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Indicators for analysis of the bioeconomy in Ukraine

Scientific problem. Global achievements and scientific discoveries, made during last years in the area of life sciences, convince scientists to connect future evolution of all the mankind with the progress of biotechnologies which together with nanotechnologies and bioinformatics are able to form a strong basis for positive changes in economics, politics, and society. Existing global problems, such as exhaustible natural resources, supplying the constantly growing population with food and medicine, and environmental pollution have conditioned the search of an alternative to chemical raw materials and technologies, and replacement of traditional production with bioproducts and bioprocesses. The development of bioeconomy is an extremely important sector for Ukraine which, on one hand, possesses a considerable potential for that, and on the other hand – the necessity of cutting down production power inputs, restoration of soil capacity, increase of rural inhabitants employment, supply of national production with provisions and raw materials. Ukraine, as well as the rest of the world, understands the need to counter global challenges of our time, such as climate, environmental, social changes in order to give future generations a chance for living. Transition to the knowledge based bioeconomy has become a sign of the times.

Analysis of recent researches and publications. As to Ukrainian publications, there are a lot of works devoted to the bioenergy (Geletukha G., Zheleznaya T., Kucheruk P., Olejnik E. [3], Andrejchuk I., Metoshop I., Aleksin O. [1]) and it is the lack of publications where indicators of the bio-economy are investigated. Moreover the bioeconomy is a powerful tool

for achieving of sustainable development. The development of all sectors of the bioeconomy makes it possible to ensure food safety, public health, cleaner industrial production and mitigating climate change. Maciejczak [11] points out that use of renewable resources and application of circularity are the basic contributions of bioeconomy to the development based on sustainable principles, through ensuring a positive environmental and social impact associated with the economic growth. Some scientists attempt a difficult task – to give the definition bioeconomy. As Gołębiewski [5] notes, different definitions of bioeconomy can be found in the literature; in the most general terms, it denotes a sustainable production of renewable resources (products of agriculture, forestry, fisheries and fishing) and their conversion into food, feed, bio-based products, fibres and bioenergy. Maciejczak and Hofreiter [12] made an evaluation of the selected definitions of bioeconomy and found that the concept was based on the sustainable use of renewable biological resources through innovation, by delivering products, to address both individual needs and public expectation.

The objective of the article is to determine and evaluate the condition of bioeconomy in Ukraine. The study was based on the source literature on the subject, programming documents of the European Union and guiding principles for the bioeconomy development policy in EU. Statistical data by State Statistics Service of Ukraine, Eurostat and World Bank were used for the evaluation of the size of bioeconomy.

Statement of the main results of the study. The most complete definition, we consider, we see in "Communication on Innovating for Sustainable Growth: A Bioeconomy for Europe": "The bioeconomy encompasses the production of renewable biological resources and their conversion into food, feed, bio-based products and bioenergy. It includes agriculture, forestry, fisheries, food and pulp and paper production, as well as parts of chemical, biotechnological and energy industries. Its sectors have a strong innovation potential due to their use of a wide range of sciences (life sciences, agronomy, ecology, food science and social sciences), enabling and industrial technologies (biotechnology, nanotechnology, information and communication technologies (ICT), and engineering), and local and tacit knowledge" [8].

In Ukraine, we are aware that development of the bioeconomy can help to solve some important questions. Expected results from the development of the bioeconomy in Ukraine are social, economic and environmental.

Social results:

- diversification of agricultural economy and its growth;
- rural development;
- improving of human health, environment and quality of life

Economic results

- reducing costs,
- improvement of product;
- emergence of new products and markets;
- reducing dependence on non-renewable resources

Environmental results

- prevention of pollution;
- reducing greenhouse effect and emissions some poisonous substances

Thus, the creation of system of relevant indicators which allows monitoring of the bioeconomy development is important as well as determination of regional bioeconomy criteria.

Thus we propose such regional bioeconomy criteria: environmental, economic and social ones [10].

Environmental criteria. Resource availability is clearly classified under natural resources in the supply factors of our model of the bioeconomy. Whether from domestic production or through imports, the availability of sustainably sourced biomass is the single most important driver of bioeconomy development. Both from the literature and the practical experiences of regional partners it is apparent that without biomass a functioning bioeconomy is impossible. Therefore biomass availability is the first criterion identified, and is classified as an essential criterion of bioeconomy development.

Economic criteria.

Clusters. The literature review highlights the role of clusters in successful bioeconomy and we group this, as a contributor to the innovation capacity in the region economy, as clusters pool knowledge and resources in extending the productive capabilities of firms via greater innova-

tion. This is further reinforced by the experiences of the regional partners, whom all have their bioeconomy concentrated within small geographical areas. This highlights the importance of successful clusters to a successful bioeconomy [4].

Finance. The development of bioeconomy is further aided by availability of funding to companies and new technologies via instruments such as microfinancing and guarantees of large scale orders and it should be noted that finance models vary across the EU.

Infrastructure. Infrastructure refers to the capacity of the transport, communications, complementary industries and utilities network in and around a bioeconomy. Therefore, this is classified as capital in the model above as the factor of production which increases both the efficiency and the productivity of other factors of production [6].

Industrial culture. Industrial culture covers a large number of characteristics of the business base of a region and is classified under the innovation category of our model above. It includes the innovation culture; the rate of formation of SMEs (which the literature suggests is a key criteria for strong bioeconomy development as SMEs can fill "gaps" in the value chain and are more prone to innovation); and the presence of multinationals (which can promote growth of the bioeconomy through the potential for large-scale investment).

Industry mix. The industry mix of a bioeconomy can play a desirable role in developing bioeconomy. Collaboration across industries such as agrifoods and chemicals in research and development including collaborator and integer business models augment existing innovation successes and improve the performance of the bioeconomy. This is classified under the innovation category of our model [4].

Innovation. Innovation is a key criterion in the growth and establishment of bioeconomy and its importance is reflected in its classification as a factor of production in our model above. While bioeconomies may exist on current technologies, the growth of new technologies is a key to future growth and in sustaining the bioeconomy against competitors.

Macroeconomic trends. The demand for bioeconomy products is an important criteria and falls into both the consumer and business demand classifications in our model. The literature highlights the role of consumer preferences in the development of bioeconomy (for example, the global emphasis on climate change driving consumers to more sustainable energy sources) and suggests consumption and production incentives to stimulate demand [4].

Social criteria

Demographics. A range of demographic factors are desirable criteria of bioeconomies. Larger markets via greater population growth can stimulate greater demand and is classified as consumer demand. In addition, greater public acceptance for bioeconomy products and a more skilled labor force by increasing levels of education and human capital increases both the productivity of the bioeconomy sector and the demand for their products with can be classified under both consumer demand and capital in our model above.

Academic Institutions. Clustering and innovation within bioeconomy is augmented further by desirable criteria such as containing high quality universities or research institutes. Collaboration between institutions and industry further increases innovation output. Beyond this, the quality of those collaborations and research institutes are clearly paramount to successfully benefitting from these criteria; and this will be explored further in the work to quantify these criteria.

Regulation. Regulation of the safety of bioeconomy products with clear technical standards (to reassure producers and consumers) as well as stronger intellectual property rights securing the incentives to innovate are key criteria [9]. Standardization and methods of 'locking in' markets, along with the enforcement of intellectual property rights, provide a large degree of certainty to private companies operating (or wishing to operate) in the bioeconomy sector [4].

Public attitude. Public acceptance of bioeconomy products is a desirable criteria and feeds into other drivers such as safety issues which involves effective governance/regulation as well as consumer preferences and can enhance the take-up of bioeconomy products. This falls under consumer demand in the model above (Table 1).

Table 1

Regional bioeconomies criteria

Criteria	Characteristics	Market model driver	Importance of criteria		
			Essential	Key	Desirable
Environmental criteria					
Biomass availability	Resource availability	Natural resources	+		
Domestic production of biomass	Resource availability	Natural resources			+
Land use	Resource availability	Natural resources		+	
Infrastructure	Infrastructure	Capital	+	+	
Economic criteria					
Cluster size	Clusters	Innovation			+
Cluster management	Clusters	Innovation		+	
Cluster governance	Clusters	Innovation		+	
Commercialization of innovative technologies	Innovation	Innovation		+	
Diffusion of technology	Innovation	Innovation		+	
KET R&D focus	Innovation	Innovation			+
Consumer preferences	Macroeconomic trends	Consumer demand			+
Public support and acceptance	Macroeconomic trends	Consumer demand		+	
Household income	Macroeconomic trends	Consumer demand			+
Availability of funding	Finance	Capital			+
Proximity to financial institutions	Finance	Capital			+
Rate of SME formation	Industrial culture	Innovation		+	
Presence of multinationals	Industrial culture	Capital/ innovation			+
Economic history	Industrial culture	Capital		+	
Collaboration	Industrial culture	Innovation		+	+
Entrepreneurial culture	Industrial culture	Innovation		+	
Quality of workforce	Demographics	Labor			+
Social criteria					
Prominent universities or research institute	Institutions	Innovation			+
Regulation	Regulation	All		+	
Intellectual property rights	Regulation	Innovation			+
Governance	Regulation	All	+		
Trade policy	Regulation	Consumer&business demand			+
Size of population	Demographics	Labor/ consumer demand			+

Source: [4].

The analysis above outlines the decisions made in prioritizing criteria of the bioeconomy, based upon the literature review and how regional economies (both bioeconomy and other sectors) develop. Each criterion is matched with a bioeconomy model characteristic and a market model driver, agents that help the corresponding models function. Linking the criteria to these characteristics and drivers may indicate what role each criterion plays in the models or in other words, what aspects of the bioeconomy or market it influences.

Indicators of bioeconomy development are special indicators for measurement of production of bioproducts, extent of use of biotechnology, environmental impact of human activity, human health, and the quality of their life. We offer a system of indicators to assess the level of development of the bioeconomy.

Table 2

A system of indicators for assessment the level of development of the bioeconomy

Bioeconomy sectors	Indicators of development
"Green sector" (agriculture, forestry)	• crop area and yield of biotech crops (canola, soy, corn, sugar sorghum, sugar beet etc.); • the number of varieties of plants created using biotechnology methods; • increase of using of biological control in plant growing(% to by the base period); • increase of using of biological veterinary drugs (% to by the base period); • the share of agricultural waste recycled with biotechnology methods (%); • area of organic farming (ha); • area of fast-growing forest plantations (ha); • increase of using of biological drugs in forestry (% to by the base period); total biomass production (thousand tons).
"Red sector" (bio-pharmaceutics)	• registered original biopharmaceuticals; output of diagnostics, biocompatible materials, product of cell -based technologies.
"White sector" (Industrial biotechnology what combines biotechnology in the food, chemical and oil industry)	• the share of bioplastics and biopolymers in total consumption of polymer products (%); • the share of biomass in total volume of raw materials recycled in the chemical and petrochemical industry (%); • the share of raw materials in the timber industry processed with biotechnological methods (%); • increase of using of biological materials in oil-and-gas production (% to by the base period); production of amino acids, proteins, vitamins, lipids, nucleic acids, pigments, enzymes
Bioenergetics	• the number of enterprises for the production of biofuels, biogas, solid biofuels • production of biofuels (bioethanol and biodiesel), biogas, solid biofuels (tons); • production of electricity from renewable sources (T-watt) • purification polluted surface and ground water, soil with preparations for biodegradation (%)
"Blue sector" (fish farming, the use of aquaresources	• the use of biotechnology in aquaculture (feed, medicines, etc.) (% to the base period)
"Grey sector" (environmental protection, bioremediation)	• share biological treatment facilities in the total (%) • the share of processed municipal solid domestic waste (%); • planting of settlements (ha); • reduction of CO2 emissions (%); • reducing the share of irrevocable consumption in volume of used water (%); • reduction of ingress of contamination into water bodies (%) • reducing the use of pesticides and other chemicals (kg/ha); • reducing the proportion of degraded land (%); area of soils subjected to bioremediation (ha).
Science sector (research structures, institutions, centers)	• the number of research institutions (structural units), which researches bioeconomy; • the number of schools that trains specialists for bioeconomy; • adoption of new subjects (like bio-, nanotechnologies) into training programs in high schools; the number of employees engaged in research and development in organizations.
Sector of Infrastructure of bioeconomy development	the number of objects of innovative infrastructure that promote the development and commercialization of biotechnology, nanotechnology (such as logistics, biofuel stations, special newsletters, youth projects in the field of bio- , nanotechnology etc.)

Source: [2]

That approach to creating the system of indicators makes possible to track the dynamics of bioeconomy level both across the sectors and in complex.

Nowadays the main sector of bioeconomy in Ukraine, in our opinion, is agrarian ("green") sector.

In this context we need to form a new attitude to agrarian production through the prism of the bioeconomy development with the help of informational, biotechnological and innovative tools. Also throughout the whole chain "production – processing - realization" we need to minimize waste in order to reduce our ecological footprint and transformation of waste into an additional resource.

The size of the bioeconomy can be measured by means of the value added it creates and the employment it holds [13]. The share of the bioeconomy in total employment is also used as an indicator of economic size. In the table below we show some indicators which can characterize size of the bioeconomy in Ukraine.

Table 3

The indicators of Ukrainian bioeconomy size in 2011-2014

	2011	2012	2013	2014
Agriculture, value added (% of GDP) (including forestry, hunting, and fishing, as well as cultivation of crops and livestock production	9,5	9,1	10,2	11,8
Employment in agriculture, female (% of female employment)	20	19	19	13
Employment in agriculture, male (% of male employment)	21	20	21	17
Forest area (% of land area)	16.5	16.6	16.6	16.7
Arable land (hectares per person)	0.71	0.71	0.72	-
Arable land (% of land area)	56.1	56.1	56.1	-
Rural population (% of total population)	31	31	31	31
Renewable energy consumption (% of total final energy consumption)	2.73	2.83	-	-

Source: http://data.worldbank.org/indicator

These data allow us to understand how significant is the bioeconomy share in Ukraine's economy as well to conclude on the future prospects of the bioeconomy. In our opinion, since agricultural sector in Ukraine occupies an important place, the bioeconomy has good prerequisites for its development.

Discussion. Value indicators which characterize size of the bioeconomy strongly depends on the definition of bioeconomy what we use. The fact that the term "bioeconomy" is not established, moreover, it is the subject of scientific debate. Accordingly, the subject of these debates is the list of indicators that reflect the size of the bioeconomy as well.

Conclusions. Bioeconomy is a complex and polydimensional and requires a systematic approach for its examination. Development of the bioeconomy can help to solve some important matters namely ensuring food security, managing natural resources on the principles of sustainability, reducing dependence on non-renewable resources, mitigating and adapting to climate change, creating jobs and maintaining the competitiveness. It is an important task to determine the bioeconomy as a scientific term, to develop the criteria and indicators describing the regional bioeconomy. We need the system of indicators for the analysis of the bioeconomy, which can help our vision of the future prospects of the bioeconomy in Ukraine.

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Закарпатська державна сільськогосподарська дослідна станція

Підвищення ефективності функціонування фермерських господарств Закарпаття

Постановка проблеми. Нині в аграрній сфері економіки основу сучасного підприємництва становлять фермерські господарства, практика функціонування яких вказує на те, що вони не потребують великих витрат і забезпечують високу оборотність капіталу та гарантують прибуток за можливості досягти невеликого ризику. Оцінити економічну ефективність діяльності фермера можна, виходячи з інтересів підприємця та застосування найпридатніших для цієї форми підприємництва методів і показників аналізу [1].

У методиці дослідження фермерських господарств особливе значення має оцінка їхньої економічної ефективності, де головним критерієм є дохідність (як додана вартість на одиницю ресурсів – 1 га, 1 робітника, 1 грн виробничих витрат). У свою чергу економічну ефективність виробництва визначають відношенням одержаних результатів до витрат засобів виробництва та живої праці.

Оцінка корисного ефекту в аграрному виробництві для фермера – це дохідність і завжди стосується й співвідноситься до земельної площі або продуктивної худоби [8].

Аналіз останніх досліджень і публікацій. Значний внесок у розв'язання проблем