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THE STRENGTHENING FOOD SECURITY THROUGH IMPLEMENTATION OF THE CONCEPT OF SUSTAINABLE AGRICULTURE

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Abstract

Food security is an important condition for the sustainable existence and development of society. Moreover, it is important both for an individual and for various social groups and society as a whole. The situation that has developed today in the world food market is the result of ineffective management of productive forces, in particular in agriculture, the consequences of the impact of natural and crisis phenomena occurring in the world, including military actions on the territory of Ukraine. All this presents our country with the task of providing the country's population with food and fulfilling its obligations to other countries regarding food supplies. This requires further study of food security issues, taking into account modern trends.

One of such mechanisms is increasing the importance of sustainable agriculture in the global world. And this is no accident, because thanks to the implementation of the principles of sustainability in agribusiness, the global consumer market receives products and raw materials for many industries.

Keywords: sustainable agriculture, food security, world food market, the implementation of the principles of sustainability in agribusiness, global consumer market.

Introduction. Food security is one of the most important conditions for the sustainable existence and development of society. Moreover, it is important both for an individual and for various social groups and society as a whole. Food security is a component of the economic and, in general, national security of any country.

Effective mechanisms for ensuring food security contribute to improving the social climate in society. The state of health of the population, the quality and duration of life, and its level, in general, are to some extent determined by the adequacy of the country's food supply. The standard of living of the population in a particular country depends on the level of development of industry, agriculture, the state of the public sector of the economy, and scientific and technological potential. But the main factor in this list is the immediate state of the domestic food market, the degree of its dependence on the global food market, the financial capacity of the population to meet their needs, and the ability to consume safe, high-quality and nutritious food. The food dependence of a country arises as a result of inefficient agriculture and the agri-food sector in general. Without ensuring food security, it is impossible to successfully solve economic and social problems, positively influence global processes, and defend the country's national interests. Solving the problem of food security is a priority of state policy, an object of scientific research, etc. The study of all aspects of food security, its forms, qualitative and quantitative characteristics, mechanisms and tools used is not only relevant from a scientific point of view, but also has practical significance in finding the best ways to further reform the industry and modernise it.

The current situation on the global food market is the result of inefficient management of productive forces, in particular in agriculture, and the effects of natural and crisis phenomena taking place in the world. Today, this list of influencing factors has been supplemented by the consequences of military operations on the territory of Ukraine, which is one of the leaders in the agricultural sector [1-3].

All of this poses complex macroeconomic challenges for Ukraine in terms of providing the country's population with food and fulfilling its obligations to other countries regarding food supplies. This necessitates further study of food security issues, taking into account current trends.

Materials and methods. The research was based on the learning of global reports and statistical data of the Food and Agriculture Organization of the United Nations, statistical data of the State Statistics Service of Ukraine, State Customs Service of Ukraine, national and regional reports.

Results and discussion. One of the mechanisms for addressing food security is to increase the importance of sustainable agriculture in the global world. This is no coincidence, as the global consumer market receives products and raw materials for many industries thanks to the implementation of sustainability principles in agribusiness. And most importantly, food and feed for livestock. Moreover, the demand for these resources is constantly growing and is under threat of shortage due to forecasts of an increase in the world's population [4].

Sustainable agriculture allows us to optimise this process, reducing the damage to the environment and future generations. This practice includes the transition to renewable energy sources, careful land use and the elimination of environmental pollution (Figure 1).

Figure 1. Use of renewable energy sources in sustainable agriculture

Sustainable agriculture is a complex of management decisions made by farmers and the data required for qualitative analysis provided by remote sensing technology (Figure 2).

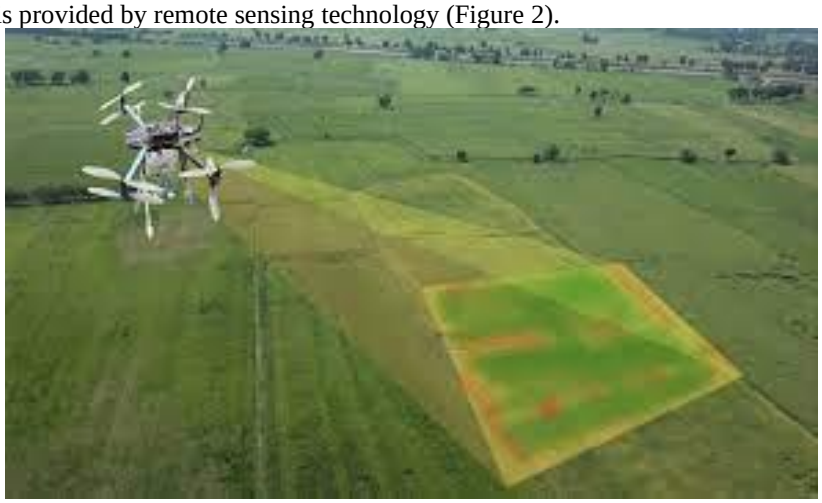

Figure 2. Use of remote sensing technologies in sustainable agriculture

The technologies used in sustainable agriculture contribute to stable and continuous production, which will ensure sufficient resources in the future.

According to research by the Food and Agriculture Organization of the United Nations (FAO), this practice includes five principles:

- improving the food chain;
- protecting and saving natural resources;
- improving the well-being and economic situation of people;
- promoting the resilience of ecosystems and communities;
- support for government initiatives and regulations.

Therefore, it is clear that the main goal of sustainable agriculture is to ensure food security, both in the short and long term. Other positive effects of sustainable agriculture include

- preservation of soil fertility and biodiversity;
- improving the environment, minimizing or preventing pollution;
- reduced use of non-renewable natural resources;
- economic development of rural areas and improvement of the quality of life of the rural population;
- raising environmental awareness and responsibility in society.

The most important aspect of sustainable agriculture is the ability to produce healthy food with minimal environmental damage through the rational use of each land plot without using intensive traditional technologies.

The concept of sustainable agriculture is based on three pillars: environmental, social and economic.

Ecological, or agroecological, is an environmental approach to management that reduces pollution and consumption of non-renewable natural resources.

Social, or socio-territorial, which is the basis for providing the world's population with sufficient food, fair employment and development for individual territories. Economic, which is the basis for the efficiency and profitability of agribusiness.

These three pillars of sustainable agriculture are closely interconnected. For example, fertilizer application tailored to the specifics of a particular plot of agricultural land can save farmers' resources and help protect the environment.

In order to reduce the negative impact on soils and, as a result, on the environment, sustainable agriculture uses nitrogen-fixing plants instead of fertilizers, and natural plant defenders instead of aggressive pesticides. Methods such as minimal or zero tillage, crop rotation, optimal irrigation, use of cover crops, permaculture technology, etc. are also used.

Crop rotation, which involved planting different types of crops in a certain sequence, has contributed to soil conservation and environmental sustainability. Soil compaction is minimized as the root systems of different plants differ from each other; the soil is saturated with nitrogen through the use of nitrogen-fixing plants;

pest control is improved for specific crop types; and soil depletion is reduced. In addition, the amount of chemicals used is reduced, and the supply of organic matter to the soil stimulates the activity of soil biota and reduces agricultural risks.

Efficient farming is usually carried out on irrigated land, which involves the use of significant water and energy resources. Sustainable development in agriculture is aimed at optimizing water and energy consumption. This is done by growing crops that are less demanding on water consumption and using modern irrigation methods. For example, drip irrigation, compared to furrow irrigation, uses 20-40% less water while increasing yields by 20-50%.

The use of cover crops in the off-season has allowed farmers to carry out soil erosion control measures. If used as green manure, they contribute to the accumulation of organic matter in the soil and reduce the amount of fertilizer used. Such plants fight weeds and retain moisture in the soil.

In contrast to regular ploughing, minimal or no-till prevents soil loss due to wind and water erosion. In addition, this technology prevents soil compaction and minimizes greenhouse gas emissions, which contributes to environmental sustainability.

Sustainable weed control methods are aimed at preserving natural resources by eliminating chemicals and implementing environmentally friendly methods.

Permaculture, one of the technologies of sustainable agriculture, artificially creates ecosystems with their diversity and stability. This contributes to the development of sustainable agriculture by reducing waste, using renewable sources, combating pollution and increasing soil fertility in ways that are safe for the environment.

In addition to the practices described above, sustainable agriculture uses other practices. These include biodynamic and organic farming; integration of livestock and crop production; intercropping; mulching; conservation tillage; use of biofuels and zero-emission transport, etc.

The choice of technologies and methods used to support sustainable agricultural production depends on the particular agricultural producer, its specifics and the crops it grows.

Like the Concept of Sustainable Agriculture, sustainable agriculture itself has three components of sustainable development: economic, environmental and social.

The economic benefits include:

- reduced costs due to the use of precision farming methods;
- ensuring food security by increasing crop yields;
- energy savings due to the avoidance of fossil fuels (natural resources) whenever possible.

The benefits of the environmental component of sustainable agricultural production are as follows:

- protection of natural ecosystems;
- preservation of biodiversity, creation of conditions for animals close to natural ones;
- soil conservation, prevention of erosion and depletion;
- minimizing water and air pollution;
- conservation of non-renewable natural resources.

The social component of sustainable agriculture has characterized by:

- increase in wages;
- reduction of social inequality;
- improved public health due to reduced chemical pollution of soils and agricultural raw materials.

However, sometimes the benefits of implementing sustainable agriculture are accompanied by certain difficulties for agricultural producers, such as the lack of sufficient research, initiatives and support from government authorities at various levels, and sometimes insufficient logistical support.

An important component of implementing sustainable agriculture is managing its resources, namely by preserving natural resources: soil, water, air, etc.

Soil is an essential medium for plants. Therefore, effective agriculture is not possible on poor or unsuitable land. Sustainable agriculture can reduce soil erosion and restore soil fertility. It preserves soil fertility by using polyculture, crop rotation, ecological fertilizers and fertilizers of natural (animal) origin, etc. This provides the necessary amount of nutrients, as well as the means to combat plant diseases and pests.

Soil conservation is an important part of sustainable agriculture, as it addresses the problem of topsoil loss, primarily by preventing erosion. As mentioned above, sustainable agriculture practices include the use of cover crops, the construction of windbreaks and minimal tillage.

Successful management of water conservation in sustainable agriculture is also a key to its effective operation. In conditions of low precipitation, artificial irrigation is the only way to conduct agricultural activities. As the need for water resources will only increase in the future, water management requires special attention and responsibility.

The use of sustainable agriculture practices allows us to:

- eliminate soil salinity through desalination;
- prevent leakage of fertilizers that pollute the soil and cause sedimentation in water bodies;
- optimize water use through smart irrigation, rainwater harvesting and reuse of resources;
- prevent the destruction of habitats within the catchment areas;
- select plants that are resistant to drought;
- consider the need to plant in atypically dry years (based on historical data to predict weather trends).

The modern agricultural sector is dependent on oil-based fuels, which are a non-renewable source. The only way to overcome this dependence is to use energy-saving technologies in agriculture that use renewable energy sources. The most promising areas of development of the industry as a sustainable one are:

- the use of highly efficient solar-powered irrigation systems or biofuel equipment;
- growing crops for alternative fuels;
- use of biomass to convert it into bioenergy;
- use of wind and solar energy for the needs of agricultural enterprises.

Clean and fresh air is essential for human life. However, almost all agricultural activities pollute the

atmosphere with chemicals, dust, fossil fuel emissions and methane, which is produced in large volumes in livestock production.

According to the results of the analysis of the state of the atmospheric air, in 2021 alone, agriculture accounted for more than 10% of all greenhouse gas emissions in the world on average. Compared to 1990, this indicator increased by 12%.

Sustainable agriculture provides an opportunity to improve air quality by reducing dust through reduced tillage, the use of cover crops and agroforestry methods, and the installation of windbreaks of plantations.

Recently, technologies using satellite and space-based observation sources have been widely used.

Sustainable crop production, as one of the sectors of agriculture, is not just a stable business for agricultural producers. It is also a specific challenge for every participant in the food chain responsible for food security.

The use of new technologies in sustainable agriculture allows for continuous monitoring of production and facilitates its management. One of the most advanced methods is remote sensing. This method is a reliable source for analysing and forecasting crop development, quality and productivity of agricultural land, resource use, biodiversity control, etc. (Figure 3) [5].

Figure 3. The stage of using remote sensing technology in sustainable agriculture

Programmes and platforms used in this technology allow for efficient management of crops and production resources. One of the most convenient online tools for implementing precision farming methods that contribute to the development of sustainable agriculture is the EOSDA Crop Monitoring platform. This application allows for the efficient use of fertilizers and other agrochemicals (e.g., plant protection products) by applying zoning and changing application rates (Figure 4).

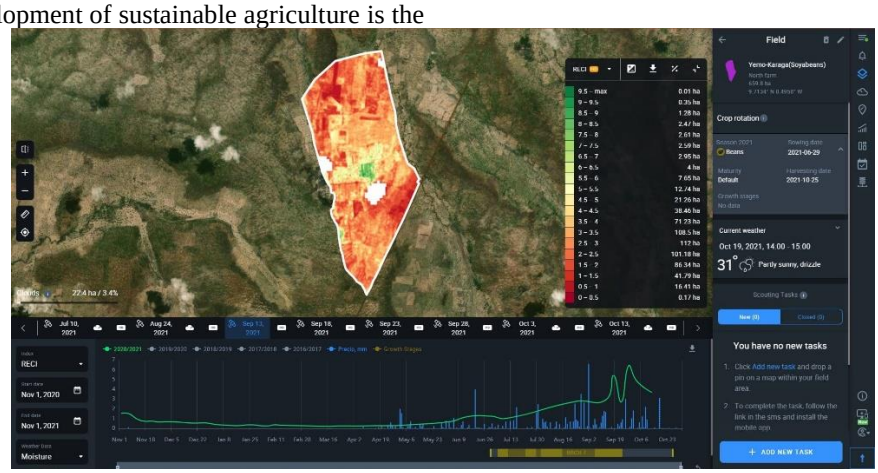

Figure 4. Example of variable rate fertilizer application

The technology is based on dividing the field into several zones. Areas with healthy vegetation are shown in green, while critical areas are shown in yellow and red. By differentiating the required rates and treating the green and red zones accordingly, farmers can reduce the use of agrochemicals. This will save financial resources and improve the environment.

Efficient use of water can also be achieved through the use of programs that take into account soil moisture data. By monitoring these parameters, you can provide the farmer with timely information about possible problems that may be caused by waterlogging or plant water stress. It is possible to ensure the healthy development of crops and preserve the harvest by taking measures to combat the lack or excess of moisture. By tracking the weather forecast and monitoring for possible rainfall, users of this app can adjust irrigation, which will save water resources.

Monitoring programs also provide up-to-date information on the condition of crops and allow us to respond quickly to any deviation from the standard values for the current stage of plant development.

Recently, another effective mechanism for managing sustainable agricultural resources has been used – agro-scouting. Agro-scouting involves collecting information from the field (in the form of specified parameters) to control the quality of work performed (tillage, irrigation, harvesting, etc.), determine the condition of crops (vegetation stage, activity, health, presence of diseases and pests), and develop technical specifications for field treatment.

Unfortunately, Ukraine does not have a developed institution of agro-scouting. However, with the support of foreign investors and partners, including the USAID program, work is underway to establish agro-scouting centers to provide agricultural producers with a range of services. The purpose of these centers is to optimize agricultural technologies, improve the productivity and quality of fruit and berry products, and enhance the professional knowledge and practical skills of young specialists of specialized higher education institutions (HEIs) in line with the needs of the agricultural market.

The scouting function helps to reduce fuel consumption and emissions by reducing the need for field visits. Regular field inspection is particularly difficult when the farmland under control is large in area or located in different places. Remote monitoring of crop condition greatly facilitates this process, as field scouting becomes necessary only when a problem is detected through specific deviations in the values of the monitored indicators. This procedure identifies critical areas of the field for additional inspection. This saves travelling time and reduces fuel consumption. Upon arrival at a specific critical zone, a scouting specialist can quickly identify plant diseases, pest infestations, excessive weeds, etc. Based on the results of the scouting reports, the agricultural producer can choose the most effective plant protection product for the affected areas.

Another effective tool for eliminating errors in farm management planning is the so-called EOSDA Crop Monitoring work logbook. This form of management allows you to store information about all completed and planned field operations. This will help to eliminate the possibility of errors in production, allows you to track changes in plant development after each procedure, storing all the necessary data in one place (Figure 5).

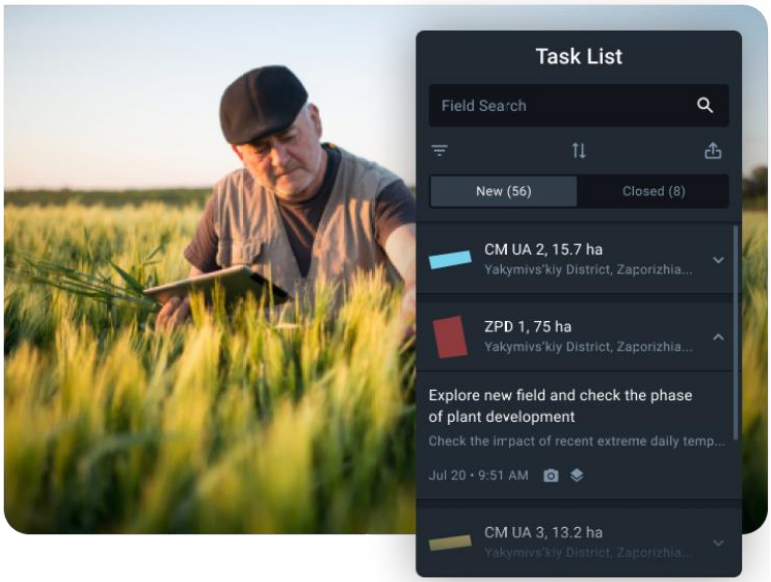

Figure 5. An example of the use of agro-scouting in sustainable agriculture and keeping a logbook [5].

In addition to the existing capabilities of EOSDA, the program can use patented EOS SAT imagery to conduct analytical analysis based on satellite data. This allows for more efficient use of modern remote sensing technologies for the development of sustainable agriculture [7-9].

Conclusion. Sustainable development of society in the global world is impossible without any security, especially food security. The provision of food to the population and the environment are an important condition for human life and activity.

Today, sustainable agriculture is becoming increasingly important in the global world. Implementation of sustainability principles in agribusiness allows to optimize this process, reducing environmental damage through transition to renewable energy sources, careful land use and elimination of environmental pollution.

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