# Development of environmental accounting as a tool for assessing the economic potential of biotechnologies

*Alexey* Popov*

Ural State University of Economics, Yekaterinburg, Russia

**Abstract.** Global environmental problems have a significant impact on the state of the economy and require the development of new approaches to reduce the negative impact on the environment and the development of new management methods, including the use of biotechnology. The article studies the issues of implementation and use of environmental accounting as a tool for assessing the economic potential of biotechnologies. Based on the review of the points of view of famous scientists, the author's definition of environmental accounting is formulated, taking into account its multifaceted nature, and the basic principles of its organization are revealed. The use of environmental accounting tools is justified, including calculation of resource savings, determination of the effect of reducing costs for waste management and recycling to identify the potential benefits of using biotechnology, which is illustrated by the example of agriculture, biodiesel production and pharmaceuticals. The main problems of implementing environmental accounting are highlighted, including the lack of standards and unified methods, the low environmental responsibility of a number of enterprises, and high implementation costs. Promising directions for using environmental accounting to assess the economic potential of biotechnologies are revealed, including reducing environmental and financial risks, developing new business strategies, increasing product competitiveness and environmental responsibility of business, which ultimately corresponds to the goals of sustainable development while continuing further research in this area.

## 1 Introduction

Modern world realities demonstrate an increase in environmental problems, the main of which are climate change, loss of biodiversity, environmental pollution, etc. Biotechnology is one of the sources of their solution, in particular by creating environmentally friendly production processes and strengthening the sustainability of agriculture. Biotechnologies represent enormous economic potential, they serve as a source for the development of new products, medicines, include the research and development of bioenergy and other innovative industries, contributing to economic growth and the creation of new jobs. In light of the increasing environmental and social risks associated with biotechnology, at the

*Corresponding author: prepodpopov@yandex.ru

present stage there is a need to develop strict standards and rules for their accounting and control. Environmental accounting is a tool for monitoring and assessing the compliance of biotechnological projects with environmental standards. In turn, investors, potential partners and government authorities are increasingly paying attention to environmental sustainability and social responsibility of companies, which is disclosed in sustainability reporting. Environmental accounting, as a source of information about a company's environmental activities, is also a tool for demonstrating the contribution of an economic entity to solving environmental problems, which thereby helps attract investment. Companies that can effectively consider and minimize environmental risks have certain competitive advantages. Environmental accounting helps optimize resources and bring the management of environmental aspects of business to a whole new level. Global trends in environmental sustainability and responsible consumption are also becoming increasingly important to both consumers and regulators, and biotechnology companies must keep up with these trends to maintain their reputation and market access. In the world scientific literature today, the issues of assessing the economic potential of biotechnologies are widely covered; in this regard, the works of R. Herring [1], G. Moshchini [2], J. McCluskey [3], etc. should be noted. Russian scientists also carry out research in this field of science, in particular, E. A. Bessonova [4], A. G. Vorzhetsov [5], O. V. Kudryavtseva [6], etc. Dissertations in particular by A. V., Ivanova [7], A.A. Kozhukhovskaya [8], etc. devoted to building the potential of biotechnologies are of scientific interest.

In recent years, environmental accounting has emerged as a separate area, providing information on environmental responsibility and environmental activities of companies. The issues of its formation and implementation abroad are summarized by S. Schaltegger [9], Yu. J. Anad [10], N.Z. Muller [11], etc. Russian researchers T. N. Gogoleva [12], L.V. Chkhutashvili [13], K.S. Saenko [14] and others also substantiate the need to establish environmental accounting as a factor of sustainable development. At the same time, aspects of using environmental accounting data to assess the economic potential of biotechnologies are not fully disclosed in modern studies. Consequently, the questions raised in this article are timely and relevant. Environmental accounting allows for a multifaceted assessment of the impact of biotechnology on the environment and society, which in turn contributes to the sustainable and efficient development of this industry.

## 2 Materials and Methods

This study was conducted using general scientific methods, including a review and description of the definition of environmental accounting, analysis of the methodology for its maintenance, as well as grouping and comparison of data. Special research methods include modeling the results of using environmental accounting data to assess the economic potential of organizations, illustrated by the examples of agriculture, biodiesel production and pharmaceuticals, analyzing the strengths and weaknesses of the implementation of environmental accounting, problems and prospects for its use, as well as substantiating conclusions regarding the effectiveness of implementation in order to mitigate environmental risks, build economic potential and ensure sustainable growth.

To analyze the issues of using environmental accounting data to assess the economic potential of biotechnologies, it is necessary to highlight this definition, since in the scientific literature there is no consensus on the definition of environmental accounting. Environmental accounting is a multifaceted concept that may be interpreted differently by authors depending on their professional field and interests. In Table 1 we have reviewed the author's interpretations of this definition.

**Table 1.** Disclosure of the author's approaches to determining environmental accounting.

| Scope of application | Author and their work | Author's definition |
|---|---|---|
| Accounting and Finance | *M. J. Epstein*, Improving environmental management with full environmental cost accounting, Environmental Quality Management, 6, 1 (1996) | A system of accounting methods and technologies designed to identify, measure, analyse and manage environmental costs and assets, and to provide information about the environmental aspects of an organization's activities |
| Business administration | *A. K. Pramanik, N. C. Shil, B. Das*, Environmental accounting and reporting with special reference to India (2007) | Part of an integrated approach to ensuring high-quality corporate governance of an organization, which consists of ensuring transparency of public activities in relation to environmental aspects |
| Ecology and sustainability | *J. A. Frankel*, The environment and globalization (2003) | A tool for assessing and accounting for the impact of human activities on the environment, and identifying measures to reduce these impacts to achieve more sustainable development |
| Field of science | *G. Lehman*, Disclosing new worlds: a role for social and environmental accounting and auditing, Accounting, Organizations and society, 24, 3 (1999) | An interdisciplinary field of research that combines knowledge from the fields of biology, ecology, economics and accounting to analyze and account for the impact of economic activities on the natural environment |

The various definitions presented in Table 1 highlight the versatility of the concept of environmental accounting and its importance as a tool for better understanding the relationship between economic activity and the environment. Previously conducted research on this topic made it possible to derive the author's definition of environmental accounting, by which in this work we will understand the management subsystem in the form of accounting and analytical support that generates representative information about the environmental activities of the organization in order to ensure its effectiveness and the adoption of appropriate decisions by internal and external users of the specified information. [15] Environmental accounting helps organizations and society evaluate and consider environmental aspects when making decisions and managing resources.

Also, to justify the use of environmental accounting as a tool for assessing the economic potential of biotechnologies, it is necessary to dwell on a number of postulates in this area.

The subject of environmental accounting is the systematic analysis and assessment of the impact of an organization's production and economic activities on the environment. This involves measuring, analyzing and assessing a range of indicators, as well as reporting on various environmental aspects such as pollutant emissions, use of natural resources, energy consumption levels, biodiversity levels and other environmental impact factors.

The objects of environmental accounting are the activities of an organization, production, products, services or certain actions that may have an impact on the natural environment. Environmental accounting can be applied both to specific production processes and to strategic decisions aimed at the efficient use of natural resources.

Environmental accounting methodology is a system of tools and methods that are used to collect, analyze and report environmental data. It includes the elements presented in Figure 1.

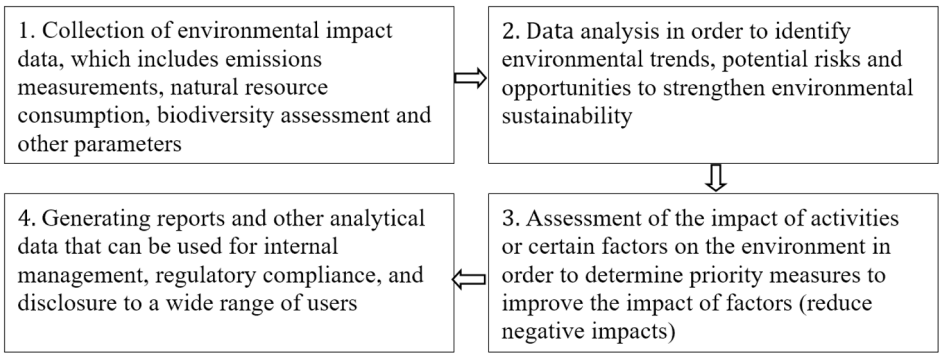


**Fig. 1.** Basic elements of environmental accounting methodology

Environmental accounting methodology may vary depending on the specifics of the organization, industry and accounting goals, but is always focused on studying the impact of activities on the environment and managing this impact to achieve sustainability and compliance with environmental standards.

## 3 Results and Discussion

Environmental accounting provides many tools and data that can be used to assess the economic potential of biotechnologies. This assessment through the lens of environmental accounting includes the following steps:

1. Identification of the environmental aspects of biotechnologies associated with their application, including assessment of the use and compliance with standards for the consumption of natural resources, emissions and pollution, changes in biodiversity and other environmental factors.

2. Data collection and monitoring to assess the environmental impacts of biotechnologies. This includes measuring emissions, analyzing resource consumption, monitoring air and water quality and other environmental parameters.

3. Assessing the impact of biotechnology on the environment, which also includes identifying risks and opportunities, for example, the use of biotechnology achievements can reduce the consumption of chemical fertilizers and pesticides in agriculture, which has a positive effect on the environment.

4. Economic assessment of indicators related to environmental activities. This may include calculating resource savings, reducing waste management and contaminant treatment costs, and assessing the market potential for environmentally sustainable products and services created using biotechnology.

5. Comparison with alternatives. The assessment of the environmental potential of biotechnologies is carried out taking into account alternative methods and technologies; in particular, biotechnologies can be compared with traditional production methods in terms of their environmental and economic indicators.

6. Decision making and strategic planning. Based on the results of the environmental accounting assessment, decisions are made on the implementation, development, or closure of biotechnological projects. This section is included in the general direction of developing a sustainable development strategy, which also requires determining the size of investments and developing measures to reduce environmental risks.

7. Reporting and communication with stakeholders, including investors, clients, regulators and the public. Clear and transparent information about environmental performance and sustainability plans helps improve reputation and attract investment.

In summary, environmental accounting allows not only to assess the environmental impact of biotechnologies, but also to identify opportunities for creating environmentally sustainable and cost-effective solutions. This is important both for biotech companies and for society as a whole striving for sustainable development. An illustration of the use of environmental accounting data for the purpose of assessing the economic potential of biotechnologies is presented in Table 2.

**Table 2.** Possibilities of using environmental accounting to assess the economic potential of biotechnologies

| Scope / method of application | Agriculture and agricultural biotechnology | Biodiesel production | Pharmaceutical industry, drug production |
|---|---|---|---|
| Use of biotechnology (example) | Introduction of genetically modified plants that are resistant to pests will reduce the use of pesticides and increase yields | Using microorganisms to produce biodiesel from biomass has the potential to reduce dependence on oil and reduce greenhouse gas emissions | Use of biotechnology to develop biological drugs reduces the need for traditional drugs made from chemical compounds and eliminates animal testing |
| Environmental accounting | Data collecting on quantities of pesticides used, water resources, and emissions associated with GM crops | Data collecting on energy consumption, water consumption and $CO_2$ emissions during biodiesel production | Data collecting on the costs of raising and testing animals, as well as analysis of the environmental impact of drug production and chemical compounds |
| Economic assessment | Calculation of cost savings on pesticide use and increasing yield revenues | Calculation of energy savings and $CO_2$ cost reductions and assessment of biodiesel market potential | Calculation of animal testing cost savings and potential revenues from the biological drugs market |
| Result | Possibility of reducing costs and increasing agricultural profits through the introduction of biotechnological methods | Sustainable biodiesel production is assessed as effective in reducing environmental impacts | Ecological methods of drug development are economically attractive and contribute to improving the company's image in the market |

Examples given in Table 2 clearly demonstrate the capabilities of environmental accounting, which, among other things, determines the correlating relationships between environmental sustainability and economic efficiency, contributing to a comprehensive integrated approach to the development and practical implementation of biotechnologies.

The implementation and use of environmental accounting as a tool for assessing the economic potential of biotechnologies may face a number of problems and challenges, including:

- Lack of data to assess the environmental impacts of biotechnologies, including information on emissions, resource consumption and biodiversity change; in some cases, such data may be limited in use or unavailable.
- Complexity of measuring a number of environmental parameters, including the level of impact on biodiversity, assessing environmental effectiveness, etc.; some cases require

the involvement of highly professional experts and significant resources for the examination.

- Subjectivity of environmental impact assessments, dependence on the methodology used in its implementation; this may cause discrepancies and complicate comparisons between different studies.
- Lack of a unified international standard and approved methodology for environmental accounting and evaluation of its results based on environmental reporting data; this may complicate the comparison and analysis of data due to their incomparability.
- Cost of conducting environmental assessment, which requires additional financial and time resources, which may limit the use of biotechnologies by small companies and start-ups in this area.
- Short-term focus, difficulty in assessing long-term benefits from the introduction of environmental accounting and investment in environmental protection measures.
- Lack of motivation due to the ambiguity of direct economic benefits from introducing environmental accounting into practice.
- Difficulty in assessing and interpreting results by stakeholders with opposing goals.
- Uncertainty of results due to practical difficulties in forecasting environmental and economic performance indicators.
- Ambiguity of the regulatory framework, difficulties in compliance with environmental norms and rules by business entities, high penalties, which can negatively affect their economic potential.

The need to overcome these problems and challenges highlights the importance of developing more effective environmental accounting methodologies and standards, as well as training and encouraging companies to manage the environmental aspects of their activities using environmental accounting data in the context of biotechnology.

The use of environmental accounting as a tool for assessing the economic potential of biotechnologies has significant promise and can contribute to more sustainable and innovative development of enterprises and society as a whole. In the course of our study, we identified the following benefits:

- Creation of innovative business strategies due to a better understanding of the environmental impact of production and economic activities, with the goal of moving towards more environmentally friendly production processes and developing products with a smaller environmental footprint.
- Assessing the environmental impact of biotechnology reveals opportunities to reduce costs associated with resources and environmental management, such as reducing energy consumption, optimizing the use of water resources and creating zero-waste industries.
- Increased competitiveness due to the fact that companies that actively apply environmental accounting improve their ratings among consumers and investors, which helps attract additional investment and expand sales markets.
- The introduction of environmental accounting helps companies comply with environmental standards and requirements set by regulators, which reduces the risk of legal problems and penalties.
- Innovativeness of activities and entry into new markets. Assessing the environmental impacts of biotechnology helps develop new products that meet consumer needs, opening new opportunities for innovation.
- The use of environmental accounting contributes to the achievement of sustainable development goals set at the global level in terms of reducing greenhouse gas emissions and preserving biodiversity.

These areas demonstrate that environmental accounting is an important tool for assessing the economic potential of biotechnologies and contributes to the integration of

environmental aspects into business strategies, which is important both for the environment and for the economics of enterprises, industries and the state as a whole.

## 4 Conclusion

In the modern world, where addressing environmental issues and ensuring sustainable development have become key priorities, the use of environmental accounting as a tool for assessing the economic potential of biotechnologies is becoming increasingly important. Environmental accounting provides the opportunity to comprehensively analyze and assess the impact of biotechnological innovations on the environment, as well as integrate environmental aspects into business strategies and management decisions. The main goal of environmental accounting in this aspect is to identify opportunities for reducing resource consumption, developing new types of bioenergy, reducing costs, leveling environmental risks, etc. Also, the introduction of environmental accounting allows you to comply with the requirements of environmental legislation, improve the company's reputation, provide it with a competitive advantage, and attract more investments, which ultimately ensures sustainable business development. However, the implementation of environmental accounting may face a number of challenges associated with the lack of unified methods and standards, insufficient environmental responsibility of business, the use of outdated industrial technologies, etc.

Overall, environmental accounting is an integral tool for a balanced assessment and development of directions for the development of the biotechnology industry. Its application ensures the adoption of innovative solutions that have practical implications for the environmental and economic sustainability of society. At the same time, rapid changes in these industries ensure the need for further scientific research and practical efforts in the field of implementation and improvement of environmental accounting and the development of biotechnology in order to more fully identify the potential of this tool.

## References

1. R. Herring, R. Paarlberg, The political economy of biotechnology, Annual Review of Resource Economics, **8** (2016)
2. G. C. Moschini, Biotech - Who Wins? Economic Benefits and Costs of Biotechnology Innovations in Agriculture, Estey Journal of International Law and Trade Policy, **2**, 1753-2016-141118 (2001)
3. J. J. McCluskey, Political economy of the media and consumer perceptions of biotechnology, American Journal of Agricultural Economics, **86**, 5 (2004)
4. E. A. Bessonova, I. R. Rudenko, Development of the biotechnology cluster in the economy of the Russian Federation. Innovative economy: Prospects for Development and Improvement, 8 (2017)
5. A. G. Vorzhetsov, Modernization potential of biotechnology. Bulletin of Kazan Technological University, **15**, 6 (2012)
6. O. V. Kudryavtseva, E. Yu. Yakovleva, M. V. Wilt, Typology of biotechnologies and the place of the Russian bioenergy industry in it. Bulletin of the University, **13** (2014)
7. A. V. Ivanova, Organizational and methodological mechanism for introducing innovative forest biotechnology products to the market (2015)
8. A. A. Kozhukhovskaya, Philosophical aspects of modern biomedicine: ontognoseological analysis (2023)

9. S. Schaltegger, R. Burritt, Contemporary environmental accounting: issues, concepts and practice, Routledge (2017)
10. Y. J. Ahnad, E. Lutz, Environmental accounting for sustainable development. The World Bank Symposium. The World Bank (1989)
11. N. Z. Muller, R. Mendelsohn, W. Nordhaus, Environmental accounting for pollution in the United States economy, American Economic Review, **101**, 5 (2011)
12. T. N. Gogoleva, Yu. I. Bakhturina, Environmental accounting in the system of types of accounting, International accounting, **3(343)** (2015)
13. L. V. Chkhutiashvili, Organization and improvement of environmental accounting at Russian enterprises, LEX RUSSICA, **2** (2014)
14. K. S. Saenko, Innovation and Environmental Accounting: prerequisites and general principles of their formation and development, Audit and Financial Analysis, **5** (2007)
15. A. Popov, Implementing Environmental Accounting as a Factor of Organization's Economic Security, Proceedings of the Ecological-Socio-Economic Systems: Models of Competition and Cooperation (ESES 2019) (2020)