

SOLVING THE FOOD CRISIS IN THE CONTEXT OF DEVELOPING THE BIOECONOMY OF THE AGRO-INDUSTRIAL COMPLEX OF UKRAINE

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Abstract. In modern conditions of the development of the agro-industrial complex of agriculture, the introduction of bioeconomy on a scientific basis is of particular importance. Overcoming global modern challenges: economic, ecological and social problems, including the food crisis, is impossible without a clear understanding of the development of the bioeconomy. The bioeconomy will contribute to sustainable development in order to ensure the long-term competitiveness of agriculture and forestry, food and chemical industries, as well as to mitigate climate change and greenhouse gas emissions. Due to the implementation of the bioeconomy, the following global problems can be solved: food shortages associated with population growth; depletion of mineral resources; environmental pollution and social aspects. Ukraine has a huge raw material potential for the development of the bioeconomy, while not reducing the level of food production. That is, today Ukraine not only provides itself with a sufficient amount of food products, but also exports a part of agricultural products; possesses a significant natural-economic, scientific and production potential for increasing the volume of production of agricultural products by improving the culture of agriculture, mastering innovative technologies. The article analyzes the development of bioeconomic strategies in the European Union based on their general characteristics. The analysis is based on 349 identified regional bioeconomic strategies (published and under development). It covers three categories of strategies according to the focus of the bioeconomy, i.e., specialized strategies, strategies with a strong bioeconomy focus, and strategies with minimal bioeconomy content. The state of the bioeconomy in Ukraine was analyzed and recommendations were offered for their structuring in accordance with the codes of Classification of Economic Activities by types of economic activity. Conclusions are made regarding the role of bioeconomy in the post-war revival of Ukraine.

Keywords: food crisis, potential supplies, competitiveness of a country, agro-industrial complex, agriculture, European integration, sustainable bioeconomy strategy, biomass.

JEL Classification: E 20, O 13, Q 28, R 13.

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Introduction. At the high-level conference “The Bioeconomy – Enabling the European Green Deal in Challenging Times” which took place on 6 and 7 October in Brussels, the conclusions of the “EU Bioeconomy Strategy Progress Report” [1], adopted in June 2022 and highlight the role of bioeconomy policy to enhance policy coherence and system thinking. A number of bioeconomy success stories from EU research and innovation will be presented, alongside evidence for a successful implementation of the EU Bioeconomy Strategy. There was also an opportunity to discuss how the bioeconomy can help to better manage certain trade-offs, by addressing the question of how increasing biomass demand for energy and industrial needs can be matched with increasing climate and biodiversity objectives.

Bioeconomy encompasses all sectors and associated services and investments that produce, use, process, distribute or consume biological resources, including ecosystem services. From the food we eat to the furniture in our house and the clothes we wear,

the bioeconomy, as one of the Union's largest sectors, is already present in our daily lives. Bioeconomy can be the natural enabler and result of the European Green Deal transformation.

The EU Bioeconomy Strategy Progress Report [1] states:

To meet the high stakes and ambitions of the European Green Deal it is essential to ensure environmental integrity and to close the projected 'biomass gap' between supply and demand of biomass for food, materials and energy. While the three action areas of the 2018 EU bioeconomy Strategy aim to close this gap, additional focus should be given to resolve multiple pressures on land for mitigation, nature protection and supply of biomass. Also, a better understanding of overall consumption of biological resources is needed to help shifting to more sustainable consumption patterns.

Following the unprovoked Russian invasion of Ukraine, the need to enhance the transition towards both clean energy and sustainable, resilient, and fair food systems has never been stronger and clearer. Future implementation of the EU Bioeconomy Action Plan will have to take into account the implications on food and energy prices, as well as prices of energy-intensive products, and global supply chains, and address resulting additional pressure on natural resources within ecosystem boundaries.

A strong EU Bioeconomy Strategy with a focus on all three dimensions of sustainability contributes to achieve the goals outlined in the European Green Deal. Progress of the 2018 updated Bioeconomy Strategy is promising and encourages to continue and further strengthen various activities. However, to in order to fully exploit the strength of the Bioeconomy Strategy, additional efforts are needed, especially with regard to further actions on resolving multiple pressures on land and sea and on the overall consumption patterns of biological resources.

Literature review. The aspects of the bioeconomy were studied by domestic scientists: V. Baidala, S. Belous, V. Bugaychuk, V. Butenko, O. Vdovichena, I. Grabchuk, I. Gushcha, M. Dobrivska, L. Ilkiv, T. Kachala, A. Klymenko, O. Kucher, O. Litvak, V. Lyamar, I. Nesterenko, N. Petrukha, S. Petrukha, V. Proskura, S. Proskurina, A. Proshchalykina, O. Ryabchenko, M. Talavirya, V. Zhebka, M. Yareмова and others.

Bioeconomy research in the agro-industrial complex of Ukraine was carried out by: V. Baidala, V. Bugaychuk, V. Butenko, I. Grabchuk, I. Gushcha, M. Dobrivska, V. Zbarsky, L. Ilkiv, A. Klymenko, O. Kucher, O. Litvak, N. Petrukha, S. Petrukha, S. Proskurina, A. Proshchalykina, M. Talavirya, V. Zhebka, O. Shubravska and others.

Aims. The aim of the article is to study the bioeconomy in the context of the development of the agro-industrial complex of Ukraine to overcome the economic crisis and develop measures for their development.

Methods. Research methods: general scientific methods: analysis, synthesis, induction, deduction, systems approach and modeling – to study the theoretical issues of forming a strategically-oriented model of sustainable development; generalization method – for the formation of a strategically oriented model of sustainable development.

The research methodology involves the use of general scientific and specific methods used in economics, ecology and biotechnology, and is based on an interdisciplinary approach.

The scientific novelty of the obtained results is to determine the directions of development of Ukrainian bioeconomy based on the use of biotechnology in food, agricultural and environmental sphere.

Result. The current structure of the food system lies at the center of a nexus of global problems, stretching from poverty to environmental degradation. The increase in food production needed to meet the anticipated demands of the near future cannot be achieved by simply extrapolating current trends in production and consumption. A continuation of the recent historical trends of expansion and intensification will undermine the very resource base on which the food system itself depends.

The preservation of ecosystems and the future wellbeing of the human population are all centrally dependent on a structural transformation of the food system towards a sustainable and resilient state.

Global food and agricultural production have increased significantly since the end of WWII spurred by a combination of population and economic growth along with technological and cultural shifts in production practices. Due to increases in population, wealth, and urbanization, the world has seen an overall increase in food demand, coupled with a shift in dietary preferences towards more resource-intensive foods.

The Green Revolution played a significant role in establishing intensive agricultural production methods globally and shaping the reigning philosophies in mainstream agricultural practice. Global yields have steadily increased since the 1950s; there is more food produced today per person than ever recorded. Though widely credited with helping avert anticipated large-scale food shortages in the post-WWII era, the intensification practices brought on by the Green Revolution have also been critiqued for driving ecological degradation, unsustainable resource consumption, and entrenching dependency on non-renewable resources like fossil fuels.

Intensification, consolidation, and specialisation are some of the large scale behavioural trends inherent to the food system. Intensive practices dominate the system as a whole and a small number of actors in the fields of production, processing and retail control most of the food system and strongly influence policy making. Loopholes in trade agreements are widely abused by more powerful nations, resulting in unfair competition for developing countries, ultimately manufacturing dependence and eroding local food security.

Recent trends and policies towards growing non-food crops, like biofuels and biomaterials, are leading to re-assignment of land and other base resources, resulting in less availability of these resources for food production. Funding for agricultural research and development is mostly available in higher-income nations, leaving lower-income nations behind. Research and development efforts have been focused on enhancing conventional production methods, with very little funding allocated to the development of sustainable agricultural techniques [2].

Climate change is a growing threat to our food systems, with impacts becoming increasingly evident. Rising temperatures, changing precipitation patterns, and extreme weather events, among other effects, are already reducing agricultural yields and disrupting food supply chains. By 2050, climate change is expected to put millions of people at risk of hunger, malnutrition, and poverty.

Aspirations for food systems are extremely high. Global summits in 2021 highlighted the central role of food systems transformation in the world's response to climate change as well as meeting multiple other development goals. Action to address climate change is underway but must be hastened by accelerating innovation, reforming policies, resetting market incentives, and increasing financing [3].

For the development of human society in the third millennium, a crucial role is assigned to biotechnological research, including those in the field of agrarian biotechnology and sustainable agriculture. Among many scientific concepts and views on ways to overcome the food problem, one can single out the main concepts. First of all, these are concepts that directly associate the provision of food to the population with the demographic situation on Earth. The second group should include technocratic teachings. Less numerous, but extremely versatile, is the humanistic direction.

The limits of the intensification of the production of agricultural products and food were determined by the possibility of using the renewable resources of the planet (energy, mineral resources for the production of machinery, fertilizers).

The statement of modern scientists and agribusiness representatives that "biotechnology will feed the world" is now being criticized by some economists. They believe that these technologies could certainly contribute to the growth of agricultural productivity and the solution of the food problem in poor and developing countries. However, they are practically inaccessible to local farmers. Therefore, agricultural biotechnology is currently not a sufficient condition for providing the world with food - they primarily ensure the maximization of the profits of farmers in developed countries.

Biotechnology has turned from an ordinary industry into a system-creating factor in the development of the economies of individual states and the world economy in general. A special term denoting this phenomenon appeared - bioeconomy and the field of bioeconomy based on relevant knowledge.

According to the forecasts of experts of the Organization for Economic Cooperation and Development (OECD), in the 21st century biotechnology will play a crucial role in political and economic stability in both developed and developing countries and will have an anthropogenic impact on the planet. Due to the achievements of biotechnology, humanity will be able to take full advantage of the plant in the coming decades as the cheapest and most ecologically safe factory for the production of most of the materials, food, medical drugs, chemical compounds, raw materials, etc. that are necessary for people. Biotechnology co the environment, because it reduces the risk of toxic contamination of soils and groundwater, and increases the efficiency of agriculture. As a result, it will be possible to combine the provision of food for the constantly growing population with the cessation of environmental destruction trends [4, p. 185-186].

Throughout the development of mankind, the improvement of biological and agronomic technologies for obtaining food products took place along with the optimization of methods of soil cultivation, product processing and the attraction of new energy resources. However, during the millennia, the agricultural products themselves, obtained as a result of such development of agricultural technologies, have practically not changed. In this sense, biotechnologies can be conditionally comparable to evolutionary agricultural technologies [4, p. 192].

The specificity of the modern world food problem is that there is generally enough food to eliminate hunger in the world, but there is unevenness in its production and consumption, that is, the geography of food production does not coincide with the geography of their consumption. Developed countries, in which 21% of the world's population lives, account for 46% of the world production of grain crops (including wheat - 54%, potatoes - 58%, sugar - 32%, oil - 34%, meat - 45%, milk - 60%). The situation with providing food products of own production in the least developed countries, where 43% of the world's population lives, is difficult. They provide, respectively, 24% of the world production of cereals, potatoes - 19%, sugar - 24%, oil - 24%, meat - 9%, milk - 10%. The traditional system of agriculture, which provides the main part of food in these countries, is not designed for such a population.

Even more striking is the inequality in the distribution of the world consumption fund: the share of developed countries in the world consumption fund for all products (except rice) significantly exceeds the share of their population in the world. The uneven distribution of production and consumption in the world leads to a situation where in some countries there is malnutrition and hunger, and in others - excess production and consumption of food. This state of the world food system implies a mandatory increase in the intensification of production and an increase in the circulation of food products through the channels of domestic and foreign trade for the normal supply of food products to the global population. It is absolutely obvious that there is a need for further development and expansion of the capacity of the world agro-food market, as well as the equalization of its certain disparities, based on the search for new biotechnologies.

The main advantages of agricultural products obtained with the help of new biotechnologies include: – increasing the yield of crops due to providing them with specified properties and reducing losses from diseases and pests; – reducing the use of pesticides and herbicides and thus reducing the chemical impact on the soil; - releasing renewable natural resources, replacing them with more productive ones obtained with the help of biotechnology; – reducing the level of impact on the environment due to the use of less harmful methods of soil cultivation; - reduction of plant and animal disease level, etc. [4].

The global environmental and food problems of humanity in today's realities negatively affect both highly developed economies and the economies of developing countries. Food shortages due to population growth, the depletion of mineral, raw and energy resources, environmental pollution, the spread of Industry 4.0 and smart technologies, the growth of consumption and the spread of the ideology of consumerism require the search for mechanisms to maintain a balance between the

consumption of limited resources and the accumulation of waste, which cause ecological damage to the environment and the population of the planet.

The solution to the outlined problems is provided by the bioeconomy, the narrative of which is the human use of natural potential on a restorative circular basis in the sphere of realizing the goals of sustainable development.

Significant theoretical developments and best practices of implementing a sustainable bioeconomy in the countries of the European Union are an essential basis for intensifying research, determining directions and opportunities for the formation of a bioeconomy in Ukraine [5, p. 65].

Many European regions have multiple strategies in place, or under development, that are relevant to the bioeconomy or tackle it from different angles. This means that the number of bioeconomy strategies at regional level is considerably higher than the number of regions with bioeconomy strategies.

Research has revealed that there are 359 strategies (published and under development), at regional level in the EU-27 that are fully or partially dedicated to bioeconomy and contribute to its deployment across European regions (situation as of November 2021). Of these, 345 are strategies at (sub-national) regional or local level. In addition, 14 multi-regional strategies have been identified that cover different regions. Of these, 10 have a cross-border, macro-regional or interregional perspective, while 4 cover various regions in one country.

Of the total 359 regional and interregional strategic frameworks, 334 are published (as of November 2021). Of these 334, 324 are regional and 10 are multi-regional strategic frameworks. Of these regional strategies, 32 are fully dedicated to bioeconomy, 83 cover bioeconomy within a sectoral strategy and 209 treat bioeconomy as an embedded topic within a wider strategic framework (Figure 1).

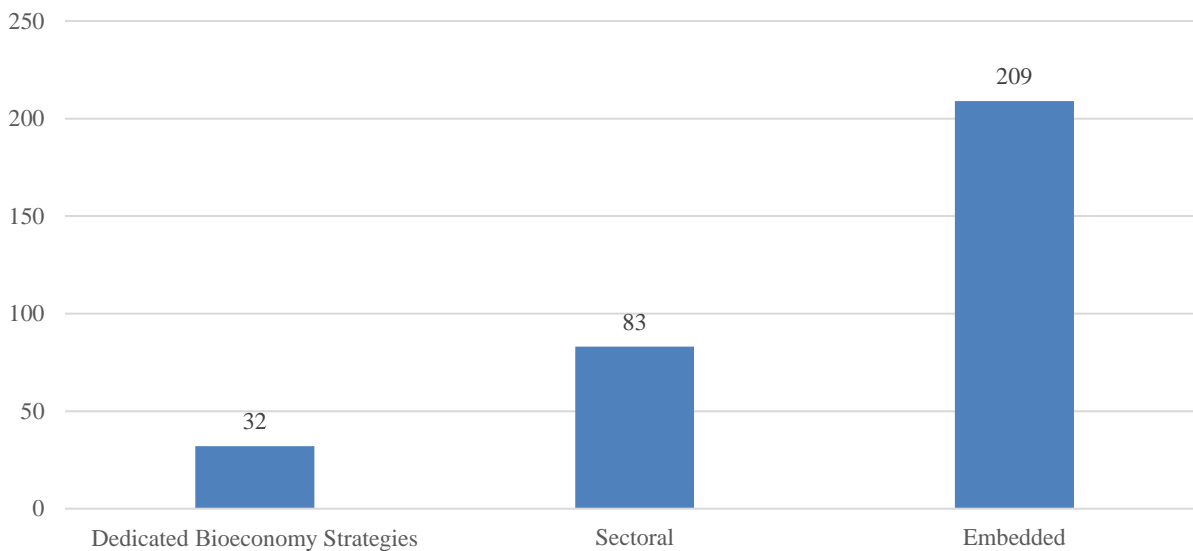


Figure 1. Regional strategies where bioeconomy is treated as a main theme, sectoral topic or is embedded in a wider strategic framework (no. of strategies) [6]

Overall, 41 strategies (32 regional and 9 multi-regional) are fully dedicated to the bioeconomy, i.e. directly focus on the deployment of the bioeconomy. Of those remaining, 97 strategies have a strong focus on the bioeconomy, whereas 196 have a minimum bioeconomy content.

Bioeconomy is addressed in sectoral strategies in 83 cases of the published regional strategies (Figure 2). In most cases, it is addressed in forestry plans/strategies (29), followed by waste plans (26), strategies on energy (13) or focusing on agriculture/agri-food (11). Bioeconomy is addressed in sectoral strategies on aquaculture/fisheries or algae (3) or on construction (1) in several cases.

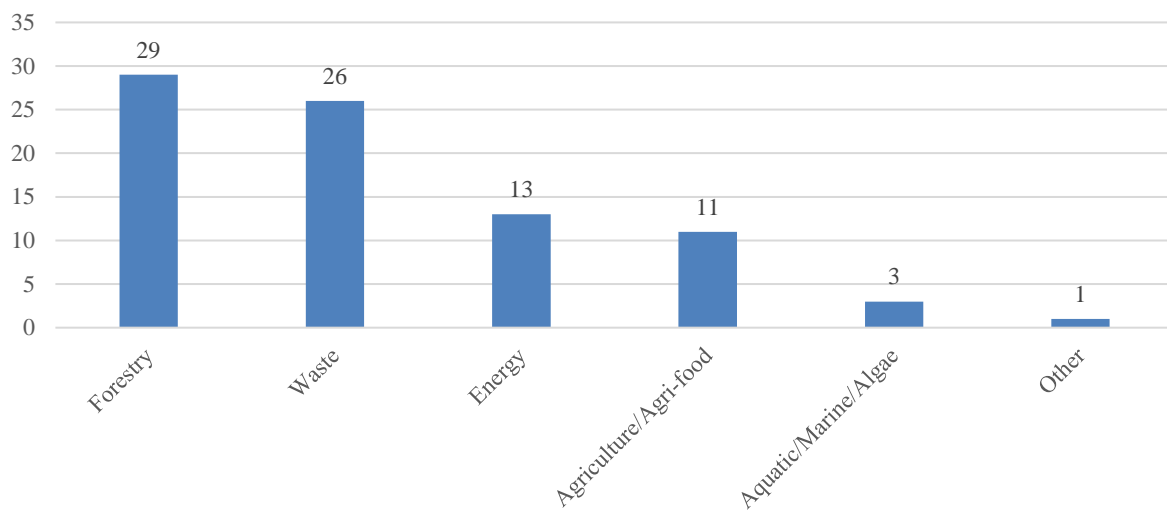


Figure 2. Bioeconomy covered in sectoral strategies (no. of strategies per sector) [6]

In 210 cases (209 regional and 1 macro-regional), bioeconomy is embedded into wider strategic frameworks (Figure 3). This is mostly the case within regional/territorial or rural development plans (54), within Smart Specialisation Strategies (49), within the context of circular economy strategies (31), within strategies for economic/industrial development or sustainable development strategies/plans (17), within climate/low-carbon plans (15), and within regional research/innovation strategies (12). In several cases, bioeconomy is part of green (5) or blue transition (3) strategies or of recent Recovery and Resilience Plans (RRP) at regional level (2).

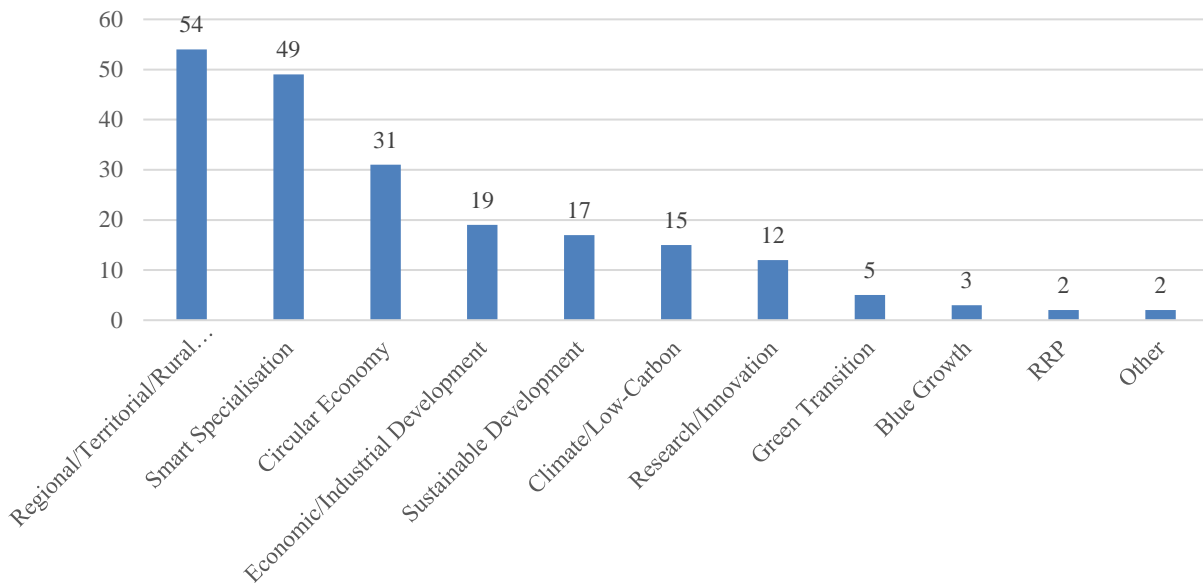


Figure 3. Bioeconomy embedded in wider strategies (no. of strategies per theme) [6]

The EU Bioeconomy Strategy [7] defines five objectives: ensuring food and nutrition security; managing natural resources sustainably; reducing dependence on non-renewable resources; mitigating and adapting to climate change; and strengthening European competitiveness and creating jobs. The analysis investigated which of these objectives are pursued by the regional strategies. The most prominent objectives of the different strategies are outlined below.

Figure 4 shows the strong emphasis of all regional bioeconomy strategies on the sustainable management of natural resources (within 270 of 349 strategies, 77%).

Reducing the dependence on non-renewable resources is also one of the most extended goals of the regional strategies (236 or 68% of the strategies). Evidently, many strategies, especially those where bioeconomy is embedded in Smart Specialisation or economic strategies, refer to the aim of strengthening the competitiveness of the regions and creating jobs (220 or 63%).

Furthermore, most strategies are also aligned with Europe's overall goal of mitigating and adapting to climate change (200 or 57%), which is often inherent to the use of bioeconomy resources.

Less than one third of the strategies mentions ensuring food and nutrition security as a dedicated goal (95 or 27%).

The picture hardly changes if the analysis is limited to those strategies with a strong bioeconomy focus and the dedicated regional bioeconomy strategies. One difference that can be observed is that fully dedicated strategies pay greater attention to nutrition and food security (16 out of 32 strategies, 50%) than the average of all strategies analysed.

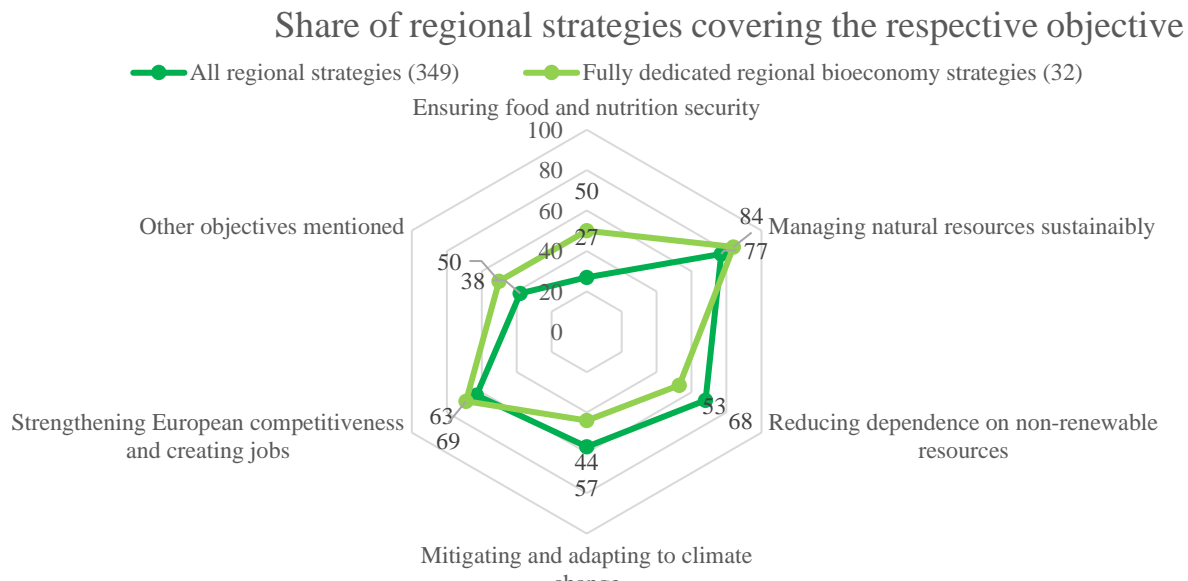


Figure 4. EU Bioeconomy strategy objectives in regional strategies (% of strategies) [6]

Today, the problem of limited fossil resources and the provision of food, medicine for the population, environmental pollution has led to the search for alternatives to traditional production. One of the effective directions is the use of biotechnologies, bioproducts and bioprocesses, that is, the development of bioeconomy. This issue is an extremely relevant direction for Ukraine, which will ensure the reduction of production energy costs, the restoration of soil fertility, the increase in the level of employment of the rural population, the provision of food and raw materials for domestic production [8; p.74].

Modern bioeconomy is the production of materials, food and feed, fuel and many other biological resources. Bioeconomy can offer resource-efficient, ecologically safe and sustainable production systems of food, feed, fuel and agro-industrial products with added value and, therefore, a healthier and more prosperous future [8; p. 75].

In addition to reducing the impact on the climate, a sustainable bioeconomy can have various co-economic and social benefits, such as diversity of energy supply, easier access to energy, more sustainable agricultural practices, wider implementation of sustainable forest use, reduction of land degradation, economic development of rural areas [8; p. 75].

In the current conditions, the process of forming a bioeconomy, which involves the transition of the most important branches of production, including agriculture, to the use of renewable biological resources, is becoming extremely relevant. Bioeconomy is capable of solving a number of economic, ecological and social problems, namely: providing the population with high-quality food products, reducing production energy costs, transitioning to organic farming, restoring land resource potential, etc. That is, the bioeconomy, as a high-tech part of the economy, represents a new approach to the rational use of resources and their restoration, increasing energy efficiency, increasing the sustainability of agriculture and industry [9; p. 129].

Ukraine has all the prerequisites, sufficient potential and resources, for the effective development of the bioeconomy, as indicated by the SWOT analysis of the development of the bioeconomy in the agricultural sector of Ukraine [9; p. 133].

On the territory of Ukraine, the topic of deep grain processing has already gained a certain reach, has a number of supporters and even ardent supporters. Bioeconomy will allow, among other things, to bring the grain and elevator industries to a new level, include them in the chain of higher technologies and significantly expand business horizons.

At the current stage of the development of society, a resource-efficient and viable bioeconomy is the engine of progress, primarily in agriculture and the food industry, which have a tendency to further growth due to the increase in the population of the planet (in 2020 – 7 billion, in 2050 – 9 billion people).

In order to achieve high rates of economic growth, Ukraine must take a course towards the bioeconomy – to create a more innovative and low-emission economy by combining the needs of viable Ukrainian agriculture, food security and the sustainable use of renewable resources. The need for the development of the bioeconomy in Ukraine is determined not only by economic factors, but also by social, ecological and even political aspects.

The transition from fossil to renewable resources is an important element of the environmental transition envisaged by most developed countries. Weak integration of Ukraine's bioeconomy and biotechnologies into the economic space of the European Union is an obstacle to achieving the goals of a circular, sustainable bioeconomy of the EU [10, p. 191].

In order to better understand what real steps Ukraine should take in the field of bioeconomy, it is necessary to structure it. However, there is no single approach to the bioeconomy in the world, it covers many different sectors, which requires its own national methodology.

Based on the EU definition, the European Commission conducted a survey and classified the bioeconomy into 3 sectors: core, partial and indirect bioeconomy.

The main bioeconomy includes areas such as agriculture and forestry, fisheries, food industry, bioenergy and biofuels. The partial bioeconomy in the EU-27 includes chemicals, plastics, construction, pharmaceuticals, textiles, waste management and biotechnology. Engineering, technology, equipment manufacturing, trade, water supply and similar services have an indirect effect on the bioeconomy.

Such a classification allows the best calculation of the economic contribution of the country's economy to the bioeconomy, but it is difficult to use it to determine breakthrough technologies in certain industries. Therefore, it is proposed to carry out the structuring of the bioeconomy of Ukraine by sector (Table 1).

In September 2020, the Cabinet of Ministers of Ukraine approved the “Forecast of Economic and Social Development of Ukraine for 2021-2023”, prepared by the Ministry of Economic Development, Trade and Agriculture, according to which most of these goods of the agro-industrial sector could be processed in Ukraine with high added value. In particular, corn and wheat by the method of wet grinding, and processing products – starches, fodder and bioethanol are guaranteed as raw goods,

sold on foreign markets. Semi-drying corn oil could launch the paint industry of Ukraine, 90% of which is imported due to the lack of raw materials for its production in our country.

Table 1. Codes of Classification of Economic Activities and types of economic activity related to the bioeconomy of Ukraine [11]

Codes of Classification of Economic Activities and types of economic activity			Branches
A	01	Agriculture, hunting and related services	Agriculture
	02	Forestry and logging	Forestry
	03	Fish farming	Fisheries
C	10	Production of food products	Food industry
	13	Textile production	Textile industry
	20	Production of chemicals and chemical products	Chemical Industry
	21	Production of basic pharmaceutical products and pharmaceutical preparations	Pharmaceutical industry
E		Water supply; sewerage, waste management	Water supply
D	35	Supply of electricity, gas, steam and air conditioning	Green energy
F	41	Construction of buildings	Construction
I	56	Food and beverage activities	Food industry
M	72.1	Research and experimental developments in the field of natural and technical sciences	Scientific and research activities

Ukraine's total need for investments in deep processing of grain, which means in the country's bioeconomy, is estimated at \$15 billion, which is 2 times higher than the amount of investments necessary for the sustainable growth of Ukraine's economy. Such investments would create 85,000 high-paying jobs and, according to the American methodology of the state of Indiana, support 0.5 million jobs.

A sustainable bioeconomy should be aimed at achieving neutrality of land degradation and restoration of degraded lands. Realization of this potential requires investments, innovations, development of strategies and implementation of systemic changes.

Climate change has already led to high summer temperatures, which negatively affect the yield of fields, especially in the south of Ukraine. To combat this problem, the government has already begun to formulate field irrigation strategies in the Kherson, Odesa, and Mykolaiv regions, and farmers are experimenting with seeds of drought-resistant hybrids. Solving problems with high temperatures and water supply can increase yields in these regions. At the same time, it should be understood that the heat is consistently moving to the north and the experience of the southern regions will soon have to be applied in the middle zone of Ukraine [12].

To overcome these problems, domestic scientists and the community propose gradual steps [13-19]:

The national policy of supporting the development of the bioeconomy in Ukraine should be effective in terms of indicators of economic and social efficiency, as well as environmental safety. Therefore, the formation of a long-term strategy of state support for the formation of a biosocial economy, which will be aimed at the following results,

is currently becoming more and more urgent: improving the quality of life, improving the environment as a result of the involvement in the processing of biomass raw materials, as well as industrial, agricultural and household waste, the development of the agricultural sector on principles of sustainability and increasing its economic efficiency and competitiveness, as well as forestry and fisheries; reducing dependence on imported energy sources through the development of bioenergy; increase in employment, especially in rural areas; improving interaction between science, business and society regarding the use of innovative biotechnologies; formation and development of the bioeconomy infrastructure as a result of the creation of agrobiotechnological clusters.

In our opinion, the strategy of long-term state support for the development of the bioeconomy should be aimed at:

1) for the development of the scientific and resource base, which includes areas such as improving the personnel training system for biotechnological enterprises, as well as for carrying out scientific research; creation of mechanisms that contribute to the acceleration of the development of the bioeconomy (formation of the appropriate legislative field); stimulating the use by enterprises of technologies related to the use of renewable resources; comprehensive support of the agricultural sector as the main resource base of the bioeconomy;

2) the development of a competitive sector of research and development in the field of biotechnology, which includes such directions as the development of the mechanism of commercialization and introduction of biotechnology; narrowing the gap between research and the market; coordination of the needs of science and production; promoting the formation of a positive image of biotechnological products; promotion and popularization of biotechnologies both among producers and among consumers; formation of "green thinking"; creation/development of a system of measures that facilitate the easier entry of bioproducts into the market;

3) support (facilitation) to the creation of agro-bioclusters on the territory of Ukraine, which includes such directions as the creation/development of a system of activities within the framework of social partnership that stimulate the formation of agro-bioclusters; rational use of biological resources as a basis for the creation and further development of territorial agro-bioclusters (based on the study of existing technological chains; development of alternative energy; positioning of Ukraine on the market of high-tech products.

A real direction in the formation of the bioeconomy in Ukraine can be the creation of bioclusters, where a network of enterprises that use by-products of production is formed around the main enterprise, for example, a large biofuel plant, and the general transport, logistics and social infrastructure is developed. Similar bioclusters are now being actively implemented in the USA. The cost of building bioclusters in the grain-growing regions of Ukraine is estimated by experts at 2 billion dollars. After the launch of bioclusters aimed at the formation of agricultural biotechnology, grain demand in the domestic market may increase by 12-15 million tons per year. At the same time, each plant, purchasing \$100 million worth of grain annually, will be able to produce \$500 million worth of products and will create at least 3,000 jobs at the enterprise and

in related industries. In order to fully realize the possibilities of the bioeconomy, a systematic approach to its development is necessary.

In Ukraine, this direction is just starting to emerge, but it is already quite prospective. There are many opportunities of reuse of agricultural resource residues [4].

Discussions. Today, the bioeconomy of the EU-27 employs about 17.5 million people, which is 9% of the workforce. The bioeconomy generates 1.5 trillion euros (about 10% of GDP), including the tertiary sector of the bioeconomy (bioservices).

A sustainable bioeconomy can be a key tool of the Green Deal in the post-COVID-19 era, making the EU more sustainable and competitive.

In view of the above, in the future it is necessary to ensure sustainable management of the bioeconomy, protecting national states, business and the population from negative impacts by complementary implementation of progressive innovative biotechnologies.

As a result of the study, it was established that Ukraine can create a sustainable, innovative, resource-efficient economy, integrated into the global space, which combines food security with the sustainable use of renewable energy sources and resources for industry. Biomass can replace products obtained with the use of fossil fuel resources. Residues and waste, raw materials of agriculture and forestry can be used to ensure ecologically clean production.

As a result of the war in Ukraine, a catastrophic drop in GDP is expected. According to estimates by the World Bank, the economy of Ukraine will decrease by 45.1 percent in 2022, with the scale of the fall in GDP depending on the duration and intensity of the war [20]. It is also predicted that the rate of world GDP will decrease from 6.1% in 2021 to 3.6% in 2022, the countries of the European Union from 5.4 to 2.9%, respectively. Developed countries will lose 1.9% of GDP and have an increase of only 3.3%. Developing countries will suffer the most as a result of military actions in Ukraine, whose growth rates will increase from 6.8% to 3.8% in 2022.

We concluded that that the state policy of Ukraine should be aimed at the development and implementation of mechanisms for restoring production, preserving, and creating new jobs related to the reconstruction of the national economy, in infrastructure sectors, construction, industry and providing economic incentives for the labor force reimmigration [21].

It was determined that in the post-war period, the bioeconomy should become a priority to support the economic recovery of Ukraine, since a sustainable bioeconomy returns resources to the real sector, creates jobs, promotes an increase in the level of environmental friendliness of production and consumption, and allows optimal use of limited resources on a waste-free circular basis [22].

Conclusions. To overcome the food crisis, one of the most important is the agricultural direction and the development of the agro-industrial complex. It is a kind of core of the bioeconomy, as it serves as its main raw material base.

In the modern environment of globalization, the bioeconomy is the most important direction in the development of world economic activity. Biotechnologies open up new opportunities for mankind to create innovative products capable of

solving many global problems, including food supply while simultaneously reducing the adverse impact on the environment.

State support for the development of the bioeconomy is necessary, since the emergence of a business in the field of biotechnology in the district will create new jobs, increase the added value created in the region by producers of agricultural products, and compensate for rather harsh climatic conditions. Thus, maintaining economic growth and the growth of the population's well-being in the long term is possible only with the introduction of new technologies in the agro-industrial complex of Ukraine, which will allow solving current global problems, such as overcoming the food crisis.

Author contributions. The authors contributed equally.

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References:

1. European Commission, Directorate-General for Research and Innovation, (2022). European bioeconomy policy : stocktaking and future developments : report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Publications Office of the European Union. Retrieved from <https://data.europa.eu/doi/10.2777/997651>
2. The Global Food System: An Analysis. Retrieved from https://www.metabolic.nl/publication/global-food-system-an-analysis/?gclid=CjwKCAiAp7GcBhA0EiwA9U0mth2ZhSRqgNafzy06g7rMlzX2pRYjCKQ_blakpshHvIFO SF1jez5IDRoC99QQA vD_BwE
3. Global Food Policy Report 2022: Climate Change & Food Systems. Retrieved from <https://gfpr.ifpri.info/2022/05/11/climate-change-and-food-systems-transforming-food-systems-for-adaptation-mitigation-and-resilience/>
4. Gonta, D., Kyrylyuk, E., Proshchalykina, A., Ryzhenko, N. (2020). *Formation of the components of the national bioeconomy of Ukraine in conditions of acceleration of scientific and technological progress: monograph*. Cherkasy: CHNU named after B. Khmelnytskyi.
5. Oleshko, A., Olshanska, O., Budiakova, O. and Bebkov, S. (2022). Development of sustainable bioeconomy: the experience of the European Union and opportunities for Ukraine. *Agrosvit*, 3, 64-69. doi: 10.32702/2306-6792.2022.3.64
6. European Commission, Joint Research Centre, Haarich, S., Kirchmayr-Novak, S., Bioeconomy strategy development in EU regions, Borzacchiello, M.(editor), Sanchez Lopez, J.(editor), Avraamides, M.(editor), Publications Office of the European Union, 2022. Retrieved from <https://data.europa.eu/doi/10.2760/065902>
7. European Commission (2018). A sustainable bioeconomy for Europe: strengthening the connection between economy, society and the environment. Updated Bioeconomy Strategy. doi: 10.2777/478385.
8. Yasnolob, I.O., Demyanenko, N.V., Chernenko, K.V. (2021). Conceptual principles of bioeconomy strategy. *Market infrastructure*, 54, 74-77.
9. Talaviryia, M., Gazuda, L., Gazuda, M. (2021). Prospects for the development of closed cycle bioeconomy in Ukraine. *Geopolitics of Ukraine: history and modernity*, 2 (27), 128-138.
10. *Intellectualization of the socio-economic development of Ukraine in the perspective of post-war recovery: monograph* (2022). / for the science. ed. O. V. Olshanska, A. A. Oleshko, Z. Ya. Shatska. Kyiv: KNUTD. doi: 10.30857/978.617.7763.05.4
11. State Statistics Service of Ukraine (2010), "National classifier of Ukraine. Classification of economic activities (CTEA) DK 009:2010" Retrieved from <http://registral.kiev.ua/kved>
12. Retrieved from <https://elevatorist.com/blog/read/671-kurs-ukrainyi-na-bioekonomiku>
13. Baidala, V.V. (2016). *Bioeconomy in Ukraine: formation, development prospects and macroeconomic influences: [monograph]*. Sumy.
14. Baidala, V.V., Butenko, V.M. (2014). *Investments in the bioeconomy as a factor in the sustainable development of the agricultural sector of Ukraine*. The main priorities of the development of the agro-industrial complex of Ukraine in the context of economic, food and energy security of the country: a monograph / Ed. Doctor of Economics, Professor Yu.O. Nesterchuk. Uman: Publishing and Printing Center "Vizavy" (Publisher "Sochinsky").

15. Baidala, V.V. Butenko, V.M. (2015). Methodical approaches to assessing the potential of the bioeconomy in Ukraine. *Business information*, 4, 29-34.
16. Shubravska, O. (2010). Bioeconomy: analysis of global development and prerequisites for development in the agrarian sector of the economy of Ukraine. *Economy of Ukraine*, 10, 63-73.
17. *Innovative transformations of the agrarian sector of the economy: a monograph* (2012). / [Shubravska O. V. and others]; under the editorship Dr. Econ. Sciences Shubravska O. V.; National Acad. of Sciences of Ukraine, State University "Institute of Economics and Forecasting of the National Academy of Sciences of Ukraine".
18. Litvak, O.A. (2015). Bioeconomic approach in the development of the agrarian sector of the economy: theoretical, methodological and practical aspects. Mykolaiv National Agrarian University. Mykolaiv: MNAU.
19. Litvak, O.A. (2015). Bioeconomic priorities in the development of the agricultural sector. *Hlobalni ta natsionalni problemy ekonomiky*, 8. Retrieved from: <http://global-national.in.ua/issue-8-2015>
19. Concept of the State Strategy for the Development of Ukraine's Bioeconomy until 2030 Retrieved from: <https://nubip.edu.ua/node/72005>
20. The World Bank Group (2022). Protecting the most vulnerable must be foremost in addressing economic fallout of war in Ukraine. Retrieved from: <https://www.worldbank.org/en/topic/conflict/brief/the-w>
21. Oleshko, A., Budiakova, O. and Kvas, V. (2022). Regulatory role of the state in the recovery of the national economy. *Ekonomika ta derzhava*, 8, 4-13. doi: 10.32702/2306-6806.2022.8.15
22. Oleshko, A., Olshanska, O., Budiakova, O. and Bebko, S. (2022). Directions of bioeconomy development in the perspective of postwar recovery of Ukraine. Problems of innovation and investment development. "Economics and Management" series, 18-28. doi:10.33813/2224-1213.28.2022.2

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