crops, the use of economical soil cultivation, the introduction of scientifically grounded norms of organic fertilizers, the use of good

¹ Бойко П. І. Біологічна та екологічна роль сівозмін у землеробстві. Київ : Знання, 1990. 48 с.

² Коваленко Н. П. Екологічно збалансовані сівозміни в системі альтернативного землеробства: історичні аспекти. *Агроекологічний журнал*. 2012. № 4. С. 95–99.

³ Коваленко Н. П. Наукові основи становлення та розвитку землеробства в Україні. *Вісник аграрної науки*. 2017. Спеціальний випуск (травень). С. 60–66.

⁴ Бойко П. І., Коваленко Н. П. Проблеми екологічно врівноважених сівозмін. *Вісник аграрної науки*. Київ. 2003. № 8. С. 9–13.

fertilizers, mulching and biohumus⁵. Important was the creation of varieties and hybrids with high environmental adaptability, the use of biological products for the protection of plants from weeds, diseases and pests, the introduction of environmentally friendly agro-technical and biological measures in the cultivation of crops⁶. Their use contributed to the optimal cultivation of crops, as it was aimed at curbing the development of harmful organisms and did not require the use of poisonous substances⁷.

1. The Role of Agrarian Science in Improving the Efficiency of Organic Technologies in Ukraine in the 1990s

The adoption of the resolution of the Council of Ministers of the USSR No. 279 «On Establishment of the Ukrainian Academy of Agrarian Sciences» had a positive impact on the development of agrarian science in Ukraine. The above-mentioned scientific and methodological and coordination center for the development of agrarian science in the country was able to solve the most complex problems of agro-industrial production and to carry out basic and applied research⁸. With the foundation of the Ukrainian Academy of Agrarian Sciences, preconditions were created for eliminating interagency obstacles, technological completion of scientific developments, a comprehensive approach to the scientific support of all branches of the agro-industrial complex⁹. New for agricultural science was the program-targeted approach to the organization and implementation of scientific research¹⁰. This helped deepen the ability to plan scientific research, strengthen the link between scientific and industrial activities, and initiate the transition from predominantly departmental management of science to the management of the entire cycle of scientific and technological progress.

⁵ Бойко П. І., Бородань В. О., Коваленко Н. П. Екологічно збалансовані сівоzmіни – основа біологічного землеробства. *Вісник аграрної науки*. 2005. № 2. С. 9–13.

⁶ Коваленко Н. П. Становлення та розвиток науково-організаційних основ застосування вітчизняних сівоzmіни у системах землеробства (друга половина ХІХ – початок ХХІ ст.) : монографія. Київ: ТОВ «Нілан-ЛТД», 2014. 490 с.

⁷ Орехівський В. Д. Еволюція наукових основ органічного землеробства в Україні (друга половина ХІХ – початок ХХІ ст.) : монографія. Вінниця: ТОВ «Нілан-ЛТД», 2017. 550 с.

⁸ Созінов О. О., Бусол В. О., Зубець М. В. Українська академія аграрних наук 1991–1995. Київ: Аграрна наука, 1996. 263 с.

⁹ Коваленко Н. П. Науково-організаційна діяльність Координаційно-методичної ради УАСГН, МСГ УРСР, ПВ ВАСГНІЛ та УААН з проблем сівоzmіни у системах землеробства України (1956–2010 р.). Київ: ФОП Корзун Д. Ю., 2011. 90 с.

¹⁰ Коваленко Н. П. Екологічно збалансовані сівоzmіни в системі альтернативного землеробства: історичні аспекти. *Агроекологічний журнал*. 2012. № 4. С. 95–99.

The Ukrainian Academy of Agrarian Sciences introduced a new form of creative association of scientists of different fields of activity – scientific and methodological centers. Institutional bases around which scientific and methodological centers were formed were institutes of the relevant direction¹¹. In order to increase the efficiency of the research institutions of the NAAS network, a number of structural adjustments were made and the staff of the scientific units was improved. Separate institutions and units that were not operating effectively were eliminated. The experimental farms, which have lost their connection with science and performed exclusively production activities, have been transferred to the system of the Ministry of Agrarian Policy and Food of Ukraine.

This period was characterized by the creation of narrow-industry research institutes that solved problems for the effective development and practical implementation of organic technologies. So, in 1992 the Department of Agrotechnology was organized at the Institute of Cruciferous Cultures of NAAS, where they developed effective cultivation of rapeseed in different rotational rotations. In the same year, the Department of Agroecology was established at the Institute of Agroecology and Biotechnology of the NAAS. The main in his activity was the development and implementation of scientific bases of agri-environmental monitoring, forecasting the ecological and economic efficiency of agricultural production, rational agricultural use in Ukraine¹². In the 1990s, the reorganization of state regional agricultural research stations into complex regional centers of scientific support – institutes of agro-industrial production took place. Their activity was to improve existing ones, to develop and implement rational measures for organic farming for different soil and climatic conditions; creation and improvement of organic technologies for crop production.

In the 1990s, the research institutions of the NAAS network made the transition from the development of common complex scientific and technical programs to the narrow-sectoral ones, which facilitated the concentration of efforts of the co-executing institutions to solve particular problems that needed priority processing. In this period, economic analysis

¹¹ Коваленко Н. П. Становлення та розвиток науково-організаційних основ застосування вітчизняних сівозмін у системах землеробства (друга половина XIX – початок XXI ст.) : монографія. Київ: ТОВ «Нілан-ЛТД», 2014. 490 с.

¹² Коваленко Н. П. Становлення та розвиток науково-організаційних основ застосування вітчизняних сівозмін у системах землеробства (друга половина XIX – початок XXI ст.) : монографія. Київ: ТОВ «Нілан-ЛТД», 2014. 490 с.

of results and mathematical processing of research data were considered as valuable components. Mathematization and operationalization of knowledge in agriculture have provided the beginning of science, which was based on objective facts and exact values¹³. Scientists have been collecting, processing and accumulating numerous data on biological, crop, productive, breeding, technological, statistical and other characteristics of crops¹⁴. They have developed and implemented into production automated systems for evaluating the efficiency of cultivation of crops using organic technologies in Ukrainian agriculture. Of particular importance was the increase in productivity basic and applied researches, formation of scientific bases of development of organic agriculture in the market conditions, substantiation of priority directions of research work, delineation of tasks of innovative development of research institutions. A new approach has been the program-oriented approach to the organization and implementation of scientific research in organic farming. This contributed to the deepening of the possibility of planning scientific activities, opening new opportunities for establishing relationships between scientific and industrial activities, initiating the transition from mainly departmental management of science to the management cycle of scientific and technological progress in general.

In 1991, the Ukrainian Academy of Agrarian Sciences developed the first Republican scientific and technical program «Development of fundamental bases for providing the population with high quality food at optimal energy consumption and preserving ecological well-being»¹⁵. During 1991–1995, the Department of Agriculture of the NAAS carried out scientific and methodological guidance in the direction of «Development of theoretical bases of soil fertility reproduction and principles of modern intensive agriculture that will provide high quality production and environmental protection», where NAAS networks in different soil and climatic conditions of Ukraine. Scientists have constructed maps of soil zoning according to the indicated indicators for

¹³ Kovalenko N. P. The evolution of application mathematical statistics methods have presented for processing of results of field experiments in agriculture in Ukraine (second half of XIX – beginning of XXI centuries). *Історія науки і біографістика*. 2016. № 2. URL: <http://www.inb.dnsgb.com.ua/2016-2/en/09.pdf>. (дата звернення: 30.06.2019).

¹⁴ Бойко П. І., Коваленко Н. П. Методика сучасних і перспективних досліджень у землеробстві. *Вісник аграрної науки*. 2008. № 2. С. 11–17.

¹⁵ Звіт про роботу Української академії аграрних наук за 1991–1995 роки. Київ: Аграрна наука. 1996. 264 с.

the main crops. The estimation of ecological significance of their agrophysical features by three gradations is presented: optimal, permissible, inadmissible. Zoning of arable lands of Ukraine was carried out, which reflected the conditions of cultivation of basic crops by soil and physical indicators. The complex of measures for biological biology of agriculture based on the use of manure, by-products of agricultural products, siderates, local application of moderate norms of mineral fertilizers together with trace elements and calcium-containing compounds. It was determined that short rotational crop rotations with alfalfa and intermediate crops increased the fertility of irrigated lands¹⁶.

In 1991, the Ukrainian Academy of Agrarian Sciences, jointly with the State Agricultural Committee of Ukraine, developed the first Republican targeted comprehensive scientific and technical program «Food-95». During 1991–1995, the Department of Agriculture of the NAAS carried out scientific and methodological guidance on the project «Soil Fertility», where the research work was performed by the research institutions of the NAAS system in different soil and climatic conditions of Ukraine. Scientists have carried out preliminary normalization of soil fertility indicators, set optimal, acceptable and unfavorable parameters for growth and development of leading crops¹⁷. The ecologically safe standards of application of non-litter manure and products of its processing, ways of using by-products of crop production, spropel, vermiculite and other raw materials of the country, which ensured an increase in the use of organic fertilizers¹⁸. Scientists have developed the scientific basics of landscape agriculture, worked out basic models of soil-protective contour-reclamation systems of agriculture. Their development ensured the prevention of soil erosion and increased the productivity of eroded lands¹⁹.

Scientists have worked out a system of measures to increase the flow of biological nitrogen into the soil through the use of local waste, increase the production of compost, the use of siderates, microbiological preparations, the expansion of crops of legumes, especially perennial

¹⁶ Бойко П. І., Коваленко Н. П. Сівозміни з короткою ротацією. *Пропозиція*. 1998. № 2. С. 16–17.

¹⁷ Звіт про роботу Української академії аграрних наук за 1991–1995 роки. Київ: Аграрна наука. 1996. 264 с.

¹⁸ Орехівський В. Д. Еволюція наукових основ органічного землеробства в Україні (друга половина ХІХ – початок ХХІ ст.): монографія. Вінниця: ТОВ «Нілан-ЛТД», 2017. 550 с.

¹⁹ Бойко П. І., Коваленко Н. П. Проблеми екологічно зрівноважених сівозмін. *Вісник аграрної науки*. Київ. 2003. № 8. С. 9–13.

grasses. The production of technology of application of unconventional ameliorants, which improved the agro-technical properties of podzolic soils, was proposed, increased their productivity by 30–40%, reduced the absorption of radionuclides by plants in the territories contaminated by the emissions of the Chernobyl nuclear power plant²⁰. Scientists have worked out zonal soil-protective resource-saving systems of soil cultivation in crop rotation of different specialization on the basis of a modern complex of soil-cultivating machines and tools. A resource-saving fertilizer system has been proposed to provide planned yields while reducing mineral fertilizer consumption by 15–30% due to the widespread use of organic residues. In particular, straw, stems, siderates, provided that the number of nutrients in the soil and the biological characteristics of the crops are taken into account.

During 1996–2000, the Department of Agriculture, Reclamation and Agro-ecology of the NAAS provided scientific and methodological guidance on the scientific and technical program «To develop zonal systems of renewable agriculture for different forms of production organization». The scientists worked out the scientific bases and models of zonal conservation systems of agriculture, which took into account the socio-economic and soil-climatic conditions as much as possible, corresponded to the newest land relations at that time and provided an increase of productivity of crops by 25–30% and ecological stability²¹. The basis of models of systems of agriculture became the optimal structure of acreage and crop rotation, which provided a scientifically sound reduction of plowed land and increase of natural biocenoses and contributed to the restoration of nature conservation functions of agroecosystems. For the cultivation of environmentally friendly crop production, scientists have developed regulations for the use in organic agriculture of traditional and non-traditional types of fertilizers, and worked out a system of measures to optimize plant nutrition. According to the scientific and technical program «To develop the scientific basis for the creation of modern reclamation systems, technological and technical measures to improve the productivity of reclaimed lands, improve their ecological status and rational use of

²⁰ Коваленко Н. П. Становлення та розвиток науково-організаційних основ застосування вітчизняних сівозмін у системах землеробства (друга половина ХІХ – початок ХХІ ст.) : монографія. Київ: ТОВ «Нілан-ЛТД», 2014. 490 с.

²¹ Звіт про діяльність Української академії аграрних наук за 1996–2000 роки та 2000 рік. Київ: Аграрна наука. 2001. 352 с.

water resources» developed an improved system of agriculture on irrigated lands, which included the structure of sowing systems and ration crop rotation, tillage, fertilizers; energy saving technologies of growing crops on irrigated lands, recommendations on the directions of use of irrigated lands, including those that have not been irrigated temporarily, as well as – withdrawn from crop rotation and flooded²².

Researchers have developed resource-saving and energy-saving systems of land use, by means of which the optimal use of the natural resource potential of agricultural landscapes is made under the conditions of limited resource provision²³. Their theoretical basis was the results of studies of the bioenergy balance of agroecosystems with different levels of biologicalization of technological processes and taking into account the ecological and energy status of soils, features of modern agro-technologies. Scientists have developed the technology of integrated use of microbiological preparations, growth regulators and trace elements, the use of which has ensured the increase of grain yields by 3–17%. The efficiency of non-traditional means of chemicalisation, which facilitated the use of local raw materials and provided environmental friendliness of agricultural technologies, was established.

Effective resource-saving biological models of grain cultivation technologies have been developed. They provided for the complete or partial elimination of the means of chemicalisation and the use of the mineral fertilizer aftereffect crop rotation and use of by-products of agricultural precursors²⁴.

2. Development of Agrarian Science for the Improvement of Organic Farming in Ukraine in the 2000s

During 2001–2005, the Department of Agriculture, Reclamation and Agro-ecology of the NAAS, which was granted the status of National in 2010, carried out scientific and methodological guidance on the scientific and technical program «To develop zonal farming systems that will ensure the rational use of agricultural land, extended reproduction and cultivation and protecting them from erosion, increasing productivity and resistance to

²² Орехівський В. Д. Еволюція наукових основ органічного землеробства в Україні (друга половина XIX – початок XXI ст.) : монографія. Вінниця: ТОВ «Нілан-ЛТД», 2017. 550 с.

²³ Звіт про роботу Української академії аграрних наук за 1991–1995 роки. Київ: Аграрна наука. 1996. 264 с.

²⁴ Орехівський В. Д. Еволюція наукових основ органічного землеробства в Україні (друга половина XIX – початок XXI ст.) : монографія. Вінниця: ТОВ «Нілан-ЛТД», 2017. 550 с.

agrocenoses». Scientists of the research institutions of the NAAS network have developed the scientific bases for stabilization of land use and the system of rational use and protection of land for different soil and climatic conditions of Ukraine. They took into account the different degree of interaction between natural and anthropogenic factors, especially in erosion-hazardous agricultural landscapes, based on contour-landscaping organization of land use and land tenure²⁵.

It was important to optimize the structure of agricultural land by removing from the intensive use of eroded slopes and other low-productive lands, bringing the share of ecologically sustainable biocenoses up to 45–50% in the agricultural landscaping structure. Theoretical foundations and practical recommendations for the rational use of a wide range of agroindustrial complex chemistry agents have been developed, including organic and mineral, organo-mineral bioactive fertilizers, plant by-products and siderates, biologicals, growth promoters and trace elements. influence on actual and potential fertility of the main soil variations on the state of the environment²⁶.

A differentiated system of agro-measures for management of soil fertility and organo-mineral nutrition of crops in ecologically clean agrophones was developed according to the scientific and technical program «Develop technologies for soil conservation and rational use and their fertility». It included: selective application of soil-free tillage, joint local application of organic-mineral fertilizers, lime, trace elements, manure and by-products²⁷. Methodological bases of organic, organo-mineral fertilizers, plant growth stimulants on the basis of organic waste were worked out; technology of obtaining a mixture for reclamation with fertilizer effect on the basis of waste of the sugar processing industry, animal husbandry, production of superphosphates.

During the implementation of the scientific-technical program «Agro-ecological monitoring and modeling of sustainable agro-landscapes and agroecosystems» the Concept of balanced development of agroecosystems in Ukraine for the period up to 2025 was developed²⁸. Scientists have

²⁵ Звіт про діяльність Української академії аграрних наук за 2001–2005 роки та 2005 рік. Київ: Аграрна наука, 2006. 544 с.

²⁶ Коваленко Н. П. Наукові основи становлення та розвитку землеробства в Україні. *Вісник аграрної науки*. 2017. Спеціальний випуск (травень). С. 60–66.

²⁷ Орехівський В. Д. Еволюція наукових основ органічного землеробства в Україні (друга половина ХІХ – початок ХХІ ст.) : монографія. Вінниця: ТОВ «Нілан-ЛТД», 2017. 550 с.

²⁸ Звіт про діяльність Української академії аграрних наук за 2001–2005 роки та 2005 рік. Київ: Аграрна наука, 2006. 544 с.

improved the technology of complex application of biological preparations and poly-mineral fertilizers for various crops in different soil and climatic conditions of Ukraine.

During 2001–2005, the research institutions implemented the State Scientific and Technical Program «Industrial Biotechnologies for Agroindustrial Complex», during 2006–2010 – «Agrobiopromsystem». Scientists have developed a draft National Strategy for the Greening of Agricultural Production on the Basis of Integrated Agricultural Biologization. Reconstruction has been completed laboratories for the production of biological plant protection products and quality control of pesticides and crop production²⁹.

During 2006–2010, the Department of Agriculture, Reclamation and Agro-ecology of the National Academy of Sciences of Ukraine carried out scientific and methodological guidance on the scientific and technical program «To develop systems for assessing the current state, protection and efficient use of soils using geoinformation technologies». Scientists have determined the scientific and applied bases, directions of protection of rational use of irrigated and irrigated lands of Ukraine³⁰. The modern complex of regionally oriented measures for protection of soil from water and wind erosion is offered, taking into account the latest achievements of science and technology. Technologies of creation and application of liquid and solid organic and complex bioactive organo-mineral fertilizers with attraction of local raw materials according to the improved recipe have been worked out. This approach has ensured the expansion of the functional capabilities of the components of organo-mineral fertilizers, a decrease of 10–15% of unproductive nutrient losses, an increase of 20–25% of the efficiency of agricultural production.

According to the scientific and technical program «To develop scientific bases of agriculture, adapted to the natural environment and market conditions of management», scientists have worked out the system of agriculture on ecological-landscape basis for different soil and climatic conditions of Ukraine with different level of intensity and resource supply. The systems of agriculture for stabilization of land use and structure of

²⁹ Коваленко Н. П. Становлення та розвиток науково-організаційних основ застосування вітчизняних сівозмін у системах землеробства (друга половина XIX – початок XXI ст.) : монографія. Київ: ТОВ «Нілан-ЛТД», 2014. 490 с.

³⁰ Звіт про діяльність Національної академії аграрних наук України за 2006–2010 роки та 2010 рік. Київ: Аграрна наука, 2011. 422 с.

natural complexes have been improved. The soil-protective contour-reclamation system of agriculture, regional models of optimization of the structure of land use of agricultural enterprises of Ukraine have been developed. The methodology of monitoring of eroded lands and the model of territorial structure have been worked out agro-landscapes on ecological-landscape principles³¹. Peculiarities of crop placement in short rotation crop rotations based on determination of biological interaction of crops based on their compatibility, role and evaluation of precursors, norms of crop rotation in crop rotation, phytosanitary status and soil toxicity are determined. The economic efficiency of combining in the system of fertilization of bedding manure and mineral fertilizers in moderate norms with involvement in biological circulation of by-products of crop and siderate is established. The influence of fertilizers on the functioning of microbial coenoses is determined, the efficiency of inoculation of cereal seeds with a complex of microorganisms is proved.

According to the scientific-technical program «Scientific and practical substantiation of sustainable development of agroecosystems of Ukraine» scientific and methodological aspects of creation of multifunctional microbial preparations for ecologically-safe integrated systems of protection and fertilization of plants have been developed. Scientists have searched for active strains of microorganisms with agronomically useful properties, and selected the optimal technological parameters for the cultivation of microorganisms. Their influence on the ecological and biological condition of the soil and the quality of the products have been determined³².

During 2011–2015, the Department of Agriculture, Reclamation and Mechanization of the NAAS provided scientific and methodological guidance under the program «Scientific Basics of Rational Use, Protection and Quality Management of Soils for Sustainable Fertility». Scientists have developed the scientific foundations of landscape adaptation of irrigated, irrigated and saline lands. Quantitative and qualitative parameters of a set of adaptive measures have been established, taking into account the ecological, agronomic and economic and economic conditions of the respective arrays, fields and their areas. Scientists have proposed a method

³¹ Орехівський В. Д. Еволюція наукових основ органічного землеробства в Україні (друга половина ХІХ – початок ХХІ ст.) : монографія. Вінниця: ТОВ «Нілан-ЛТД», 2017. 550 с.

³² Звіт про діяльність Національної академії аграрних наук України за 2006–2010 роки та 2010 рік. Київ: Аграрна наука, 2011. 422 с.

of complex automated evaluation and minimization of erosion risk in modern agricultural landscapes, developed a methodology for stabilizing soil erosion resistance, created a database of modern crop rotation structure with the analysis of their effect on the erosion parameters of soil agrophysical properties by elements of agricultural landscapes³³.

According to the program «To develop the scientific basis for the development of agriculture in the stabilization of land use and the structure of natural lands, the use of technologies for competitive production of crop production, conservation and reproduction of soil fertility» scientists have established a significant deterioration of the physical and chemical properties of soil in terms of prolonged perennial peregrination. As the removal of gray loamy loamy soil from intensive use led to the gradual depletion of the soil absorption complex with calcium and magnesium compounds, resulting in increased potential and exchange acidity³⁴. It was determined that the best results of reproduction of multi-species permanent natural herbs with high homeostatic self-renewal were provided when spontaneous reproduction was combined with the starting sowing of legumes from three to four ecologically adapted to the local ecological conditions with the addition of different herbs.

Scientists have justified that in short-rotation crop rotations, zero tillage compared to the traditional one provided higher reserves of productive moisture in a meter layer of soil, which amounted to 104,9–108,9 mm in soybean crops, and 94,1–104,2 mm in corn. The ratio of the mineralization intensity of humic and fulvic acids with the intensity of by-product humification, which was wrapped in a 0–20 cm black soil layer, was reflected in the non-polishing treatment, which affected the increase in the total humus stock and changes in its group and fractional composition³⁵. The use of organic fertilizers helped to improve the biological regime of the soil, which led to the formation of bacterial diversity and increase its species forms. It has been found that biologized fertilizer systems have led to an improvement in the photosynthetic and chlorophyll potential of plants.

³³ Звіт про діяльність Національної академії аграрних наук України за 2011–2015 роки та 2015 рік. Київ: Аграрна наука, 2016. 520 с.

³⁴ Орехівський В. Д. Еволюція наукових основ органічного землеробства в Україні (друга половина XIX – початок XXI ст.) : монографія. Вінниця: ТОВ «Нілан-ЛТД», 2017. 550 с.

³⁵ Коваленко Н. П. Становлення та розвиток науково-організаційних основ застосування вітчизняних сівозмін у системах землеробства (друга половина XIX – початок XXI ст.) : монографія. Київ: ТОВ «Нілан-ЛТД», 2014. 490 с.

According to the subprogramme «To develop theoretical bases and models of functioning of agro-systems and means of technological management of processes of self-renewal in the steppe zone agriculture», it was found that the use of microbial preparations provided an increase in the efficiency of soybean cultivation in grain-steam-cultivated and grain-sowing crop rotations. When performing the subroutine «Theoretical Foundations and Ecologically Safe Methods of Regulation of Weed of Field Crops in Modern Agriculture», it was determined that the greatest competitiveness against weeds was obtained when growing winter wheat after black steam³⁶. A lack of ability to withstand weeds in sugar beet, especially in the initial growth stages, was detected. Therefore, adhering to the elements of the technology of cultivation of this crop provided better clearing of the field of weeds.

The program «Ecological Safety of Agroindustrial Production» developed a method of ecological evaluation of technologies for growing basic crops, which ensured consideration of agrochemical, phytosanitary, ecotoxicological, sanitary-hygienic and other characteristics and avoiding negative impacts on the environment³⁷. Scientists have substantiated the principles of determining ecological coefficients to evaluate the feasibility of fertilizing crops for the use of nitrogen fixation and nitrous oxide emissions. They have developed a method for biological disposal of pathogenic soil microflora, which consisted of pre-sowing treatment with spore bacteria and provided prolonged plant protection against disease. Scientists have proposed a method of accelerating the decomposition of postharvest residues, based on the joint use of a complex of microorganisms. Obtained polyclonal antiviral sera for up to two viruses – cucumber mosaic virus and spotting virus of tomatoes. According to the program «Scientific bases of rational water use and land reclamation in the conditions of socio-economic transformation of rural territories» scientists have substantiated the components of the technology of creating long-lasting hay-pasture grassland for use on drained podzolic silt and soils³⁸.

³⁶ Орехівський В. Д. Еволюція наукових основ органічного землеробства в Україні (друга половина XIX – початок XXI ст.) : монографія. Вінниця: ТОВ «Нілан-ЛТД», 2017. 550 с.

³⁷ Коваленко Н. П. Становлення та розвиток науково-організаційних основ застосування вітчизняних сівозмін у системах землеробства (друга половина XIX – початок XXI ст.) : монографія. Київ: ТОВ «Нілан-ЛТД», 2014. 490 с.

³⁸ Орехівський В. Д. Еволюція наукових основ органічного землеробства в Україні (друга половина XIX – початок XXI ст.) : монографія. Вінниця: ТОВ «Нілан-ЛТД», 2017. 550 с.

Important was the implementation of the program «Scientific basis for the development of organic production of agricultural products and the mechanisms of its functioning in Ukraine». According to the subprogramme «Scientific bases of forming of zones of organic production of agricultural goods are taking into account ground-climatic terms» placing and optimal areas of new economies is certain scientists from the conduct of organic agriculture, their specialization in accordance with the soil and climatic conditions of the forest-steppe³⁹. The main limiting factors that hindered the development of organic production were identified, the optimal area of organic farming was established, which amounted to 800–1000 ha in the presence of livestock, 1000 ha – for grain and beet farms. The zoning of the forest-steppe was developed according to the suitability for organic farming, which characterized the soil-ecological features and the resource potential of the lands for growing basic crops. Scientists have worked out the methodological aspects of obtaining organic fertilizers from by-products of crop and waste animal husbandry, which was to improve the methods of processing organic matter and their composition. Enhancement of fertilizer functionality was due to the addition of substances with expanded active surface, enzymatic and microbiological preparations at various stages of composting.

The implementation of the sub-programme «Innovative Technologies for Competitive Organic Production of Crop Production» with the application of an organic fertilizer system in short rotational rotations resulted in a reduction of moisture costs for the formation of a dry matter unit of the crop. Optimization basic models of reproduction of fertility of washed soils have been worked out, the prerequisites for development of introduction of organic production of agricultural products in Ukraine have been analyzed, the main scientific and methodological approaches to their solution have been determined. It was found that the main measures for increasing soil fertility under organic farming conditions were liming and application of organic fertilizers. It has been found that the use of an organic fertilizer system and microbial preparations in short rotational rotations promoted the destruction of bacterial, fungal and viral diseases of crops⁴⁰. Scientists have developed a stable green conveyor from scattered

³⁹ Звіт про діяльність Національної академії аграрних наук України за 2011–2015 роки та 2015 рік. Київ: Аграрна наука, 2016. 520 с.

⁴⁰ Коваленко Н. П. Становлення та розвиток науково-організаційних основ застосування вітчизняних сівозмін у системах землеробства (друга половина XIX – початок XXI ст.) : монографія. Київ: ТОВ «Нілан-ЛТД», 2014. 490 с.

grass stands on drained lands without mineral fertilizers and with a four-fold mowing, which helped to obtain 5,0–5,5 t/ha of absolutely dry weight.

It has been determined that when engaging enterprises, the oils of fat and malt production in organic agriculture, their waste can be used as fertilizer in agrocenoses, provided the annual quality control of fertilizers with the determination of environmentally sound standards for their application⁴¹. The ecological substantiation of production waste norms is developed, which is recommended to be used in agroland landscapes for ground fertilizer, on the content of nutrients and pollutants in substrates. The use of litter manure, straw, and biomass of post-harvest siderates is justified for the efficient cultivation of crops in organic farming. The highest efficiency of the use of alternative sources of organic matter and microbiological preparations as a result of the combination of wrapping straw wheat-lupine mixture treated with bio-degrader.

According to the sub-program «System of Quality Assessment of Organic Production», elements of the regulatory and methodological support for the procedure of controlling the production of organic products based on the Law of Ukraine «On Production and Circulation of Organic Agricultural Products and Raw Materials» and international requirements have been developed. Scientific and methodological approaches to the standardization of weed, disease and pest management methods for organic farming have been identified. The list of biological preparations for further certification is proposed for use in plant protection technologies against diseases and pests. Biologicals were divided into 2 groups: direct action – biopesticides and indirect action-drugs that improved plant growth. Important principles have been established for the application of elements of organic farming technology. In particular, determining the action to prevent the development of erosion processes, maintain a satisfactory structural condition, regulate the regime of organic matter and mineral elements of the soil, reduce weediness of crops, regulate the phytosanitary state of soil and water balance of agrocenoses⁴².

During the implementation of the subprogram «Scientific bases of formation and functioning of the organic production market» elements of organic production technology are identified: observance of crop rotations,

⁴¹ Звіт про діяльність Національної академії аграрних наук України за 2011–2015 роки та 2015 рік. Київ: Аграрна наука, 2016. 520 с.

⁴² Орехівський В. Д. Еволюція наукових основ органічного землеробства в Україні (друга половина XIX – початок XXI ст.): монографія. Вінниця: ТОВ «Нілан-ЛТД», 2017. 550 с.

application of organic fertilizers, siderates, mulching, destructors, organic remedies, growth regulators⁴³. Organic fertilizer systems were established, which were based on the following components: manure application, use of by-products of crop production for fertilizer except for the part that was directed to the needs of animal husbandry; intensive sideration; pre-sowing seed treatment of all major and intermediate crops with biological microbial preparations⁴⁴. According to the program «Scientific and engineering-technological bases of creation of ecologically safe industrial biotechnologies and equipment for production and use in agrobiocenoses of biological plant protection products» the structure of entomological production quality management system was determined and the method of calculations of entomological production processes was developed⁴⁵. Conceptual approaches to the formation of organic farming system based on the application of biological plant protection are proposed.

CONCLUSIONS

Thus, analyzing the trends of agricultural science in the 1990s showed that with the organization of the Ukrainian Academy of Agrarian Sciences, the preconditions were created to increase the effectiveness of sectoral research and increase the efficiency of the introduction of organic technologies in different soil and climatic conditions of Ukraine. Scientific and organizational activities of the National Academy of Agrarian Sciences of Ukraine in the 2000s in the direction of the development of organic agriculture ensured the expansion of the network of sectoral research institutions, their uniform geographical location and coverage of different areas of research. Scientists have developed effective technologies of organic farming, the practical implementation of which in different soil and climatic conditions of Ukraine has ensured the increase of soil fertility, obtaining quality agricultural products and preserving the environment.

It can be concluded that the development and implementation of energy-saving and resource-saving technologies, which ensured a

⁴³ Звіт про діяльність Національної академії аграрних наук України за 2011–2015 роки та 2015 рік. Київ: Аграрна наука, 2016. 520 с.

⁴⁴ Бойко П. І., Бородань В. О., Коваленко Н. П. Екологічно збалансовані сівозміни – основа біологічного землеробства. *Вісник аграрної науки*. 2005. № 2. С. 9–13.

⁴⁵ Коваленко Н. П. Становлення та розвиток науково-організаційних основ застосування вітчизняних сівозмін у системах землеробства (друга половина XIX – початок XXI ст.) : монографія. Київ: ТОВ «Нілан-ЛТД», 2014. 490 с.

significant increase in the production of quality products and increased profitability of the crop industry, became especially relevant. Scientists of the research institutions have developed and improved scientifically grounded crop rotations with the cultivation of legumes and side crops, perennial legumes and their mixtures, post-harvest and post-harvest crops, using by-products. Effective use of rational soil cultivation, organo-mineral fertilizers, integrated weed, pest and disease control systems has been proved.

Established that one of the directions of successful plant protection in organic farming was the creation of environmentally safe industrial biotechnologies for the production and use in agrobiocenoses of biological plant protection products. They were introduced along with agrotechnical and organizational ecologically safe measures of plant protection: scientifically based alternation of different crop groups in rotation; optimal timing and methods of soil cultivation and fertilization, sowing and harvesting; seed cleaning and sorting; spatial isolation of territories, etc.

SUMMARY

It was found out that during the 1990s – 2000s the development of the agricultural sector of Ukraine was ensured by the introduction of effective technologies for growing crops under different soil and climatic conditions of Ukraine. They were based on the use of a scientifically sound structure of acreage and specialized crop rotations with effective alternation of different biological groups of crops. Important was the use of organic fertilizers and soil conservation, as well as environmentally friendly measures. With their introduction in Ukraine important practical tasks were solved: increase of soil fertility level, production of quality agricultural products and preservation of the environment.

To this end, the article, based on the system-historical approach, identifies the directions of development of agrarian science for increasing the introduction of organic farming technologies in different soil and climatic conditions of Ukraine. In particular, application of scientifically grounded structure of acreage and specialized crop rotations with alternation of different biological groups of crops, cultivation of leguminous and sider crops for green fertilizer, perennial legumes and their mixtures, post-harvest and post-crop crops, use of by-products. Important was the elaboration of systems of economical soil cultivation, introduction

of scientifically grounded standards of organic fertilizers, use of microorganisms, biohumus, creation of varieties and hybrids with high ecological adaptability, biological preparations for protection of plants from weeds, diseases and pests. It was found out that scientifically grounded technologies of organic agriculture, developed by scientists of research institutions of the network of the National Academy of Agrarian Sciences of Ukraine, were effectively implemented in the farms of different soil and climatic conditions, which ensured the increase of soil fertility, obtaining of high quality agricultural production Of Ukraine.

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