

Rodino, Steliana

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BIOECONOMY APPROACHES IN THE EUROPEAN CONTEXT

STELIANA RODINO ^{1,2}

¹ RESEARCH INSTITUTE FOR AGRICULTURAL ECONOMY AND RURAL DEVELOPMENT

² NATIONAL RESEARCH-DEVELOPMENT INSTITUTE FOR BIOLOGICAL SCIENCES,
Corresponding author e-mail: steliana.rodino@yahoo.com

Abstract: Against the background of the scarcity of fossil resources and the reduction of the availability of agricultural land, the emergence of climate change and the growth of the world population, it has become necessary to design sustainable and efficient strategies from the point of view of resource management, in order to ensure the prosperity of future generations. These strategies need to include integrated concepts across multiple sectors and levels of activity. Such a concept is considered bioeconomy. The present work represents a review of the definition of the bioeconomy in European states, the evolution of the concept and the variety of existing approaches. It will be demonstrated that the bioeconomy represents an emerging sector that is based on the creation, development and revitalization of economic systems based on a sustainable use of renewable biological resources, in a balanced way. The bioeconomy has evolved from an almost esoteric concept to becoming the core of development strategies at regional and national as well as local levels. It has also permeated the sphere of interest of the scientific and technological communities and financial and economic and industrial circles. It should be emphasized that the bioeconomy does not represent a new industry or economic sector, but a combination of production-processing sectors and final markets that are characterized by the use of renewable resources, natural resources, ecological technologies and efficient recycling.

Keywords: *bioeconomy, strategy, sustainable development, agriculture, biotechnology*

JEL classification: A1, A12, Q57

INTRODUCTION

The 21st century began with numerous problems manifested at the global level - population growth, poverty, hunger, climate change, financial and economic crises, pollution. The main driver of the emergence of problems related to the effects of climate change is represented by the highly industrialized human activity since the middle of the 20th century. This is mainly caused by the fact that economic activity is based on the use of fossil resources. Unfortunately, fossil resources are finite and their exploitation and use negatively affects the planet in many ways, with a major risk of compromising the quality of life of future generations. In addition, the world's population does not stop growing and, implicitly, the demand for resources, goods and services continues to increase. Fossil fuel shortages, world population growth, the climate crisis and other global challenges require a critical shift in human development.

The bioeconomy, or bioresource-based economy, uses renewable resources to provide human society with food, materials, energy and more. This is known as a primary step towards sustainable development. The transition from the traditional economy to a bioresource-based economy is one of the major changes that address global challenges by using natural resources, mitigating climate change and ensuring global food security (Dietz et al., 2018).

Bioeconomy is still a rather abstract concept, largely unexploited, both at the European level and in our country. In Romania, this model has a rather slow pace of development, although our country possesses enormous potential in terms of the progress of the bioeconomy sectors. First of all, it is necessary to raise awareness, to enrich the theoretical and practical knowledge that regulates this concept, to increase the technological transfer and the proper exploitation of the current results of scientific research.

Having these in mind, this article is presenting an overview of bioeconomy approaches in the European context.

Definitions and bioeconomy approaches

The definition of the bioeconomy has evolved over time (Birch and Tyfield, 2013; Staffas et al., 2013) , and recent research has characterized the bioeconomy as a polysemic term, which includes three main **Error! Reference source not found.** (Giampietro, 2019; Vivien et al., 2019) .

The first pillar is developed in a perspective of economic growth based on the **development of biotechnology** supported by the OECD, multinational companies and start-ups.

The Organization for Economic Cooperation and Development (OECD) used an early form of the notion of bioeconomy in 2004, stating that "A bioresource-based economy is defined as a concept that uses renewable bioresources, efficient bioprocesses and industrial eco-clusters to produce bioproducts, jobs and incomes that fall within the scope of sustainable development" (OECD, 2004). Five years later, the same institution defined the bioeconomy as the process of "transforming knowledge from the field of natural sciences into new, sustainable, eco-efficient and competitive products" (OECD, 2009) showing the link between the bioeconomy and sustainable development. This definition was aimed at the potential of innovations in the transformation and efficient use of biological resources.

In the definition of the American concept, although the aspect of sustainability was not emphasized, the main idea was similar to the one above: "A bioeconomy is based on the use of research and innovation in the biological sciences to create economic activity and benefits for the general public" (The White House, 2012) .

The main objective of this bioeconomy approach is economic growth and job creation (Staffas et al., 2013; Pollack, 2012) . Thus, although the positive contribution to the intensification of the unwanted effects of climate change and aspects related to environmental conservation is assumed, economic growth is clearly prioritized above the principles of sustainability.

The application of biotechnologies in various industrial sectors, as well as the commercialization of research and innovation results, will generate added value. Thus, economic growth is generated through the exploitation of biotechnologies, and suppliers of raw materials and materials, intermediaries in the relationship between biotechnology research firms and investors, play an important role in stimulating economic growth around the bioeconomy (Morrison and Cornips, 2012) . Consequently, investments in research and innovation will result in the production of scientific knowledge of high economic value, and this is an absolutely central aspect in this version of the bioeconomy.

For example, in the agricultural and agro-industrial sector, biotechnology applications play a significant role. These applications start from increasing the productivity of primary production to processed finished products, with increased added value, based on biotechnological processes (Lokko et al., 2018) .

Biotechnological applications can be classified in the following areas:

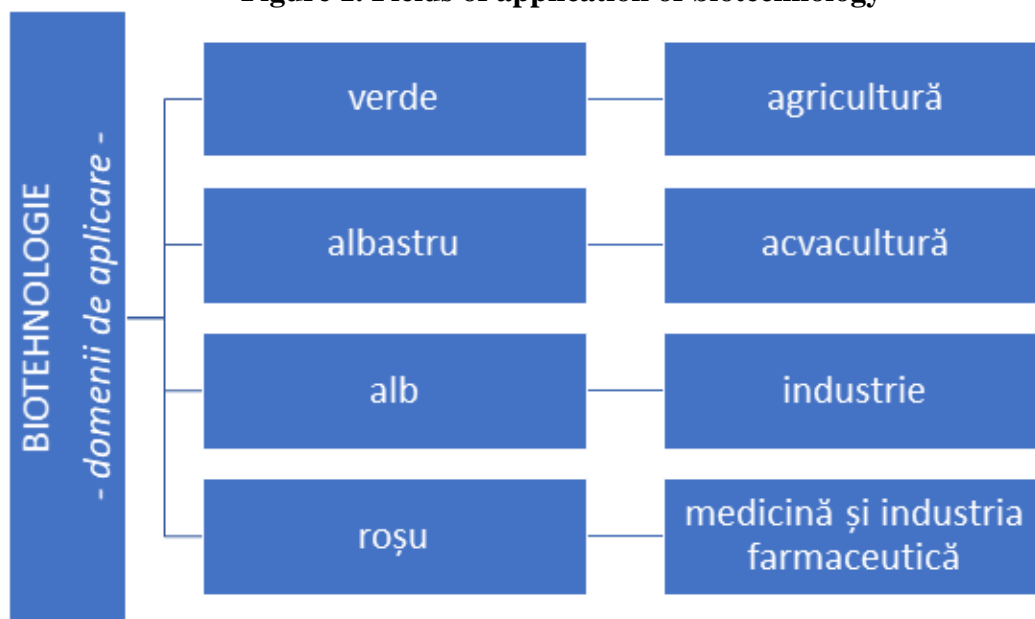
- **green biotechnology**: it is biotechnology applied to agricultural processes, for example obtaining transgenic plants resistant to adverse environmental conditions, adaptable in different soils, as well as plants resistant to diseases and pests.

- **blue biotechnology**: includes marine and aquatic applications of biotechnology; this branch of biotechnology deals with the development of aquaculture, the care of marine creatures, the treatment of polluted or waste water, and the production of food derived from the sea.

- **white biotechnology**: applies exclusively to the improvement of industrial processes; this uses yeast, molds, bacteria and enzymes with industrial applications. For example, engineering an

organism to produce a useful chemical; the use of enzyme systems as catalysts in industrial production flows;

Figure 1. Fields of application of biotechnology



Source: own processing

- **red biotechnology**: applies to medical processes, e.g. engineering organisms to produce antibiotics; regenerative therapies and the application of genetic engineering to cure disease.

The use of knowledge-based bioeconomy as a policy concept and the growing awareness of the economic contributions of industrial biotechnology at the intersection of its implementation helped launch the current notion of bioeconomy (Viaggi, 2018) .

Biotechnology applied in agriculture, offers a wide variety of scientific approaches to the improvement of plants, animal breeding and microorganisms, aiming at the development of solutions for the productivity and sustainability of agriculture. These scientific tools are very diverse and include, for example, tissue culture, molecular breeding, genetic engineering, molecular diagnostic tools. They assist breeders in providing new high-quality varieties, help farmers detect diseases, or serve industry to produce molecules with high added value to improve food or health.

The second pillar is the one developed at the European level. In the EU strategy launched by the European Commission in 2012 on the bioeconomy, this term is defined as "the production of renewable biological resources and the transformation of these resources and waste streams into value-added products such as food, animal feed, bio-products and bioenergy" (European Commission and Directorate-General for Research and Innovation, 2012) . Through this strategy, Europe has established the theoretical foundations for a **resource** - efficient economy. The goal of the bioeconomy is to build an economy based on the consumption and production of goods and services from the direct use of biological resources and its sustainable transformation (European Commission, 2018) .

This approach presents the bioeconomy as a general concept, which mainly concerns the production and conversion of biological resources and waste streams into value-added products. The bioeconomy is based on innovations that replace the dependence of human activity on petroleum resources, by exploiting biomass, for example, by developing small-scale biorefineries and methanizers to produce energy (European Commission, 2018) .

The bioresource-based vision of the bioeconomy focuses on replacing fossil fuel-based electricity, fuel and chemical production (Birch and Tyfield, 2013) . A key objective is the development of new value chains for traditional industries based on biological resources (Bugge et al., 2016) .

Figure 2. Bioeconomy in Europe according to EU Bioeconomy strategy



In the specialized literature, seven industrial branches are identified whose technological flow is based on the use of renewable natural resources for the production of bioproducts. These sectors contribute to the development of the bioeconomy, as follows: agriculture and forestry,

biorefineries, bio-chemicals, enzymes, packaging produced from renewable materials, forestry products and natural fiber textiles (Golden et al., 2015; Wreford et al. ., 2019) . Although they include them in the bioeconomy concept, some authors exclude from the category of bioproducts the traditional sectors that use bioresources in the production flow, such as: in agriculture for the production of food, feed or biofuels, as well as the pharmaceutical industry (Parisi and Ronzon. Tevecia, 2016 ; Pellerin and Taylor, 2008) .

The third pillar is based on the first statements of the term bioeconomy, from an *ecological economic perspective* (Georgescu-Roegen, 1971) . The innovations and knowledge that fall within the scope of development of this vision of the bioeconomy are directed towards the inclusion of the existing limits of the natural environment of a certain territory. An example in this regard is the implementation of agro -ecological and agro-forestry practices (Schmidt et al., 2012) .

Although closely related to the second approach, that of resource substitution, the bioecological view focuses more on the role of ecological processes in optimizing energy and nutrient use, promoting biodiversity and avoiding monoculture and soil degradation (Bugge et al., 2016) . From this point of view, what is important is the potential of regionally focused processes and systems, rather than the central role that the previous two views give to research and development activities within globalized systems (Marsden, 2012) .

Therefore, the existing opportunities for the development of rural and peripheral regions are emphasized (Levidow et al., 2013) . An important emphasis is placed on achieving the growth of the rural economy by bringing to the market products with high added value, high quality, with territorial identity. Also, this vision emphasizes the practical implementation of cultivation systems based on agro-ecological principles and bio-ecological engineering techniques (Marsden and Farioli, 2015; Pereira et al., 2018)

A key topic related to this is bio-ecological engineering techniques that aim to “design agricultural systems that require as few agrochemical and energy inputs as possible, relying instead on ecological interactions between biological components to enable agricultural systems to increase their own soil fertility, productivity and crop protection" (Levidow et al., 2013) .

With reference to the determinants of innovation, the bioecological vision of the bioeconomy highlights the identification of bio-ecological practices favorable to biodiversity conservation and environmental protection (Marsden, 2012; Siegmeier and Möller, 2013) and ecological interactions related to the reuse and recycling of materials, thus reducing waste and increasing land use efficiency.

This approach to bioeconomy also directs its attention to the implementation of circular economic processes, making the connection between the concept of circular economy and bioeconomy. The primary importance of the recycling and reuse of biological resources and other resources in the processes of the cascade use of raw materials, within industrial production is emphasized. In this sense, the bioecological vision of the bioeconomy shares features of the circular economy.

In short, the bioecological vision translates into supporting the bioeconomic transition with landscape and ecosystem approaches, rehabilitating degraded land for the production of biomass and other ecosystem services, protecting biodiversity, reducing losses and waste, also focusing on demand management and replacement or avoidance critical products (e.g. plastic), reversing the critical trends of overexploitation of natural resources and environmental degradation.

CONCLUSIONS

Certainly, defining the concept of bioeconomy has become one of the key issues in the development of innovation policies. According to what is reported in the specialized literature, the bioeconomy can be a decisive factor in contributing to the sustainable growth of global economic systems. Regardless of the underlying approach, the bioeconomy is expected to contribute to the sustainable improvement of agricultural productivity, ensure global food security, improve processes related to human and animal nutrition and health, create smart bioproducts and sustainable biofuels, contribute to the adaptation to climate change food-providing sectors (agriculture, forestry, aquaculture) and other ecosystems to adapt to climate change.

Therefore, improving the application of bioeconomy principles seems to become a reasonable choice. The transition to the bioeconomy needs a solid foundation in terms of several key sectors and activities in the economy, such as: research and innovation, the development of new and more efficient technologies; dynamic industrial, agricultural, economic and financial sectors; and, above all, coherent political initiatives aimed at financing a dynamic development of these sectors.

Last but not least, to be successful, the bioeconomy must be accepted by society. Therefore, society must be deeply involved in the multilateral dialogues conducted to develop the bioeconomy agenda, in establishing its objectives, outcomes and, of course, in identifying its potential benefits and risks. This would involve discussing sensitive ethical topics, including the use of arable land,

drinking water, the creation of biorefineries, the governance of the bioeconomy or conflicts of interest over resources.

Some hotly debated priority issues in resource use, such as the food versus fuel debate, have been resolved, at least in the European Union (EU). The safety and quality of food and feed must take precedence over any other issue, regardless of its monetary value.

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