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# THE MATRIX OF INDICATORS FOR RECOGNIZING THE AGRIBUSINESSES ECOSYSTEM ASSETS: CONVERGENCE OF SYSTEM OF ENVIRONMENTAL-ECONOMIC ACCOUNTING (SEEA) AND INTERNATIONAL FINANCIAL REPORTING STANDARDS ( IFRS)

**Irina GOLOCIALOVA, Maria COJOCARU**

Moldova State University, 60 Alexei Mateevici, Chisinau, MD-2009, Republic of Moldova, Phones/Fax: 373 60287573; 373 68094157, E-mails: irina.golocialova@usm.md maria.cojocaru@usm.md, cojocaruusm@gmail.com

***Corresponding author***: irina.golocialova@usm.md

***Abstract***

*The main objective of this research is to develop an accounting matrix for the agribusiness sector, based on current trends such as SEEA and IFRS, to support sustainable accounting and reporting. The study emphasizes the importance of developing a system of indicators that reflect the impact of the interaction between agribusiness and environmental ecosystems, particularly in the context of climate change. The research highlights the need for non-financial reports based on Global Reporting Initiative (GRI) and Environmental, Social and Governance (ESG) standards, which provide a comprehensive picture of agricultural enterprises' environmental, social, and governance performance. In this regard, it was developed a convergence matrix between SEEA and IFRS methodologies, emphasizing the importance of including ecosystem resources in agricultural accounting. The study also analyzes the existing obstacles in the Republic of Moldova for implementing SEEA in local accounting, particularly due to the lack of prerequisites for evaluating ecosystem assets in financial reporting. The research results include the development of a method for assessing agribusiness's contribution to maintaining ecosystem resources and formulating statistical indicators to monitor the state of these resources. In conclusion, the research proposes the integration of modern accounting approaches that allow investors and other stakeholders to better assess risks and opportunities related to agribusiness sustainability, thus helping prevent the ecological crisis and ensuring sustainable development.*

***Key words*****:** *agribusiness, methodology of accounting, SEEA concept, natural capital, ecosystem assets, convergence matrix*

## INTRODUCTION

In the current context of transforming economic relations, aspects of sustainable development are becoming increasingly relevant due to the worsening of global environmental and social problems. Economic activity directly impacts both climate change and societal processes. The ecological crisis characteristic of today's economy is a consequence of capitalism’s inherent goal of profit maximization. One way this goal is achieved is by undervaluing environmental resources (such as arable land, forests, water, mineral, and biological resources) used in the production of goods. These resources are often regarded by businesses as gifts from the environment, while the resulting environmental costs are passed on to society, often with the support of government policies [38].

There is no doubt that businesses rarely bear the cost of their negative environmental impacts, despite their heavy reliance on natural resources provided by ecosystems—such as fresh water, clean air, fertile soil, and biodiversity. With finite environmental reserves, this trend has inevitably contributed to the ecological crisis.

In response to the ecological crisis, the Sustainable Development Concept (SDC) was established, with environmental protection at its core. However, the SDC also aims to promote economic growth and social justice, as reflected in its 17 Sustainable Development Goals (SDGs). Notably, the SDGs highlight Goal 13, "Climate Action," and Goal 15, "Life on Land," both of which can be achieved through responsible consumption and

production (Goal 12). This goal envisions a transition to a low-carbon, green economy. Additionally, Goal 17 "Partnerships for the Goals" emphasizes the creation of inclusive partnerships to stimulate social finance and drive progress towards sustainable development [35].

In the context of the SDC, agribusiness, which has long been a source of national income growth and a form of social relations, is now endowed with an additional attribute—sustainability. Agribusiness is considered sustainable when it fulfills its social responsibility by contributing to both food security and the resolution of the environmental crisis. It is well known that a broad group of agricultural products (such as dairy, cattle hides, soybeans, coffee, etc.) are considered "direct drivers" of land degradation, and they are increasingly drawing the attention of stakeholders. An analysis by the Food and Land Use Coalition found that between 2005 and 2017, G7 members (including the EU) were responsible for approximately 30% of tropical deforestation and over 2.7 billion tons of $CO_2$ emissions, driven by imports of these agro-products [22].

Sustainable agribusiness is a key driver of development in developing countries, including the Republic of Moldova (RM). An analysis of the current national economy reveals that a significant portion of the workforce is employed in agriculture (20.9% of total jobs in 2023), yet its contribution to the Gross Domestic Product (GDP) remains disproportionately small, accounting for only around 10% between 2020 and 2022. These indicators highlight low productivity and competitiveness, making RM's agribusiness sector vulnerable [19].

One possible solution to the current situation is a significant increase in investment in agribusiness, utilizing both internal and external financing sources. Achieving this would help facilitate the transition to a sustainable agribusiness model. In the initial phase, a system of statistical indicators could serve as a tool to support this process. However, the effectiveness of these indicators will depend on their ability to adequately measure agribusiness' contribution to sustainable development and, ultimately, to resolving the environmental crisis. Additionally, addressing the environmental crisis will require assessing the actions of not only agribusiness but also other actors in the supply chain, including providers of non-financial and financial resources, consumers, and policymakers [22].

This assessment can be achieved through the integration of a specialized system of indicators into agribusiness reporting.

Society, businesses, and institutional structures require indicators that reflect the interconnections between the economy, human beings, and the environment. The development of a specific system of indicators to measure the implementation of the SDC will inevitably expand the scope of available information and, consequently, lead to changes in the format of business reporting used to convey this information to stakeholders.

The recognition of the critical role of environmental resources in promoting societal well-being within the Sustainable Development Concept led to the development of the specialized System of Environmental-Economic Accounting (SEEA). Its core principle is that to ensure the rational use and preservation of natural resources, it is essential to account for them. This system helps measure the impact of economic activities on natural resources and identify priority areas for "green" investments. The SEEA was further extended to cover agriculture, forestry, and fisheries through the System of Environmental-Economic Accounting for Agriculture, Forestry, and Fisheries [36].

The Strategy "European Moldova 2030" (hereinafter, Strategy 2030) outlines a number of priority directions for the transition to the paradigm of sustainable development and provides for a number of protective measures to neutralize the current national problems, including the environmental crisis, based on the homocentric vision of society development. At the same time, the Strategy-2030 highlights that, due to low income levels, the people of the Republic of Moldova

prioritize economic challenges over environmental concerns and fail to recognize the importance of natural resources for their well-being and sustainable development. The foundation of the society's "environmental philosophy" is a tendency to view ecosystem resources—such as land, water, minerals, and biological resources—as nature's gifts, which are perceived as free and unlimited [19].

This raises an important question: *What are the prospects for implementing SEEA provisions in the Republic of Moldova, a developing country, to mitigate the environmental crisis and ensure the sustainable development of agribusiness?*

At the same time, it is known that the Natural Capital Coalition [21] as a modern accounting practice recognizes IFRS [17]. This raises the question: *How do the SEEA provisions relate to the IFRS methodology for agribusiness accounting in the context of the Sustainable Development Goals*? The answers to these questions will support the hypotheses *(H*):

***H1***: The accounting and reporting system of the Republic of Moldova, which is oriented towards the continental accounting model, does not yet have the prerequisites to implement SEEA and provide useful information on the state of ecosystem assets in financial reporting, including agribusiness.

***H2*:** The convergence of IFRS methodology and the SEEA concept contributes to the development of a sustainable agribusiness accounting system.

Justification of the hypothesis is carried out according to the following scheme:

*Stage 1* – Characterization of the model for achieving sustainability and development of agribusiness in line with the European Moldova-2030 Strategy;

*Stage 2* – Conceptualization of the agribusiness accounting matrix in the context of the development of its sustainable accounting and reporting model;

*Stage 3* – Development of key indicators related to climate change as a result of the interaction between agribusiness and environmental ecosystems.

Numerous studies address the challenge of agribusinesses achieving a sustainable model, with a key focus on assessing resource efficiency. To illustrate the relationship between resource consumption and production volume, GDP per unit of resources used remains a prevalent metric at the macroeconomic level. However, the economic development model primarily centered on GDP growth raises concerns among academic economists [30].

The connection between economic growth and environmental degradation is currently one of the most debated topics in both scientific and public discourse worldwide. It is frequently suggested that the pursuit of economic prosperity often comes at the expense of environmental health and resource depletion [27].

In this context, assessing the condition of ecosystem assets and the services they provide is crucial for agribusinesses striving for sustainable development. According to Skika et al., a system of statistical indicators secves as one of the tools to achieve this goal. This system includes assessments of: 1) agricultural land as an investment; 2) agricultural land subject to changes in use policy; and 3) uncertainties related to current and future agricultural land use, among others [28].

However, this set of indicators fails to capture the impact of agribusiness on the condition of ecosystem assets.

Erbas (2024) [12] notes that agribusiness requires external investment, typically provided by the government through subsidies. The reluctance of real sector enterprises to invest in agribusiness is largely due to the absence of an effective valuation system for agricultural land and other ecosystem assets, which hinders the assessment of financial and social risks and the potential for increasing equity capital [12]. Such an opinion is also supported by other researchers [9, 5 ].

Furthermore, the lack of reliable information on ecosystem asset values distorts macroeconomic indicators such as GDP, Gross Value Added (GVA), and the Value of Industrial Product (VIP) [14].

The sustainable development of agribusiness directly depends on the state of the environment, making the use of modern

information tools in agribusiness management imperative. This underscores the importance of generating qualitative information about the results of this interaction [11].

Ofurum's assertion is noteworthy: the function of management, with accounting as a "language of business" includes identifying stakeholders who contribute to the increase in business capital and ensuring their interests are represented. Due to the absence of natural capital valuation in financial statements, the information provided often does not meet stakeholders' needs, leading to a financial report that falls short of its intended purpose [23].

In this regard, two ways of preparing non-financial reporting have been developed. *The first approach* is based on GRI standards and ESG-indicators and aims to present information about environmental, social, governance activities, and corporate social responsibility, but which cannot be explained in terms of currency [10].

Today, it is known as a systematization of ESG-indicators to assess the extent to which a business is committed to non-profit goals beyond maximizing the value created for its owners [7].

According to this approach, within the environmental aspect of activities, businesses focus on issues that are significant for both them and other stakeholders: compliance with environmental legislation, environmental characteristics of products, energy efficiency, energy conservation and innovation, as well as the protection of land resources and vegetation. The importance of this type of information is beyond doubt. However, it does not provide a comprehensive account of the business unit's activities and does not reflect all the factors that contribute to wealth creation and well-being [4], as it is primarily quantitative in nature.

The *second approach* is based on the "Integrated Reporting" standard. Its development was driven by the introduction of a combination of short-term and long-term indicators into practice, designed to reflect a business's ability to mobilize its intellectual (intangible) assets along with its physical (tangible) assets [16].

This approach is now known as the systematization of information through Key Performance Indicators (KPI), which characterize the quality, sustainability, and variability of a business's cash flows and revenues [10].

Each of these non-financial reporting formats serves as a complement to financial reporting, and the use of different measurement units for their indicators indicates a lack of interconnection between them, as well as between each of them and the financial reporting [15].

Meanwhile, the issue of valuation is fundamental. After all, shareholders and investors evaluate business performance in the "language" of numbers, showing information about the impact of non-financial resources on the state of the business and vice versa, about the contribution of the business to their maintenance, which is useful to them when making responsible investment decisions. At the same time, the statistical nature of ecosystem asset valuation does not contradict the IFRS methodology, since its object is reporting as a whole, the indicators of which are represented by average estimated values calculated on the basis of statistical methods [29].

The recognition by the concept of sustainable development of the crucial role of environmental resources in ensuring the well-being of society led to the development of a specialized SEEA. At the beginning, System of Environmental-Economic Accounting was presented with two documented assets: SEEA Central Framework 2012 (SEEA-CF) [40]; SEEA Ecosystem Accounting 2021 (SEEA-EA) [41]. It was further developed in relation to activities related to agriculture, forestry and fisheries [36].

The SEEA-AFF applies the ecological-economic structures and principles described in the Central Framework [34] and its aim is to integrate the data needed to describe how biophysical and management information related to production in agriculture, forestry and fisheries can be integrated into the statistical system established under the SEEA-EA [37].

At the same time, the Task Force of the Conference of European Statisticians proposed a set of core indicators and statistics related to climate change calculated using SEEA-EA. This set consists of 44 indicators, which include: total land area in general and by category; area of disturbed land and area of restoration; area of reclaimed land; amount of waste generated (emissions); amount of waste used or neutralized [33].

In addition, the Economic Commission for Europe Paper states that environmental accounting can be used to monitor and analyze a wide range of environmental issues, including climate change, although there is no specific accounting for climate change in SEEA-EA [37].

In addition, the GHG Agricultural Protocol Guidance interprets the Corporate Accounting and Reporting Standard for the Agricultural Sector [13].

The need for its development is justified by the fact that agribusiness accounts for about a quarter of anthropogenic emissions into the environment. It is noted that the most acceptable options for reducing these emissions in agribusiness are improving crop and pasture management, restoring organic soils, and rehabilitating degraded lands. This guidance aims to achieve the following objectives: to improve the consistency and transparency of accounting and reporting of emissions to the environment, to assist in the cost-effective preparation of inventories that provide accurate and objective information on their climate impact.

Such a systematic approach is expected to help inform management decisions regarding effective environmental control and the promotion of responsible agribusiness investments. The European Parliament has also adopted a similar decision [8].

Given this point, the GNG Protocol emphasizes that accounting and reporting of wastes (emissions) affecting ecosystem assets should be based on basic principles that are adequate to the principles of modern accounting methodology: relevance, completeness, consistency, transparency, reliability [13].

It is obvious that the establishment of a comprehensive system for accounting for ecosystem assets and the contribution of sustainable agribusiness to their maintenance is impossible without institutional solutions that promote the implementation of environmental-economic accounting in agribusiness and its integration with national accounting and reporting systems, including those of the Republic of Moldova.

The above studies demonstrate the importance of this issue and undoubtedly contribute to the understanding of the urgency of developing an effective SEEA-based mechanism for accounting for ecosystem assets and integrating it into accounting methodology.

In this context, the purpose of the paper is to develop an accounting matrix for the agribusiness sector, based on current trends such as SEEA and IFRS, to support sustainable accounting and reporting.

## MATERIALS AND METHODS

This research employs a combination of general scientific and specialized methods, including a systems approach, content analysis, synthesis, graphic and mathematical modeling, and a review of specialized literature. The application of the systems approach is evident in the strategic integration of specific scientific methods to develop the research methodology, which encompasses problem definition, hypothesis formulation, and justification.

The primary methods of this methodology are content analysis and matrix modeling. The content analysis method, which compares the provisions of National Accounting Standards (NAS, 2013), International Financial Reporting Standards (IFRS), and the System of Environmental-Economic Accounting (SEEA), has facilitated the development of an environmental-economic accounting algorithm for agribusiness (Table 1). This method also led to the creation of a convergence matrix between these standards (Table 2). Matrix modeling is utilized to visualize the algorithm for constructing an agribusiness accounting system based on SEEA provisions. Additionally, it aids in

developing the SEEA convergence matrix with accounting methodology (Table 2) and establishing a system of indicators for assessing the state of the ecosystem and agribusiness's contributions to its maintenance (Table 3).

The aim of the research is to explore the possibilities of developing a sustainable accounting model for agribusiness based on current trends (SEEA and IFRS) in the context of the Sustainable Development Goals.

In this regard, the following sources were used to form the evidential basis:

(i)Official documents and reports from the UN, the United Nations Economic Commission for Europe, the European Parliament, and other international organizations in the field of ecosystem asset and capital accounting systems;

(ii)The legislative and regulatory framework of the Republic of Moldova regarding accounting and reporting;

(iii)International standards related to both financial reporting and sustainable development, including integrated and non-financial reporting;

(iv)Works by renowned scholars published in scientific journals, including those indexed in the Scopus and Web of Science databases, as well as in the form of monographs.

## RESULTS AND DISCUSSIONS

### 1. Model for achieving agribusiness sustainability aligned with the National Development Strategy „European Moldova 2030"

The problem of ecological crisis has arisen as a result of human activities, especially those that qualify as businesses. Agribusiness (agricultural enterprises), as an integral part of the economic sector, is faced with a dilemma: either to gain more income from increased yields or to degrade soils, water scarcity and loss of biodiversity, in other words, to degrade the environment on whose resources it depends. The resolution of this dilemma is a challenge for the current scientific and institutional environment, the overcoming of which will lead to a balance between environment and society, the "capitulation" to which has far-reaching consequences for both agribusiness and the "health" of the entire planet.

The developments of the scientific environment contributed to the transition to the SDC and formed the methodological platform of environmental-economic accounting [1]. Environmental and economic accounting is designed to neutralize the ingrained tradition of perceiving environmental resources as a "gift" of nature and excluding their value from the cost of production. The ecological consequence of this tradition is the degradation of natural capital. In the context of the current agribusiness dilemma, consideration of ecological consequences is of particular importance. J. Richard (2009 a and b) note the lack of specific accounting standards for accounting for environmental factors and natural capital elements. The lack of a clear position on the demand for this type of information and demonstration of the benefits of such information slows down the motivation of business, including agribusiness, to keep environmental accounting and publish relevant information [24, 25].

Environmental-economic accounting is the first step in resolving this problem.

However, for the implementation of the SDC, an institutional environment must be established and clearly defined, one that promotes the reformatting of the economy by mitigating the absolutization of economic growth and encouraging environmentally-oriented businesses aimed at achieving sustainable development goals.

It is known that the core of the institutional platform, which establishes directions for the development of a particular state, region or association, is the development strategy. In RM today, the Strategy 2030 serves as such a strategy. It identifies priority areas for transition to the SDC, and establishes actions and policies to address the environmental crisis and support agribusiness in its transition to a sustainable development model. Therefore, according to the Strategy-2030, environmental components have a direct impact on a person throughout his life,

determining the state of health, labor productivity, economic growth potential, etc. At the same time, the neglect of environmental problems caused by climate change over the past years, manifested mainly in the deviation from environmental goals in favor of economic goals or the interests of narrow groups, has made society even more vulnerable. Land resources in RM are very intensively exploited and soils with a high level of quality and productivity are subject to degradation processes, the most serious of which is erosion. To maintain their productivity, agribusinesses use significant amounts of organic fertilizers and products, which are another source of soil degradation risks. The state of the land fund in agribusiness has been negatively affected by the reform regarding the form of land ownership and the process of degradation has only intensified (annually 6,400 ha of agricultural land is degraded). At the same time, the Republic of Moldova remains far behind European countries in terms of public and private investments in environmental protection [19].

Currently existing environmental economic instruments (e.g., taxes and environmental permits) are not able to change the situation. It should be noted that a similar situation occurs in other countries, for example, in Ukraine and Belarus, where the process of implementation of modern environmental policy is predominantly focused on the elimination of environmental impacts rather than on prevention [3, 20].

At the same time, the most common tools are recovery of payments for environmental pollution, waste generation, water pollution, air pollution [3, 20].

In the absence of decisive action, the impacts of climate change on agribusiness, the environment and public finance will become even more severe [19].

The key aspects of the outlined strategy that aid in identifying the issues for agribusiness transition to a sustainable development model are presented in Fig. 1.

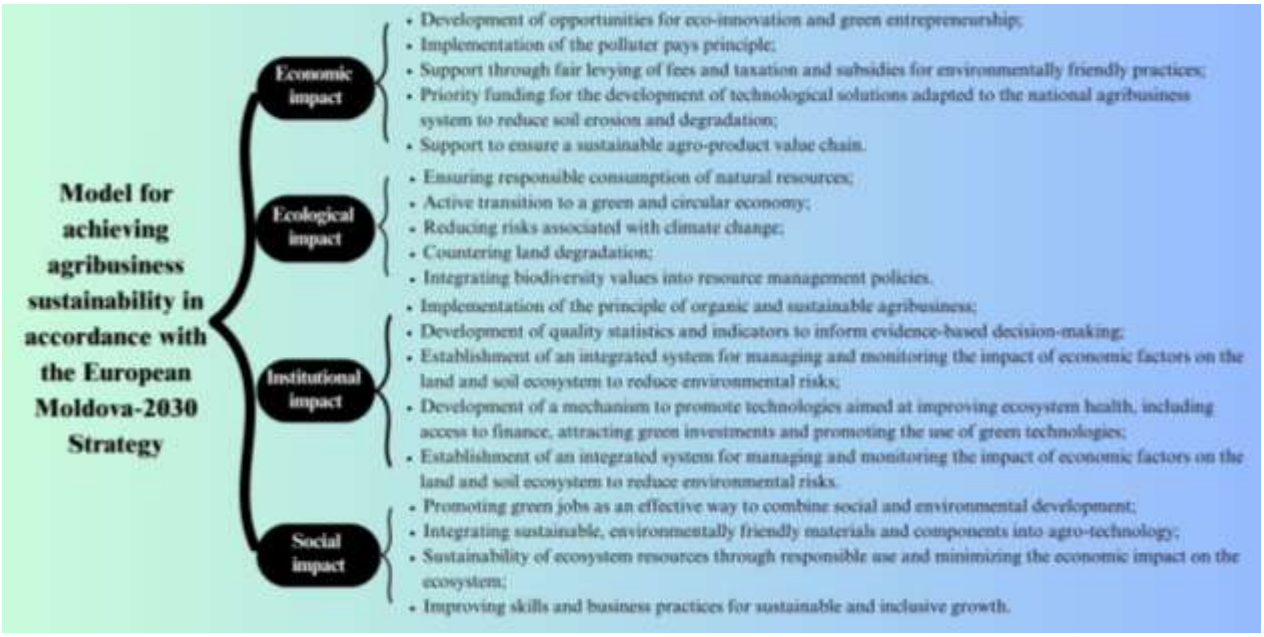


Fig. 1. Model for achieving agribusiness sustainability aligned with the European Moldova 2030 Strategy
Source: developed by the authors.

The model of achieving sustainability by agribusiness presented in Figure 1 provides for the need to develop and implement a comprehensive approach to consistently reduce external and increase internal environmental costs in agribusiness. This involves the introduction of environmental technologies, reduction of waste generation and deepening of waste recycling, and support of environmental activity of agribusiness under the modern technological mode. In this process, the environmental responsibility of

agribusiness is strengthened through the implementation of measures to prevent and eliminate negative environmental impacts during the life cycle of products (environmental aspect).

The model of formation of sustainable agribusiness provides for institutional solutions, including improvement of environmental statistical accounting and implementation of the system of national accounts on the basis of statistical data to manage and monitor the impact of agribusiness on its ecosystems (institutional aspect). This implies the development of a unified methodology for building the system of accounts. Moreover, understanding and applying the principles of environmental-economic accounting will contribute to the development of agribusiness reporting with respect to the disclosure of the ESG-contribution of agribusiness to its sustainable development model (economic aspect). In doing so, the social responsibility of agribusiness (social aspect) promotes fair labor practices, sustaining the national economy and contributing to the overall well-being of society [18].

## 2. Conceptualization of the Accounting Matrix in Agribusiness in the Context of Developing its Sustainable Accounting and Reporting Model.

However, the strategy looks to the future, so to assess the feasibility of implementing its model for creating sustainable agribusiness, it is necessary to compare the principles of SEEA with the current procedures for evaluating and presenting information on the condition of ecosystem assets used by agribusiness, as prescribed by the National Accounting Standards (hereinafter - NAS). As already noted, SEEA-AFF applies the eco-economic principles of SEEA-CF and the accounting rules described in SEEA-EA to activities related to agriculture, forestry, and fisheries. The preparation of a separate documentary act within the framework of SEEA for these types of activities is predetermined by the fact that they directly depend on the environment and its resources and, in turn, exert influence on them. SEEA-AFF emphasizes that it is, in general, a statistical system for organizing data. This means that it allows for the description and analysis of the relationship between the environment and economic activities related to agriculture, forestry, and fisheries. We briefly summarize the key points of the SEEA concept regarding the application of its provisions for organizing eco-economic accounting for agribusiness (Table 1), which the authors believe will contribute to mitigating the ecological crisis.

As stated in SEEA-AFF, the basic accounting organization aimed at establishing sustainable agribusiness can be expanded in various ways, as SEEA-AFF serves as a platform for an accounting structure designed to facilitate the integration and use of data related to activities in agriculture, forestry, and fisheries within the economic and environmental spheres.

Since the IFRS concept is recognized as a modern methodology for constructing reporting and accounting, alongside a comparison with NAS, we will conduct a critical analysis of the similarities and differences between IFRS and SEEA, and then establish the degree of convergence between them.

The developed convergence matrix will serve as a basis for creating a corresponding conceptual accounting platform in the agribusiness sector aimed at sustainable development.

It is important to note that the IFRS methodology is based on the application of economic valuation in the preparation of financial statements, for which the IFRS system includes the standard IFRS 13 “Fair Value Measurement”.

The provisions of this standard within the framework of the fair value concept recommend applying one of three approaches to valuing accounting objects: the cost approach, the income approach, and the market approach.

Table 1. Key elements of SEEA defining the framework for ecological accounting in agribusiness

| Stage | Content |
|---|---|
| **I** | The **conceptual framework** establishes an understanding of:<br>ecosystems (dynamic territorial complexes consisting of biotic and abiotic components interacting as a functional whole while ensuring the existence of ecological structures, processes, and functions, CF p. 2.21),<br>ecosystem assets (a set of ecosystem services reflecting various characteristics, processes, and types of ecosystems, CF p. 2.2.3),<br>the triad of ecosystem services (benefits provided by ecosystem functions to humanity, CF p. 2.22), the institutional sector as an economic unit (CF p. 2.6), and its products and waste (CF p. 2.5). |
| **II** | The **system of account** for ecosystem assets is designed to reflect their condition at the beginning and end of the period, in both physical and monetary terms. The monetary accounts for the condition of assets provide significant information on the interaction between business and ecosystems. An account titled 'Capital' is provided to reflect the acquisition and disposal of ecosystem assets (particularly for land and biological resource transactions in agribusiness). It is recommended to group accounts by types of activities: primary, agricultural production, environmental protection, and ecological management (CF p. 2.51, 2.60, 2.67, 2.71-2.74). |
| **III** | The **system of indicators**, based on which the condition of ecosystem assets is assessed and the ecosystem as a whole is characterized (p. 5.5.4 CA). The indicators are classified as variables since they are used to characterize biodiversity. The basis for their selection is compliance with the aspects of the concept of qualitative characteristics of information: semantic (relevance, reliability, and materiality), pragmatic (reliability, accessibility, simplicity, and comparability), and specific in the context of socio-ecological impact (completeness and cost-effectiveness). |
| **IV** | **The concept of monetary valuation**, which is central. The motivation for monetary valuation is the ability to compare different ecosystem assets and ecosystem services (p. 8.3 CA); moreover, it allows for the analysis of changes in the condition of ecosystem assets and their flows, for example, in agribusiness — analyzing changes in soil (fertility, erosion, degradation from toxic pollutants).<br>The concept of exchange value assessment is applied in ecosystem accounting (p. 8.13 EA), which includes two approaches: market and NPV. The NPV approach is recommended for evaluating ecosystem assets and their services (p. 8.37 EA). Based on monetary valuation, an analysis is conducted of five broad types of changes: improvement, degradation, transformation, reassessment, and other changes.<br>The NPV approach implies assessing the future ability of ecosystem assets to provide ecosystem services, which requires consideration of the prices and quantities of ecosystem services, institutional mechanisms, and the lifespan of ecosystem assets (EA p. 8.37). Exchange value is necessary to justify entries in the accounts of ecosystem assets. |
| **V** | **The concept of the triad of ecosystem services**: provisioning, regulating, supporting, and cultural services. In agribusiness, its economic aspect is directly linked to the use of ecosystem resources, often including both ecosystem assets and their ecosystem services, which are interpreted as contributions to the production of agricultural products.<br>Quantitative measurement of ecosystem services (provisioning, regulating, and supporting) is provided, which depends on the type of ecosystem and its characteristics. Their valuation is based on exchange value, which facilitates comparison with changes in the condition of ecosystem assets (p. 7.70). For agribusiness, a coherent valuation of ecosystem assets and services is a key element (p. 2.71 A). |
| **VI** | **The object of ecosystem accounting** is ecosystems, and in this context, it is aimed at the systematic registration of data on ecosystem assets: their used stocks, services, and changes in condition due to the impact of agribusiness. The ecosystem accounting approach includes documenting the relationships between ecosystems and units of the institutional sector based on a developed chart of accounts and the selected valuation method. In corporate accounting, the focus is on the entities of agribusiness.<br>It is recommended to establish an accounting procedure for ecosystem services, which serves as a linking concept between ecosystem assets and agribusiness (p. 6.1). Its importance is justified by the extensive use of provisioning and regulating ecosystem services by agribusiness, which are not explicitly recorded in the system of national accounts. Ecosystem services are classified as final and intermediate. |
| **VII** | **Documentation involves** the development of management forms. Systematized data on the condition of ecosystem assets are reflected in the Balance Sheet, while the flow of changes in condition (increase and decrease) is shown in the Profit and Loss Statement. |

Source: developed by the authors.

Each of these approaches includes specific valuation methods, the choice of which depends on the specific use of each accounting object. As mentioned above (Table

2), SEEA recommends using the concept of exchange value, which is based on the income and market approaches to valuing ecosystem assets and their services.

The NAS methodology is oriented towards a continental accounting model, and in this regard, its basic principle is the 'cost principle,' while reporting is prepared according to the rules of the legal approach [31]. Adhering to the cost principle excludes the application of income or market approaches to the valuation of ecosystem assets. However, their value, as is well known, is influenced by the time factor, which is determined on one hand by societal demand, and on the other hand by the value of the ecosystem, such as land, its ecosystem assets and services, which are determined by its limited productivity.

Now we will move on to the development of a convergence matrix for the IFRS methodology, the SEEA concept, and the NAS methodology regarding the formation of accounting in agribusiness aimed at sustainable development.

The development of the designated matrix is carried out according to a three-step algorithm proposed by [15]. In the first stage of the algorithm, the key points of each of the studied concepts were examined in relation to the specific characteristics of agribusiness.

The objective of the second stage was to address the following questions:

- the identification of criteria for comparing the IFRS methodology, the SEEA concept, and the NAS methodology concerning accounting in agribusiness;
- and the formulation of explanations to clarify the indicator that corresponds to the IFRS methodology, is characteristic of the SEEA concept, and complies with the provisions of the NAS.

The third stage involves the actual construction of the matrix to address the questions: *What are the prospects for the implementation of the SEEA provisions in the developing country of the Republic of Moldova to neutralize the ecological crisis and ensure the sustainable development of agribusiness?*

*How do the provisions of SEEA relate to the IFRS methodology for accounting in agribusiness in the context of sustainable development goals?*

The convergence matrix of the IFRS methodology and the SEEA is presented in Table 2.

Table 2. Convergence Matrix of Accounting Indicators of the Republic of Moldova and International Practices for Disclosing Information on the State of Ecosystems

| Criteria | Notes | NAS | IFRS | SEEA (CF, EA, AFF) |
|---|---|---|---|---|
| **The role in ensuring sustainability** | The degree of alignment with the principles of the SDC? | Low degree of alignment with the SDC | It responds flexibly to the requirements of the SDC and ensures the transition to a socio-economic model of financial reporting. | It is part of the SDC and contributes to the transition to a socio-economic model of financial reporting. |
| **Information users** | Who are the users of infor-mation about the state of ecosystems and natural capital, the source of their origin? | Owners (associates, shareholders, founders, members), creditors, clients, customers, emp-loyees, government authorities, and the public. | Existing and potential investors, lenders, and other creditors expecting a return on investment, which depends on the responsible management of all resources. | Owners (investors and shareholders), business policy developers, government, ecological economists, the public, and others. |
| **Methodolo-gical approach.** | What methodology is provided for solving the problem? | Based on traditional accounting methodology. | Based on the theory of normative accounting and reporting, the concept of financial capital, and the concept of economic valuation. | SEEA-AFF applies the principles and accounting structures contained in the System of National Accounts and SEEA and has an interdisciplinary nature: ecological economics, statistics, and economic valuation in management accounting. |

| | | | | |
|---|---|---|---|---|
| **Classifica-tions for accounting ecosystem assets:** | What classification groupings are proposed to address this issue? | They are absent. Only ecosystem resources are considered:<br>1. biological asset - a living animal or plant;<br>2. agricultural products derived from the biological assets of agriculture | They are absent. Only ecosystem resources are considered:<br>1. biological asset – a living animal or plant;<br>2. agricultural products harvested from the biological assets of agriculture;<br>3. consumed and productive biological assets. | 1. accounts (in monetary and physical terms);<br>2. types of ecosystem assets based on their boundaries;<br>3. types of ecosystem services;<br>4. products of ecosystem assets;<br>5. biotransformations and cultivated (abiotic) processes. |
| **Methods for quantitative measurement of ecosystem assets.** | Are quantitative measurement methods provided? | Not provided. It is noted that there is a need to assess quantitative changes. | Not provided. It is the prerogative of management accounting. | A system for accounting for the supply and use of ecosystem assets and their services is described. |
| **Measu-rement concept** | What valuation concept is accepted as the basic method-logy of the research? | The principle of cost. | The concept of fair value. | The concept of exchange value. |
| **Method for measuring ecosystem assets and their changes.** | What methods for measuring value are recommended? | Actual cost. The application of net realizable value is provided for in accounting under IFRS (IAS 41). | Fair value or based on income (net present value method - NPV) or market approaches. It is accepted as a priori. It is noted that it can be challenged, but only at the initial recognition of a biological asset for which there are no market quotations. | NPV method. The complexity of assessing ecosystem assets in agriculture is noted, as they are used to generate income. This requires a balanced accounting of ecological factors and economic factors (consumer demand) that influence economic decision-making regarding ecosystems. |
| **A method for measuring ecosystem services and their changes** | What methods are recom-mended for measuring the value of ecosystem services? | Not provided. | Not provided. | Based on the concept of exchange value, the priority method is NPV |
| **Change in the quantitative state of ecosystems** | Are changes in the quantitati-ve status of ecosystems taken into account? | Not taken into account. Only the modification of biological assets under the influence of biological transformation (growth, degenera-tion, reproduction, production of agri-cultural products) is considered. | Not taken into account. It is provided that managing changes in agriculture contributes to the process of biotransformation. The accounting for changes is conducted concerning the modification of biological assets under the influence of biological transformation (IAS 41) and within the framework of calculating the depletion of mineral reserves (IFRS 6). | It is an important element for integrating data on the state of ecosystems. |
| **Change in the value status of ecosystems** | What are the reasons for changes in value? | Information is absent. It is provided that biological transformation leads to the devaluation of long-term biological assets. | It is usually caused by their devaluation and depletion. It is provided that biological transformation leads to the devaluation of long-term environmental assets, the restoration of which is regulated by IAS 37 and IFRIC 1. | Caused by degradation, transformation, and revaluation. |
| **Recognition of natural capital** | Should natural capital be recognized as part of the elements of financial reporting as a component of business capital? | Not provided. | The capital method is applied regarding the contributions of non-financial participants in agriculture (IAS 20). For ecosystem resources, this method is excluded (IAS 41). | Not considered separately. However, it is a tool of the SEEA for implementing the SDC, which requires the opening of an account and recognition of natural capital as a driving force for ecological business activity. |
| **Disclosure of information** | What is the purpose of the information disclosure process? | It is defined by the need for economic decision-making by a wide range of users. | It is determined by reporting requirements aimed at assessing the value of the business and its economic impact on society. | The information goes beyond standard economic production functions. The goal is to improve the quality of data for analyzing the state of ecosystems and to ensure a structured connection between them and the economic aspect of agriculture. |

Source: developed by the authors.

In this regard, it is appropriate to emphasize the particularity of SEEA, which focuses on developing a special accounting system for ecosystem assets and their services used by agribusiness, as well as preparing managerial and statistical information and presenting it in the relevant reporting. At the same time, the role of financial accounting and reporting is recognized in the context of decision-making. Furthermore, the emphasis on statistical information does not contradict the IFRS methodology [29]. Sokolov asserts that IFRS are not focused on accounting but rather on the formation of microstatistics or statistics of individual businesses, whose reporting is statistical reporting built through the processing of accounting data [29]. The statistical nature of the data in IFRS reporting is indicated by the requirement for comparability and the use of the retrospective method for correcting errors. It should be noted that this viewpoint does not represent an innovation in accounting methodology or a criticism of IFRS. The well-known scholar and developer of the static balance concept, Sher, interpreted accounting as a branch of mathematics, and the balance sheet as a collection of statistical data characterizing the assets and liabilities of a business. The above substantiates the validity of Hypothesis *H2*.

It is evident that to the extent there is convergence between IFRS and SEEA, there is divergence between the National Accounting Standards and SEEA. Based on the above, it can be concluded that the National Accounting Standards system is based on classical accounting methodology, oriented towards the continental accounting model. Currently, there are no prerequisites for the implementation of SEEA and the presentation of useful information regarding the state of ecosystem assets in financial reporting, including in agribusiness (*Hypothesis H1*).

In this regard, it is hard not to agree with the position of the Natural Capital Coalition, which states that the integration of IFRS and SEEA, while challenging, is possible [6]. Limitations are associated with the provision of truthful information in the preparation of financial statements due to objective difficulties in obtaining data, particularly regarding the value of ecosystem services, which are influenced by market factors such as consumer demand, as well as non-market factors such as scarcity and natural disasters. At the same time, these difficulties should not hinder the search for solutions to the problem of accurately assessing ecosystem assets and their services.

**3.Development of key indicators related to climate change resulting from the interaction of agribusiness and environmental ecosystems.**

The Strategy 2030 defines the long-term goal of ensuring the fundamental right to a healthy and safe environment. Its achievement is aimed at neutralizing the environmental crisis and should be implemented by integrating the following policies into the production processes of national industries, including agribusiness:

- Monitoring and evaluation of environ-mental factors' quality in accordance with international requirements;
- Management of the quality of ecosystem services;
- Accounting for and managing the impact of the economic sector on ecosystem assets that contribute to reducing environmental risks [19].

To implement these policies, specific indicators are required, but despite the growing need for climate change-related information, users still face challenges in obtaining relevant data [32].

It is clear that the formation of value indicators characterizing natural phenomena and the economic factors influencing them, as well as the contribution of environmental resources to the production of consumer goods, is a rather complex process that requires the application of modernized measurement methods [2; 26].

Meanwhile, SEEA provides a description and recommends the use of some of these methods for both ecosystem assets and ecosystem services.

However, a set of indicators based on statistical data can serve as a starting point for obtaining the necessary information on changes in the state of ecosystem assets, and

more broadly, on climate change. This approach is outlined in the Guidance on the role of national statistical offices in achieving national climate goals [33], which states that the process should begin with the statistics and data already available, followed by creating a community of users and starting a discussion on the relevance and use of the data. There is already a practice of forming such indicators — a set of key indicators and statistical data related to climate change. Moreover, the document of the United Nations Economic Commission for Europe [13] states that environmental accounting can be used to monitor and analyze a wide range of environmental issues, including climate change, although there is no specific climate change accounting within SEEA-CF. The set of key climate change-related indicators, calculated based on SEEA, serves several purposes:

a) providing a clear picture of the most pressing climate change issues;

b) addressing the most relevant current policy questions;

c) assisting in meeting future information needs.

The most characteristic indicators of an ecosystem such as land, on the basis of which the impact of agribusiness on its condition and vice versa is to be assessed, include:

- total area of land use overall and by category;
- area of degraded land and area of restoration;
- area of reclaimed land; amount of waste (emissions) generated; amount of waste (emissions) used or treated.

Table 3. Set of Statistical Indicators for Assessing the Condition of the Ecosystem and the Contribution of Agribusiness to its Maintenance

| n/n | Indicator | Qualification of ecosystem condition indicators | | | | | Base of calculation |
|---|---|---|---|---|---|---|---|
| | | factors | emissions | impacts | consequences | adaptation | |
| 1 | Loss of land covered by natural vegetation | v | | | | | SEEA: Earth as an ecosystem |
| 2 | Total greenhouse gas emissions (CO2) resulting from agribusiness | v | v | | | | SEEA: Emissions into the atmosphere |
| 3 | Greenhouse gas (CO2) emission intensity resulting from production:<br>▪ from fuel combustion<br>▪ from land use changes | v | v | | | | SEEA: Emissions into the atmosphere (monetary valuation is difficult) |
| 4 | Carbon stocks in soil | | | v | | | SEEA: Complexity of carbon accounting (monetary valuation is difficult) |
| 5 | The ratio of degraded land area to total land area | | | v | | | SEEA: Earth as an ecosystem |
| 6 | Direct losses in agribusiness caused by ecosystem degradation (natural climate disasters) | | | v | | | SEEA: Secondary ecosystem resources |
| 7 | Share of expenditures on disaster risk reduction | | | | v | | Accounting data |
| 8 | Share of expenditures on resource and transportation taxes in the total volume of taxes and social security contributions | | | | v | | Accounting data |
| 9 | Total volume of subsidies and similar transfers related to ecosystem degradation | | | | v | | Accounting data |
| 10 | Net emissions (absorption of dioxide by soil) | | | | v | | SEEA: Complexity of carbon accounting (monetary valuation is difficult) |
| 11 | Share of agricultural land area where productive and sustainable farming methods are used | | | | | v | SEEA: Earth as an ecosystem |

Source: developed by the authors based on Conference of European Statisticians' Set of Core Climate Change-related Indicators and Statistics Using the System of Environmental-Economic Accounting (2020) [39].

Important indicators of agribusiness's contribution to overcoming the environmental crisis include payments for the use of natural resources. It is important to note that all the listed indicators are regularly presented in the official materials of the National Bureau of Statistics of the Republic of Moldova.

Using the core set of climate change-related indicators and the characteristic indicators of the primary ecosystem interacting with agribusiness, we will propose a set of statistical indicators for which a monetary valuation is possible (Table 3).

## CONCLUSIONS

A feature of agribusiness is the extensive use of non-financial resources – ecosystem resources of the environment, which on one hand contribute to societal well-being and income generation, while on the other hand degrade in the absence of a mechanism to maintain their condition. For the sustainability of agribusiness on a continuous basis, it is necessary to assess the condition of ecosystems and make investments to maintain their size. Meanwhile, the ecological crisis, including resource management issues, suggests that this condition is not being met. The result of the research is the justification of the proposed hypotheses and the synthesis of general and specific conclusions. However, the key results of the research are:

1) the development of a matrix for aligning accounting methodology and the SEEA concept in order to build an accounting system for a sustainable agribusiness model;

2) the identification of indicators for assessing changes in the condition of ecosystem assets in the context of their interaction with agribusiness and measuring the contribution of agribusiness to their maintenance in order to overcome the ecological crisis.

The matrix was developed using a three-stage algorithm: analysis of the provisions of each of the researched concepts; identification of criteria for comparison; formulation of explanatory questions to clarify the comparison indicator

As a result, the authors formulated the following conclusions:

-The model for achieving sustainability in agribusiness involves the need to develop and implement a comprehensive approach that includes four aspects: economic, ecological, institutional, and social.

-Based on the assessment of current trends, the authors consider the application of IFRS methodology to be a promising direction, which does not contradict the use of statistical information characterizing agribusiness;

-To the extent that there is convergence between IFRS and SEEA, there is divergence between national accounting standards and SEEA. It is clear that since the national accounting system is oriented towards the continental model of accounting, there are currently no prerequisites for the implementation of SEEA and the provision of useful information on the condition of ecosystem assets in financial reporting, including that of agribusiness;

-A starting point for obtaining the necessary information on changes in the condition of ecosystem assets, as well as on climate change in general, could be a set of indicators based on statistical data.

It is anticipated that the results obtained will provide businesses with a better understanding of the modern approach to shaping the informational framework of reporting, particularly regarding the recognition of mineral resources and natural capital, enabling investors to assess risks when making environmental decisions.

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