Development of bioeconomy in an innovative society

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Abstract. Scientists identify several fundamental drivers behind the advancement of the bioeconomy. These include the challenges of global food shortages due to population growth, the finite nature of minerals and energy resources, concerns about environmental pollution, the rapid progression of space exploration, the transformative influence of the Fourth Industrial Revolution and quantum computing on human behavior and societal structures, the evolution of science with a particular emphasis on the swift growth of biotechnology, the emergence of nanotechnology and nanomedicine, and the rapid pace of technological development within the context of singularity. These factors collectively contribute to an enhanced quality of life and extended life expectancy. Presently, a consensus among most academic economists is that the foremost factor driving economic growth and the development of modern nations is knowledge. It is widely believed that countries that actively harness new knowledge, effectively becoming knowledge-intensive, will be well-positioned for economic development between 2030 and 2050.

1 Introduction

The concept of "bioeconomics," also referred to as the "green" economy, has been the subject of extensive study by both Russian and foreign scholars [1]. However, the global scientific community has yet to establish a consensus on its precise definition. Russian scientists have made significant contributions to this area of research, and their insights can serve as a foundation for a deeper comprehension of the concept and the construction of various approaches to it.

Based on a scientific approach proposed by the authors, bioeconomics can be defined as an interdisciplinary field that emerges from the fusion of biology and economics, bridging natural and humanitarian (partially social) sciences. This perspective can be expanded upon to encompass a transdisciplinary approach. Given that bioeconomics lacks a unified theoretical framework, it is essential to highlight the integration of diverse scientific disciplines and practical domains dedicated to addressing critical national economic challenges. Thus, bioeconomics can be considered a fusion of theories and practices from various disciplines [2].

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The knowledge-based approach emphasizes the cognitive principles of economics as the foundation for the emergence of bioeconomics, which acts as an integrative framework uniting various scientific fields, primarily biology and biotechnology. This approach offers a theoretical and cognitive viewpoint on the essence of bioeconomy.

The process-oriented approach to bioeconomy stems from a practical perspective, viewing it as a systematic process involving the conversion of biomass into new products through the hybridization of sciences. This approach highlights bioeconomy as a practice-oriented activity.

The resource approach is concerned with the efficient utilization of natural resources, encompassing resource conservation and the sustainable utilization of renewable resources. It emphasizes that bioeconomy should be rooted in the sustainable use of biological resources from animals and plants, reducing waste and promoting eco-friendly technologies [3]. It also focuses on technology innovation, aiming to decrease the environmental footprint of economic activities. Environmental intensity indicators are used to measure this approach, including specific resource costs per unit of final product (ep) and specific pollution values per unit of final product (ez), evaluated both at macroeconomic and sectoral levels of the economy.

2 Research Methodology

The transition to renewable resources and sustainable energy requires enhanced resource efficiency. For instance, an example from Bavaria in Straubing demonstrates effective utilization of bioresources through waste-free production. In this case, a chemical plant employs a bioreactor to convert wheat straw into cellulosic ethanol, processing 4,500 tons of straw annually to yield 1,000 tons of ethanol. A systemic (biosystemic) approach to building a new economy envisions a harmonious relationship between humans and nature, where all activities coalesce into a single living organism, preserving the interaction of biological diversity [4].

However, while a systemic approach is crucial, it is insufficient. The organization of waste-free production can also be based on synergistic effects, and these two principles are intertwined. For instance, ecological agriculture combines these principles effectively. Bionics, which involves translating biological processes and structures into technological language, is fundamental to learning from nature, studying natural biotechnological transformations of substances, and adapting these processes to practical production. From a symbiotic perspective, the bioeconomy harmonizes previously incongruent phenomena, such as business and sustainability, ecosystem services and industrial applications, biomass and mass consumer products. At its core, the bioeconomy relies on biotechnologies, an interdisciplinary field according to scientists [5].

The cluster approach to constructing a bioeconomy emphasizes a territorial community comprising interlinked businesses, institutions, and organizations united by:

a) A shared technological platform.

b) Voluntary and collaborative (network) interactions.

c) Sectoral alignment or mutual complementarity across various sectors.

Incorporating an educational or competence-based approach is essential due to the rapid development of bioeconomy areas. This approach focuses on training individuals capable of making management decisions, organizing and overseeing innovative projects, and conducting complex economic evaluations. Universities offering master's programs in economics and additional professional education play a vital role in training experts with diverse educational backgrounds, equipping them to apply new knowledge effectively within various facets of bioeconomy development.

3 Results and Discussions

The extent to which the bioeconomy contributes to a country's innovative development relies heavily on the level of research, development, and production within the biotechnology sector. Biotechnology research primarily aims to create biologically active compounds, which subsequently find successful applications in producing enzymes, vaccines, vitamins, hormones, antibiotics, and more [6]. Research is also prominently advancing in areas like developing pest-resistant plant varieties, enhancing plant phytoimmunity, creating new plant and animal breeds, innovating food and animal feed, generating strains of beneficial microorganisms, and deploying biotechnologies for environmental preservation.

Integrating biotechnologies enables reductions in production costs for industry and agriculture, improves medication availability and quality of medical diagnostics and treatment, and betters environmental conditions. Countless international and domestic scientific conferences, publications, reports, and reviews generated by prominent consulting firms, stock analysts, government bodies, and nonprofit organizations are dedicated to investigating biotechnology trends, their global significance, and the assessment of their impact on national economies. Biotechnology is anticipated to be the most rapidly growing sector of the 21st-century economy (fig.1). Leading experts predict that biotechnology will contribute to 2.7% of the GDP in developed nations by 2030, with even greater contributions expected from developing countries [7].

By 2030, based on biotechnological advancements, 80% of medical products, 35% of chemical industry products, and 50% of agricultural production are projected to be produced. Additionally, by 2050, the global bioenergy market is forecasted to reach $150 billion, providing 30% of the total global energy demand from renewable sources. The USA, Germany, Great Britain, China, and Japan have achieved significant progress in the field of biotechnology, while Russia's presence in the global biotechnology market currently represents only a fraction of a percent.

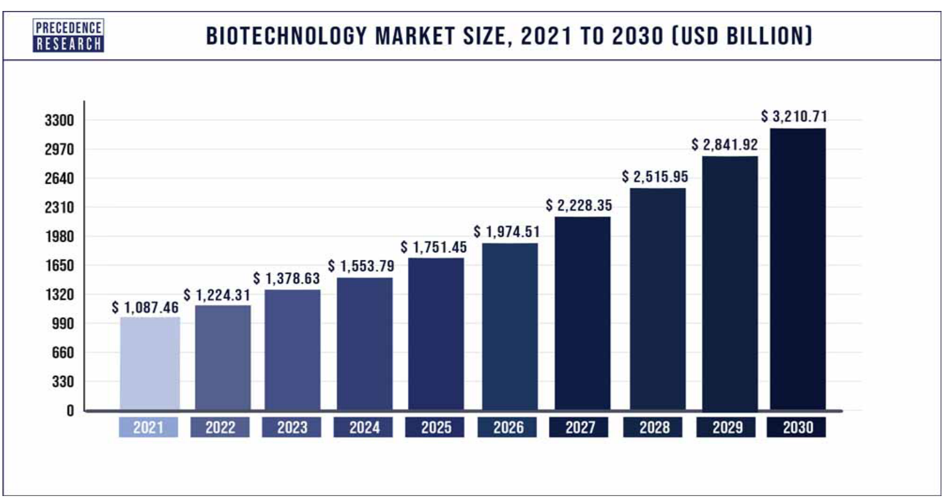

Fig. 1. Biotechnology Market Size, Share, Growth, Forecast 2023-2030.

A well-defined structure of directions for biotechnology development has been established, focusing on specific areas of application. "Red" biotechnology, encompassing biomedicine and biopharmacology, stands out as the most scientifically and practically significant sector, accounting for more than 70% of the global biotechnology market. Biopharmaceuticals alone hold 61% of the market. The global biotechnology market is projected to reach $600 billion by 2020, and by 2025, it is expected to grow by over 1.5 times compared to 2018, reaching $742 billion. The robust growth in this sector is likely to be driven by the introduction of a new wave of pharmaceutical biologics [8].

In Russia, the concept of creating innovative territorial clusters has been in implementation for several years, aiming to foster synergy between industrial enterprises, educational institutions, and scientific organizations (fig.2). Around ten biotechnology clusters have been established, each with a specific focus and expertise. These clusters include [9]:

1. The Cluster of Medical, Pharmaceutical Industry, and Radiation Technologies in St. Petersburg.
2. The Cluster of Pharmaceuticals, Biotechnology, and Biomedicine in the Kaluga region.
3. The Biopharmaceutical Cluster "Northern" in Dolgoprudny, Moscow region.
4. The Biotechnological Innovative Territorial Cluster in Pushchino.
5. The Yaroslavl Pharmaceutical Cluster.
6. The Biotechnological Cluster of the Kirov region.
7. The Cluster "Pharmaceutics, Medical Equipment, and Information Technologies" in the Tomsk region.
8. The Biopharmaceutical Cluster of the Novosibirsk region.
9. The Altai Biopharmaceutical Cluster.

These clusters are primarily involved in biopharmaceutical production and are oriented towards import substitution and the transfer of technological and business competencies from foreign companies. For instance, international corporations like AstraZeneca, Berlin Chemie, Novo Nordisk, Teva, Takeda, Novartis, and Biocad have established their presence in these clusters.

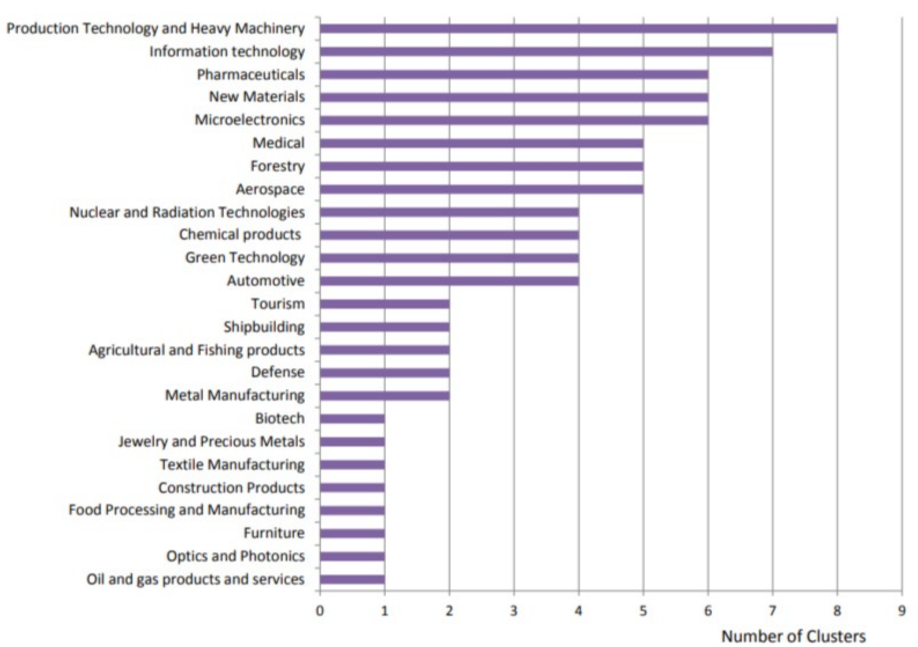

Fig. 2. Sectorial Orientation of Cluster Initiatives in Russia: the Majority Operate in Hi-tech Industries

The Severny Biopharmaceutical Cluster focuses on fostering collaboration between science and business by supporting small innovative enterprises through business incubators. It comprises over ten leading organizations in the pharmaceutical and medical industries [10].

There are plans to create additional biotechnology clusters in various regions of Russia. For example, the Belgorod region is considering the establishment of clusters for amino acid production for animal feed, including lysine, methionine, and threonine. In the Kaliningrad region, the first stage of a biotechnology cluster is set to begin operating by the end of 2015, involving the production of lactic acid and biopolymers. Moscow is also planning to create a biotechnology cluster, providing a range of services to companies, including contract and pilot production, educational programs, market assessment, legal support, and more [11].

Additionally, various incentives are under consideration, including subsidy packages, tax breaks, grants, specialized infrastructure access, and participation in industry-specific events to further promote the development of these clusters.

4 Conclusions

In the current stage of the biotechnology market's development in Russia, the focus is on market entry and expansion. The country is experiencing a growing demand for biotechnological products, leading to the active establishment of research and production enterprises across various biotechnology sectors. The increased financial support from the state serves as a stimulus for the emergence of new technologies and the development of production facilities that can handle the complete development cycle for different biotechnological products, including adhering to Good Laboratory Practice (GLP), Good Clinical Practice (GCP), and Good Manufacturing Practice (GMP) standards.

References

1. A. A. Daukaev, R. Kh. Dadashev, L. S. Gatsaeva, R. A. Gakaev, IOP Conf. Series: Earth and Environmental Science, 378 (2019)
2. A. Yu. Apokin, D. R. Belousov, Scenarios for the development of the world and Russian economy as a basis for scientific and technological forecasting, **3(3)**, 12–29 (2009)
3. Bio-Economy Technology Platforms. The European Bioeconomy in 2030: Delivering Sustainable Growth by addressing the Grand Societal Challenges (2021)
4. C. Cagnin, E. Amanatidou, M. Keenan, Orienting European Innovation Systems towards Grand Challenges and the Roles that FTA Can Play, **39(2)**, 140–152 (2020)
5. E. Reynard, M. Panizza, Geomorphosites: definition, assessment, and mapping. Geomorphol Relief , 177–180 (2018)
6. EU-Russia Energy Dialogue, *Energy Forecasts and Scenarios 2009–2010 Research. Final Report* (2021)
7. K. Haegeman, F. Scapolo, A. Ricci, E. Marinelli, A. Sokolov, Quantitative and qualitative approaches in FTA: from combination to integration?, **80**, 386–397 (2021)
8. R. Kh. Ilyasov, Spline modeling and analysis of relationships in the economy with the possible presence of regression switching points, **11(4)**, 165-175 (2018)
9. K. M.-S. Murtazova, Ecological and economic assessment of sectoral agricultural technologies, **3(15)**, 68-71 (2021)

10. A. S. Salamova, Socio-economic factors in the fight poverty and hunger in the modern world: the scientific approach of Amartia Kumar Sen, **17(1)**, 237-245 (2023)
11. A. S. Salamova, Global networked economy as a factor for sustainable development, 03053 (2020)