

WAYS TO IMPROVE THE ENVIRONMENT AND FOOD SECURITY THROUGH THE IMPLEMENTATION OF INNOVATIVE TECHNOLOGIES**Dyudyayeva O.***Senior Lecturer, Export Expert to the EU,
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Kherson, Ukraine*<https://doi.org/10.5281/zenodo.15397777>**Abstract**

Food safety and the state of the environment are two interrelated problems of today. Traditional technologies used in agriculture and the processing industry, in particular, lead to the ingress of harmful impurities and substances into food products or the ingress of them and production waste into the environment. The food industry has a negative impact on the environment, polluting atmospheric air, water and land resources with harmful emissions and production waste, leading to soil degradation. At the same time, the food industry is a link in the food chain and, due to dangerous and harmful substances that accumulate in raw materials of plant and animal origin, can have a negative impact on human health due to their entry into the body. The article considers the possibilities of using innovative environmental technologies in the industry. It is the greening of the food industry through the transition to "environmentally friendly" technologies using the example of vermiculture technology that will contribute to solving the environmental problems of society. Using earthworms, you can not only effectively utilize organic waste of plant origin, but also transform them into high-quality animal proteins and biologically active substances. ,

Thanks to the cultivation of worms in an organic substrate, you can obtain high-quality organic fertilizer (vermicompost), which contains a full range of macro- and microelements necessary for agricultural plants during their vegetation, and will also contribute to the formation of humus in the soil, thus improving its ecological state of the soil. The use of vermiculture technology in agriculture allows you to use soils continuously without reducing their fertility. Microorganisms found in vermicompost contribute to the conversion of toxic forms of heavy metals into inactive compounds.

The experience of leading countries in the world confirms the effectiveness of using vermicomposting technology to improve the organic waste management system at the state, individual regions and community's levels. In addition, the use of this ecology is quite promising for improving the ecological condition of land resources near large transport networks, around industrial facilities.

The implementation of vermicomposting technology does not require significant costs, both financial and material, including large areas. This can be effectively used for the development of small and medium-sized businesses in the production of organic fertilizers.

Keywords: ecologization, food chain, vermiculture technology, vermicompost, composting**Introduction**

Human activity and its negative impact on the environment is one of the most important problems of society. Modern trends in the development of industry and agriculture lead to a deterioration in the state of land resources due to the accumulation of heavy metals and other harmful substances in the soil. This leads to a negative impact on all living things, including humans, as they get into food products.

The ecologization of food production is a process related to production, operation and disposal, including the introduction of environmental technologies, the production of new products. When switching to modern technologies and the production of environmentally friendly (safe) products, an analysis of their impact on the environment and living organisms is carried out. Therefore, an effective solution to the environmental problems of society is possible through the ecologization of agriculture and the processing industry by modernizing individual processes of production, use, disposal, taking into account environmental factors.

The study is relevant in the context of strengthening the environmental responsibility of society through

the transition to "environmentally friendly" technologies in the food industry, increasing the environmental awareness of the population regarding healthy and safe nutrition.

Analysis of recent research and publications

Food safety, production and consumption of environmentally friendly products are one of the main tasks for scientists and industry specialists. It is impossible to imagine human life without food, but at the same time, it has negative consequences for the environment. Traditional technologies for the production of agricultural raw materials, outdated production equipment are the cause of hazardous substances and impurities in the final product, the formation of harmful substances during production, production waste and their release into the environment [1]. Greening the food industry will allow not only to remove or neutralize waste and other negative aspects of production, but also to prevent their occurrence. Therefore, today the greening of the food industry is reasonably relevant. First, the food industry has a harmful impact on the environment, polluting atmospheric air, water and land resources with harmful emissions and production waste. Secondly, food products can have a direct or indirect impact on human

health of hazardous substances that accumulate in raw materials of plant and animal origin. Thirdly, food products can pose a threat to human health due to the use of additives, such as dyes, preservatives, emulsifiers and other substances that are widely used in production today [2, 3].

The use of safe technologies that will reduce the concentration or completely prevent the ingress of harmful substances from contaminated raw materials into finished products or into individual components of the environment will contribute to reducing the negative impact on human health and anthropogenic load on the environment.

The greening of food production by switching to "environmentally friendly" technologies (for example, when using vermiculture technology) will reduce the negative impact on the environment, improve the condition of land and water resources, and promote the consumption of useful and safe products. This will also improve the management of organic waste and promote the development of small and medium-sized businesses producing ecological fertilizers.

Results and discussion

With the aggravation of the global food crisis, it can be argued that the food industry is one of the main sectors of the economy. For Ukraine, this problem is deepening due to a number of external and internal: war, the high cost of technical and technological re-equipment of production, the lack of a strategy for comprehensive greening, which would extend not only to production, but also to the entire food chain [4]. The lack of a nationwide system of support and financing of environmental protection programs at enterprises for the implementation of environmentally friendly technologies. This applies to agricultural enterprises that switch to organic technologies in order to grow environmentally friendly raw materials for the food industry.

Food industry enterprises have a negative impact on the environment due to the low level of implementation of low-waste and zero-waste technologies due to their high cost. Enterprises of the industry have a large amount of production waste and often a low level of wastewater treatment. In addition, the food industry ranks first among other industries in terms of water consumption per unit of output. This explains the creation of a large volume of wastewater with a high level of pollution by such harmful substances as nitrogen dioxide, ammonia, hydrochloric acid, soot, difluorochloromethane, phenol, which enhances the greenhouse effect. Wastewater entering water bodies depletes oxygen reserves, which leads to the death of living organisms in water bodies [4].

The use of ecological raw materials, the introduction of waste-free and low-waste technologies, optimization of technological processes, modernization of systems for cleaning emissions into the atmosphere and wastewater discharge, the introduction of modern technologies for the utilization of production waste are steps that will contribute to the greening of the industry, the production of environmentally safe high-quality

food products with minimal consumption of natural resources and the preservation of a sustainable balance in the natural environment [5].

Food products are essential goods, the state of their development affects the level of food security of any country, and their systematic development ensures social stability and economic growth [5].

In recent decades, the food industry, both in Ukraine and in the global world, has faced two challenges: the need to provide the world's population, which by 2030 may reach 8.5 billion, with high-quality and environmentally safe food products, and a careful attitude to the environment. The use of innovative technologies, including those aimed at improving the environmental characteristics of food products, is one of the ways to solve these problems. This also applies to the development of the agricultural sector, which is the primary link in the food chain. More than 70% of all harmful substances enter the human body with food. The problem of food contamination with toxins that have an immunosuppressive effect on humans and can cause malignant tumors is very acute. The use of medicines and antibiotics in veterinary practice leads to the fact that their presence is observed in 15-25% of products of animal origin. The use of pesticides and agrochemicals in agriculture leads to excessive accumulation of nitrates and heavy metals in plant raw materials. However, with the orderly use of agrochemicals and pesticides, and the reduction of chemicalization of technological processes in agriculture, it is possible to achieve a reduction in the content of pesticide residues in food products.

A high level of safety and quality of agricultural products will ensure the conditions for the entry of domestic producers into international consumer markets and increase their competitiveness [6].

The competitiveness of environmentally friendly products in the market depends on the use of modern "environmentally friendly" technologies, such as organic technologies; on the control system for agricultural products at all stages of the food chain (production, marketing); on the implementation of safety standards for agricultural and food products in accordance with international standards; proper information support for producers and consumers; and the use of modern methods of packaging and labelling products [7].

An important place in improving the environmental performance of agricultural raw materials and food products belongs to the introduction of environmental technologies [8]. The first important step towards the greening of food production is the cultivation of environmentally friendly agricultural raw materials and their use for the production of environmentally friendly food products. Obtaining environmentally friendly agricultural raw materials and food products is possible using various agroecological approaches, for example, replacing agrochemicals with organic fertilizers obtained using vermiculture technology [9-11].

Vermiculture is a modern technology that allows not only to effectively utilize organic waste of plant origin, but also to obtain high-quality animal proteins

and biologically active substances. The main and mandatory component of vermiculture technology is earthworms (Figure 1).

It is believed that the most productive lands are those on which earthworms live and reproduce. In a day, an earthworm passes through itself an amount of soil equal to its body weight, passing the soil through its intestines, it can create passages in dense soil. The extensive network of passages in the soil left by the worm can be up to 7,000 km/ha. This ensures the penetration of oxygen and water into the lower layers of the soil and improves its structure. Worms actively con-

sume plant residues (up to 200% of their mass) and after the soil passes through the intestinal tract of the worms, the content of digestible nutrients in the soil increases, and the process of humus formation is accelerated tenfold. Earthworms are able to accumulate heavy metals in their bodies, which also improves the ecological state of the soil [12].

Earthworms are very promising objects, the use of which improves the environmental performance of agricultural raw materials by using biologically active substances of natural origin and reducing the chemical load on the environment.



Fig. 1. The appearance of earthworms in the soil

They:

- contain a very wide range of biologically active compounds;
- are easily cultivated using various organic wastes on an industrial scale, as well as in private conditions;
- multiply rapidly;
- have a high coefficient of bioconversion of organic matter of waste into their own biomass (up to 10%).

The place of vermiculture is vermifarms, which can be both industrial facilities and private ones, which does not require large production areas (Figure 2).

The essence of vermicomposting is the use of earthworms to obtain environmentally friendly fertilizer - vermicompost (biohumus) from various organic substances. Such fertilizer contains a full set of macro- and microelements necessary for agricultural plants during their vegetation. The transformation of manure and other organic waste by earthworms into high-quality protein and humus fertilizer is a natural process of

self-regulation of the natural environment. The process of biohumus formation as a result of the processing of organic waste by worms continues throughout the year. In the fall, the working population of worms is removed from the mounds in order to select the finished substrate. Then a new layer of organic residues 25-30 cm thick is placed in the mounds and the population of worms is returned. The place of their placement is watered, covered from the sun and drying out, and a new annual technological cycle begins. An important condition of vermiculture technology is the creation of favorable conditions in the soil for breeding and reproduction of earthworms and microorganisms. This contributes to the natural restoration of soil fertility, the production of environmentally friendly agricultural raw materials and food products, and the protection of the environment from pollution by harmful substances [13].



Fig. 2. Types of vermiculture farms

Thus, the purpose of growing earthworms is:

- maximum conversion of organic waste into organic fertilizer (vermicompost, biohumus);
- increasing the biomass of earthworms themselves, as the most valuable source of proteins, peptides, enzymes and physiologically active substances;
- earthworms accelerate the decomposition of organic matter, which allows for the short-term conversion of organic waste into humus-rich fertilizer in an environmentally friendly way [14, 15].

The introduction of biohumus into the soil not only increases the yield of crops, but also increases the total number of bacteria, which accelerates microbial processes in the soil and improves the assimilation by plants of essential nutrients contained in a well-balanced and easily digestible mobile form. The safety and quality indicators of agricultural raw materials are improved, which is extremely important for human health.

The use of vermiculture in agriculture allows the use of soil continuously without reducing its fertility. Microorganisms contained in vermicompost contribute to the conversion of toxic forms of heavy metals into inactive compounds. This is important when introducing vermicompost into soils around large cities, industrial facilities, as well as in conditions of widespread use of mineral fertilizers and pesticides, as this will contribute to the improvement of soils and, in general, the environment [16].

Another important aspect of using vermiculture technology is solving the problem of waste management (organic). Today, in most European countries and leading countries of the world, the waste management system through reuse, recycling, composting allows

solving environmental issues of society and the environment. A separate type of recycling in the waste management hierarchy is considered to be composting - the transformation of bioorganic residues into a humus-like substance.

In the countries of the European Union, an ambitious goal has been set - the amount of waste sent to landfills in 2010 was reduced to 75% of the amount in 1995, in 2015 - to 50%, in 2020 - this is a little more than a third of all waste. Achieving this goal means reducing all waste by 8 million tons. The share of household waste, the basis of which is organic, which is recycled or composted over twenty years has increased from 18% to 45%, starting from 1995.

In the European Union, the United States of America, Turkey, and other leading countries, the requirements for the use of biohumus as an organic fertilizer are regulated by approved requirements at the level of states, municipalities, and communities.

Ukraine is also actively involved in the process of processing biowaste through composting, using biohumus in agriculture, thereby improving the ecological state of the environment, stimulating the implementation of organic technologies in the agricultural sector and food production. Today, a large number of manufacturers operate in Ukraine that have implemented vermicomposting technology, are engaged in composting organic waste, producing organic fertilizers based on biohumus, growing environmentally friendly agricultural raw materials, and producing environmentally safe food products. Information about producers of biohumus and organic fertilizers is posted on the website of the certification body in Ukraine Organic Standard

(<https://organicstandard.ua/ru/services/handbooks-and-catalogs>).

Conclusion

The greening of food production and agricultural raw materials, as one of the components of the food chain, is a major challenge for society. It is based on the rational use of natural resource potential, the requirements of reducing the negative impact on the environment, obtaining environmentally friendly (organic) and safe food products.

The negative impact of agriculture, which is the first link in the food chain, is observed in the depletion of soils, their pollution due to the use of agrochemicals and chemical plant protection products, the accumulation of harmful substances in agricultural raw materials and their entry into food products. An important task of greening the industry is to reduce harmful substances in raw materials of plant and animal origin and their entry into food products.

The transition and use of "environmentally friendly" technologies is one of the steps in the greening of the food industry.

Vermiculture is an environmentally friendly technology that uses earthworms to not only effectively utilize organic waste of plant origin, but also to obtain high-quality animal proteins and biologically active substances, and to accelerate the process of humus formation in the soil. Earthworms are able to accumulate heavy metals and other toxic substances in their bodies, which significantly improves the ecological state of the soil.

The process of cultivating worms in an organic substrate allows you to obtain high-quality organic fertilizer (vermicompost, biohumus), containing a full range of macro- and microelements necessary for agricultural plants during their vegetation.

The use of vermiculture technology in agriculture allows you to use soils continuously without reducing their fertility. Microorganisms in vermicomposts contribute to the conversion of toxic forms of heavy metals into inactive compounds. Thus, it is possible to significantly improve the ecological condition of land resources near major transport networks, around large industrial cities.

Using the experience of leading countries, through the technology of vermicomposting of bioorganic residues, it is possible to improve the system of organic waste management, which will also allow solving environmental problems.

Vermicomposting technology does not require large areas, can be implemented on vermifarms of various sizes and configurations, which will contribute to the development of small and medium-sized businesses in the production of organic fertilizers.

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