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ORIGINAL ARTICLE

Adaptive management reporting system in inter-organizational relations of agricultural enterprises according to ESG principles

Liudmila I. Khoruzhy*, Yuriy N. Katkov, Anastasiya A. Romanova, Ekaterina A. Katkova and Meri K. Dzhikiya

Russian State Agrarian University - Moscow Timiryazev Agricultural Academy, Moscow, Russia

ABSTRACT

Due to the lack of clear regulation of management accounting at the state level in Russia, the authors conducted a study based on an analysis of information sources, an expert survey on their reliability, and a case method, which resulted in a reporting form compiled for the production process of an agro-industrial enterprise (grain products) as part of inter-organizational company cooperation. The developed management reporting system (composed of eight consecutive stages: standard reports, specialized reports, itemized query reports, notification reports, statistical reports, prognostic reports, modeling results reports, and process optimization reports), on one hand, allows solving a set of tasks to increase the competitiveness of Russian agro-industrial enterprises within the framework of inter-organizational management accounting. On the other hand, the introduction of ESG principles into the management reporting system (calculation of the environmental (E) index, which assesses the company's impact on the natural ecosystem and covers emissions and efficient use of natural resources in the agricultural production process) increases the level of control and minimizes the risks of an unfair approach of individual partners to environmental issues.

Keywords*: agro-industrial complex; environmental, social, and governance (ESG); digital economy; simulation modeling*

1. Introduction

The study of economic security and the reduction of business risks of agricultural organizations is an unquestionable necessity for maintaining the competitive advantages of the agro-industrial complex (AIC) of Russia in current market conditions. The potential of inter-organizational cooperation in the AIC opens up new directions for developing instruments to support the economic security of inter-organizational cooperation and its participant enterprises. The additional latent effect resulting from the synergetic interaction of the partners in an inter-organizational group exceeds the cumulative effect of simply combined benefits of individual units of cooperation (Calandro, 2016; Khoruzhy et al., 2019; Formentini et al., 2022; Baxter et al., 2013; Ford and Mouzas, 2013; Kiss, 2020). In this study, inter-organizational cooperation is understood as a system of organizational-functional and process relations of economic entities united by common mutually

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*CORRESPONDING AUTHOR
Liudmila I. Khoruzhy,
Timiryazevskaya Ulitsa, 49, Moscow
127434, Russia;
dka1955@mail.ru

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beneficial goals, which are achieved by virtue of the synergetic effect of partnership with a high level of business culture and built on a voluntary and fiduciary basis.

Adaptive management and the most recent "adaptive co-management" have emerged as practical approaches to this process of continuous learning (Colfer et al., 2011; Smith, 2011; Velázquez et al., 2009). These approaches require participants to transition to process-oriented activities (Sayer and Wells, 2004). This, on one hand, necessitates changes in the understanding of each participant's autonomy. On the other hand, it calls for the collaborative identification of problems and the development of common goals and a joint control, monitoring, and funding system (Kristijono et al., 2022). This binds stakeholders to long-term iterative processes, both holding them accountable and increasing their powers. In the framework of the current study, we believe that the implementation of adaptive co-management in practice poses a number of problems, particularly the problem of proper management accounting. Whereas financial accounting is introduced and developed from the start of the company's operation, management accounting is implemented in the already operating enterprises. This entails an array of problems with setting up and organizing management accounting. Inter-organizational management accounting assumes its implementation in already operating companies, and the level of development of partners may differ significantly. This is the cause of the problem our study aimed to address, specifically the problem of forming an efficient adaptive management reporting system in the inter-organizational cooperation of agro-industrial enterprises. At the core of this issue is the realization of an effective system of providing information to various levels of executives of AIC enterprises to provide environmentally reasonable operational and strategic managerial decisions to improve the competitiveness of agro-industrial enterprises and reduce the business risks of their economic activities with environmental, social, and governance (ESG) principles taken into account. From our perspective, the most challenging aspect of implementing a management reporting system as part of the inter-organizational cooperation of agro-industrial enterprises is the partners' understanding of opportunities and the need to follow ESG principles, especially in the context of the business environment in which agro-industrial enterprises operate.

2. Review of literature

Approaches to the interpretation of inter-organizational cooperation were proposed by various social scientists and changed over time (Stock et al., 2014). The inter-organizational level of management accounting

as a tool to reduce business risks is not elaborated and requires detailed research to form a comprehensive and effective model of a system of management accounting of agricultural activities in the direction of risk minimization (Qrunfleh and Tarafdar, 2013; Henneberg et al., 2006; Hingley, 2005; Ramos and Ford, 2011; Lin, 2013; Khoruzhy et al., 2018, 2019).

Thus, the need to consider not only economic but also ESG criteria in making corporate decisions, and often all of them in combination with sustainable development goals, has led to the emergence of new, responsible financial instruments, products, and technologies using ESG criteria: 1) integration of ESG criteria into financial decisions, i.e., finance that stimulates sustainable economic, environmental, and social development, and 2) finance related to any financial service that integrates ESG criteria into business and investment decisions for the benefit of both customers and society at large (Alkaraan and Northcott, 2006; Starks et al., 2018). Big businesses have recognized the existence of global environmental concerns (Hutchings and Deegan, 2022). ESG principles are called to define the values of companies, models of their management, and conformity of their strategies in achieving the goals of sustainable development through the conduct of their own business (Nugmanov et al., 2018; Suleimenova et al., 2021). Accordingly, environmental principles characterize the level of the company's functioning for the benefit of the environment (Hong et al., 2019). Russian agribusiness, especially representatives of the large segment of the industry, is increasingly trying to introduce ESG principles in the development of entrepreneurship. They provide for stabilization and progressive development, including the environmental component of agribusiness. Its primary aspect is defined as a mechanism for the use of natural resources in economic activities, through which the needs of mankind would be met, considering the need to preserve the environment for future generations. The application of ESG criteria, including in agro-industrial production, is debatable. In particular, Amel-Zadeh and Serafeim (2018) focused on the use of ESG criteria when forming an investment portfolio, and Gibson, Krueger, and Schmidt (2019) shifted the emphasis in the use of ESG criteria on the investment decision-making process.

Christensen, Hail, and Leuz (2019) offered a comprehensive review of academic research on accounting and finance, in which they suggested that there is a significant difference in the disclosure of the ESG factors based on which firms carry out accounting of their activities. This situation can make it somewhat difficult to objectively compare the ESG practices of different companies. The authors considered challenges for regulators regarding the creation and implementation of reporting standards. The literature analyzed confirms that improvement in the quality and quantity of ESG data will bring benefits to capital markets in the form of higher liquidity, lower cost of capital, and a better allocation of capital (La Notte, 2022; Reidsma et al., 2015; Lutfi et al., 2022). Studies also pointed to the fact that corporate disclosure is accompanied by additional commercial and legal costs (Amel-Zadeh and Serafeim, 2018; Auganbai, et al., 2019; Ghosh and Wolf, 2021). The preparation of mandatory ESG reporting will pose difficulties in its implementation in terms of the definition of ESG standards, the materiality of disclosure of ESG data, and the use of standard wording in firms as a means of evading the essence of the issue and the difficulties of enforcement (Pedersen, et al., 2021). Christensen, Hail, and Leuz (2019) believed that success can be achieved through a combination of voluntary declarations of obligations by the private sector and enforcement requirements by regulators. Kotsantonis and Serafeim (2019) provided an assessment of sustainable investments at equilibrium and concluded that providing ESG benefits increases the asset and share prices of green firms. Regarding the issues of incorporating environmental factors

into business operations, the authors argued that sustainable investing can have a positive impact by encouraging more investment in green firms.

Friede, Busch, and Bassen (2015) conducted a meta-analysis of 60 studies, combining more than 2,200 unique primary studies. The authors reported that 90% of scientific studies found no negative correlation between ESG factors and financial outcomes, among them 48% of studies with survey results and 63% of studies with meta-analysis showing a positive correlation.

Despite the extensive sample of examined studies that described several advantages of ESG, it is worth pointing out the challenges of the practical implementation of these principles. This concerns agriculture, since the use of ESG criteria in the process of making investment decisions is more difficult to implement in this area, in particular Russia. As shown by the events of recent years (restrictions due to the COVID-19 pandemic and the armed conflict in Ukraine), the main driver of change in the rural landscape in the coming decades is likely to be the intensity, spatial extent, and location of agriculture. The intensification of agriculture provides an opportunity to close the major gap in yields and difficulties in its distribution and delivery (Zartha et al., 2019). But the intensification of agriculture alone is hardly enough to meet the needs of a growing world population. The demand for grains, vegetable oils, and biofuels (as well as resources) will also compete with the need to expand the space available for agriculture. The increasing use of land and the inevitable expansion of land allotted to agriculture will together shape the effects on the environment. The way society responds to this, and the extent to which agriculture is constrained by measures to preserve environmental values, will not be determined at the global or even national scale. First of all, competition between agricultural and environmental goals will intensify within the ecosystem processes of agricultural enterprises and even within individual agricultural enterprises. Agricultural enterprises are no longer simple actors in the industry or the landscape (depending on the interpretation). They are now recognized as entities providing multiple values and services to different interest groups (Van Ittersum et al., 2009). Adaptive co-management is increasingly seen as the evolving result of ongoing negotiations in the frequent conflicts between the interests of the group. An effective management system that reduces the risks to business development, as well as the desire to follow the principles of ESG, will provide a framework by which the results agreed upon between the stakeholders can be achieved most effectively. It is necessary to develop tools, including a management accounting system, with which to solve the contradictory problems outlined by us. Certainly, the solution to these problems will mainly depend on the changing social and economic conditions, and even on the political desires of the partners, and the solutions will vary from situation to situation. Yet, practice shows that at the current stage of business development, it is impossible to organize effective work without an effective management system.

Thus, the purpose of this study was to develop the foundations of adaptive management accounting for an inter-organizational partnership at the operational level with consideration of the principles of ESG in the context of national principles of regulation of agricultural formations.

2.1. Research questions

To achieve the goal, the following research questions were posed:

1. What are the possible mechanisms of effective inter-organizational cooperation of agricultural enterprises with the development and implementation of adaptive management reporting

in inter-organizational cooperation as a tool to support business processes and follow ESG principles with consideration of the national conditions of the development of the agricultural market?

2. When building an adaptive management accounting system, how is it necessary to keep records of compliance with ESG principles?

The research questions necessitated the need to solve a number of interrelated objectives:

1. To conduct a theoretical analysis of the degree of study of the problems of adaptive management reporting at the operational level and to develop a model of adaptive management reporting within the framework of inter-organizational management accounting of agricultural organizations considering ESG principles.

2. To develop elements of management reporting that ensure adaptability at the operational level of inter-organizational cooperation and meet the changing conditions of the external environment with consideration of ESG principles.

3. Methodology

3.1. Research approach

The research publication strategy was based on a mixed approach using qualitative and quantitative methods. The study was conducted in 2021–2022 at Timiryazev Academy and on one of the partner agro-industrial companies (consisting of three partner companies), which was the crop production unit herein named as “Liliia” (Lipetsk region, Russia).

Approaches to mixed methods research are gaining popularity in various social sciences. From a methodological point of view, blended approaches expand the set of research designs and methodological tools available to development scientists, including in terms of sample and recruitment of participants, levels of analysis, and discovery of new and important insights for both theory and practice. A mixed methods research approach can use qualitative methods (e.g., document analysis, case method) to collect information about the opinions of community members throughout the research process, as well as quantitative methods (e.g., surveys) to increase the reliability of research results (Mertens, 2007; Shanks and Bekmamedova, 2018). In general, mixed methods research allows one to better consider management issues and development prospects in complex social dynamics, which is crucial when exploring issues related to understanding social values for business, including issues related to the implementation of ESG principles.

Based on the established goal and the selected methodological approach, the study used the following research methods: analysis of documents and information sources with an expert survey to assess their reliability, along with the case method. Qualitative research methods prevailed in our study.

3.2. Research stages

In the first stage of the study, the selected information was grouped by the type of document. The first group of information sources consisted of studies devoted to the problem of inter-organizational cooperation. The second group was devoted to the consideration of the problem of management

accounting in organizations (including those in the AIC). The third group of information sources included expert opinions of researchers regarding business risks inherent in the sphere of agro-industrial production and the practice of observing ESG principles in making corporate decisions. The considered sources of information were articles from scientific peer-reviewed journals from Scopus and Web of Science published in the past 15 years.

In consideration of the limitations of the document analysis method (the quality of the selected sources, their completeness, and the subjective positions of the authors), at the second stage, an expert survey was conducted to assess the reliability of the selected sources.

The second stage of the study involved contacting 40 experts in management accounting in agricultural enterprises and agro-industrial enterprises. The criteria for the selection of experts included at least 10 years (30%) of experience in the areas under consideration or the presence of at least three articles (70%) on the subject published in the journals cited in Scopus or Web of Science databases. We consciously gave preference in the evaluation of our materials to researchers with academic experience, since they are more involved in tracking changes at the international level of research in this area. In turn, experts with extensive experience have the skills and tasks that they have accumulated based on practice and on life and professional experience.

At the first stage, the experts were asked to assess the reliability of the materials collected for the study via email. The participation of experts in this study increased the reliability of the information collected based on external criteria. For the purpose of the expert survey, a questionnaire containing 10 questions was designed to evaluate the documents selected for the study. The experts presented their assessment using the Harrington scale (Park and Park, 1998). Two of the questions in the survey were open-ended, allowing experts to make suggestions on changing the number of information sources, as well as justify their answers and suggestions. The results of the expert assessment are summarized in **Table 1**.

The experts were emailed the survey at the same time and given five days to fill it out and respond. The cover letter addressed to the experts outlined the objectives of the study and assured participants that the study would be kept confidential. Four of the experts declined to answer, citing their busyness. The experts' assessment of the selected documents averaged at a high level (according to the Harrington scale, the "high" value is in the range from 0.64 to 0.8). At the third stage of the study, the selected sources of information were analyzed. The conducted analysis was used to determine the conceptual apparatus of the main terms of the study, the consideration of ESG principles in management accounting, the composition of the management reporting system as part of inter-organizational management accounting, and the directions of analytical processing of the costs of inter-organizational cooperation of AIC organizations, as well as to develop a solution to

Table 1. Generalized data on expert assessment of reliability of information sources

N	Key characteristic	Result
1	Number of emails sent to experts	40
2	Number of responses received from experts via email	36
3	Average reliability of information sources	0.72 points
4	Number of new information sources added by experts	5 pcs.

the problem of building operational management reporting.

At the fourth stage, to study the experience of companies in creating a management accounting system, as well as to test the proposed method in practice, we used the case method. The case in question covered the experience of an AIC enterprise, specifically one of its divisions, "Liliia", located in the Lipetsk region. The subdivision engages in the cultivation of grain and interacts with various partners in this area. The agro-industrial company engages in building a management reporting system. "Liliia" was chosen as the study object among the enterprises of the agro-industrial sector experiencing difficulties in management accounting. The company's management is in search of a solution to the situation. The process of collecting information in the unit can be divided into several stages. At the first stage, we interacted with the leadership of the company. In particular, we conducted nine in-depth interviews (with the CEO, chief accountant, accountants, production director, information security manager, and development director). In-depth interviews were used to obtain information about the main needs in the implementation of management accounting systems and the main problems that hinder their implementation. At the second stage, we examined the main flow of documentation, the types of documentation with which the division works, as well as the existing management accounting system used in the division. We were granted access to the main accounting reports, which are not trade secrets. These documents allowed us to better understand the peculiarities of the operation of the management accounting system in the practical activities of the unit and take them into account when approbating the system of management accounting in the inter-organizational relations of agricultural enterprises. At the third stage, we used the triangulation method. Triangulation was performed through the triangulation of researchers (Denzin, 1970) when several researchers participated in a project. Each of the researchers participated in the processing of information, after which a discussion was held on each topic, and information agreed upon with all participants in the study was entered into the report. The triangulation process allowed us to improve the credibility of the interview data as to whether it accurately reflected the condition of "Liliia" and the quality of the information obtained. All findings from the case study were documented in a research report. The financial indicators were stated in the currency unit (CU) at the rate of 1 USD = CU 55.

4. Findings and discussion

Based on the obtained results, it was concluded that the introduction of management accounting in agricultural enterprises at the inter-organizational level requires this process to be unified and formalized. In the practical operation of the company, this process is associated with various difficulties, complications, and issues **(Figure 1**).

In the absence of clear regulation of management accounting at the state level, such accounting should be conducted within the framework of intra- and inter-organizational provisions. What should be regarded as such local documents are the local normative acts of "Uniform Provision on Accounting Policy for the Purposes of Inter-organizational Management Accounting", "Provision on Inter-organizational Management Accounting", and "Manual or Recommendations on Inter-organizational Management Accounting in the Organization". The efficiency of management accounting, as well as the feasibility of adopting an additional accounting system, can be estimated through the effectiveness of accounting tools, with a special place reserved for management

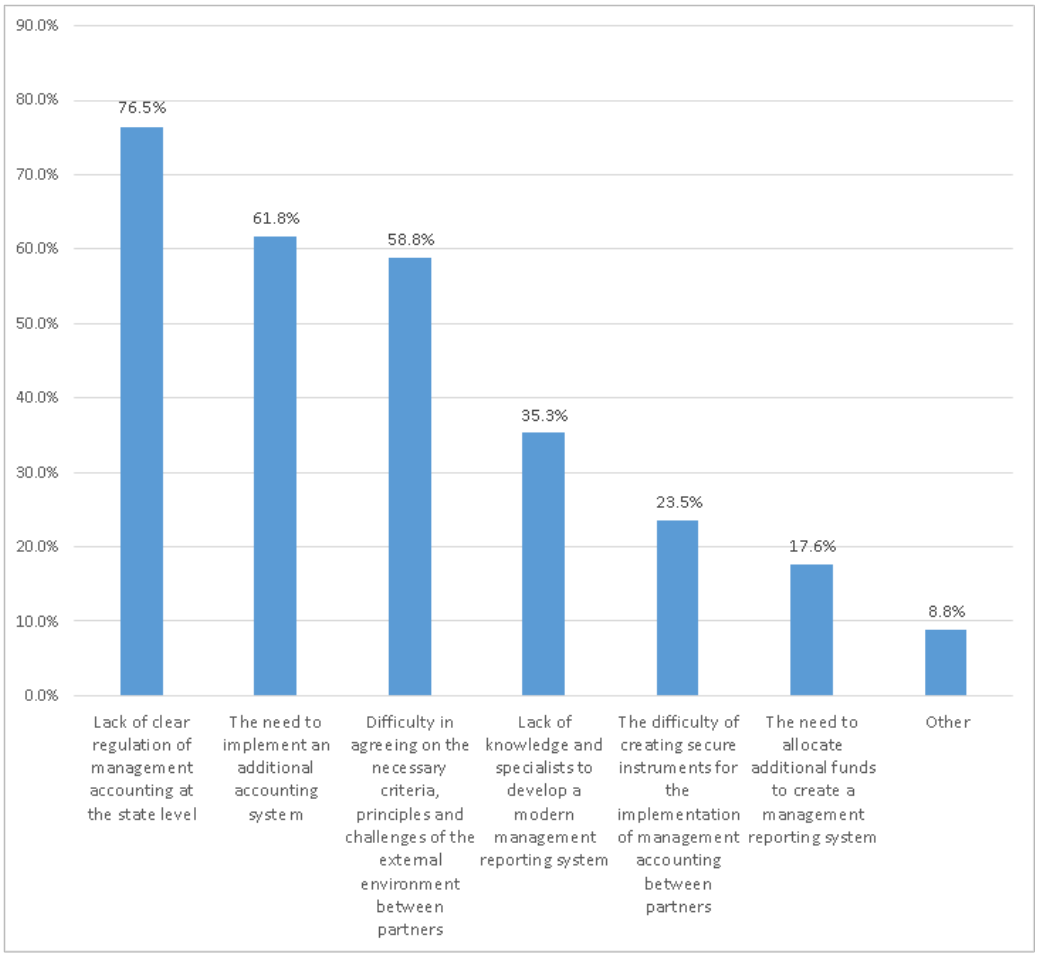


Figure 1. Main difficulties of implementing inter-organizational management accounting

reporting. At the intra-organizational level in agricultural enterprises, management reporting as a category presents an autonomous centralized system of itemized and specified information on the company's property status, capital, liabilities, revenues and expenses, facts of business life, their results, and the conditions of the internal and external environments that influenced the results of cooperation, including the principles of ESG. The unification of reporting forms and indicators in them resolves a number of issues associated with the heterogeneity of the partners' information bases and the different levels of development of the companies' information environments. A system of management reporting for inter-organizational relations has to address a set of issues, both at the primary and the collaboration levels. For this reason, the reporting system has a staggered hierarchical structure, the levels of which are interdependent and interconnected. Each element responds to the main subgoals of inter-organizational cooperation, which necessitates including each report in the management reporting system (**Figure 2**). The management reporting system of the inter-organizational management accounting system begins to form at the level of the individual partner (Stage 1 – Standard Reports), where, at the primary stage, the incoming information is registered by entering it into the system. This stage is carried out directly by the persons charged with the task at the level of the individual organization responsible for organizing the management accounting of inter-organizational cooperation. The result of this stage is the formation of standard reports, which are regulated by the accounting policy of inter-organizational management

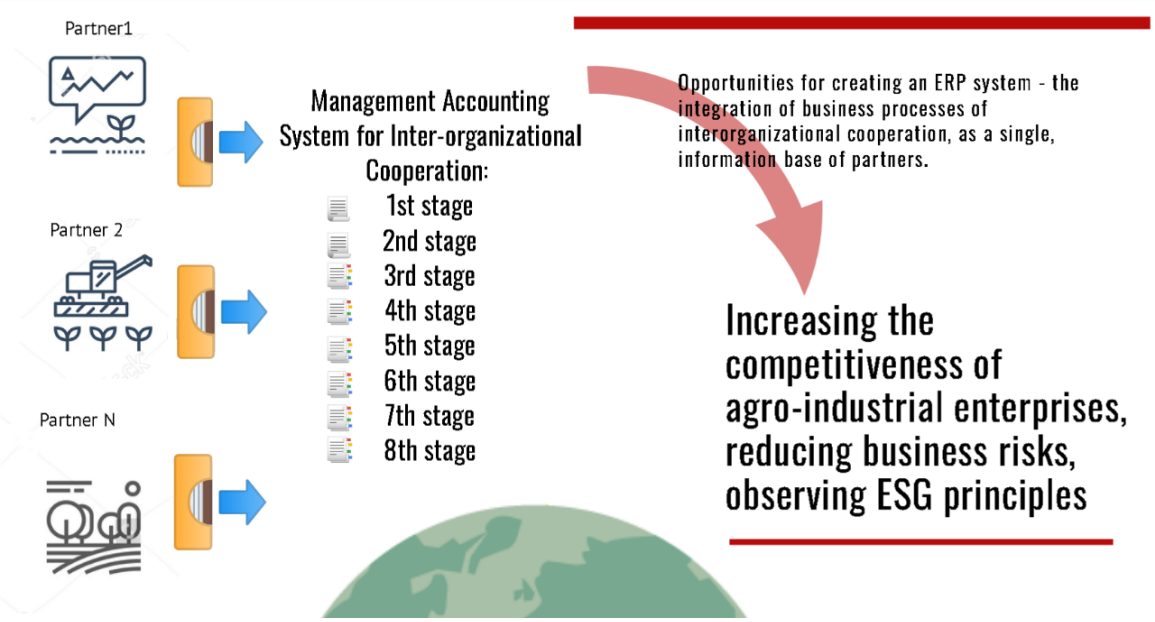
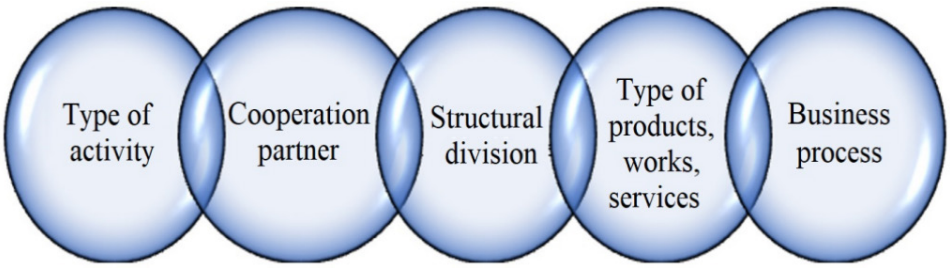


Figure 2. Graphical representation of proposed system of management reporting for inter-organizational relations



Source: Authors

Figure 3. Directions for analytical processing of costs of inter-organizational cooperation of organizations in AIC

accounting.

Kurmanova (2012) pointed to the need to form reports regarding the business structure of cooperation. This issue was addressed in the reporting system proposed by us and the Chart of Accounts of inter-organizational management accounting. The information reflected in the first-level reports allows making reports on the five key directions of analytical processing, according to the presented group of codes of the Chart of Accounts of inter-organizational management accounting (Stage 2 – Specialized Reports). The vectors of the analytical processing of costs in the system of inter-organizational cooperation are presented in **Figure 3**.

The digital form of management accounting allows displaying reports in the cross-section of five areas of analytics. Reports of the third level (Stage 3 – Itemized Query Reports) vary in their nature due to the fact that the formation of reports is contingent on the needs and challenges of the external environment. The reports become adaptive and are formed in an automated environment. The composition of reports is formed by groups of indicators, the relevance of which is identified based on the alarms triggered by deviations in the indicator analysis. As a result of the case study, we found that the most difficult issue in building an adaptive management accounting system

is accounting for compliance with ESG principles. Identification of the indicators necessary for inclusion into the management reporting system in the inter-organizational relations of agro-industrial enterprises is under discussion. In this, one of the key parameters from the point of observing ESG principles can be the calculation of the environmental index I, which assesses the company's influence on the natural ecosystem and covers the company's emissions, the efficient use of natural resources in agricultural production, pollution and waste, and innovative actions to implement the environmentally friendly design of products, wastewater discharges, and greenhouse gas (CO_2) emissions.

Compliance with these principles is supported by partnering agricultural firms. Due to sanctions imposed on Russia, the indicators will be adjusted depending on the requirements of the legislation. But their introduction into the management reporting system will increase control and minimize the risks of an improper approach to environmental problems on the part of individual partners.

As an example, we present the results of the case method. The case concerned the operation of an agro-industrial enterprise in agricultural production within the framework of intra-organizational collaboration. The agro-industrial enterprise is represented by three companies: Partner 1, Partner 2, and Partner 3. Synthetic accounts are represented by Material Costs (3100), Labor Costs (3200), Social Deductions (3300), Amortization (3400), Taxes and Fees (3500), and Crop Insurance Costs (3600). Analytical accounts, according to the Chart of Accounts in the management accounting account, are represented by the last two digits. Consider the example of material costs analytical sub-accounts to synthetic accounts:

- 00.00.00.00.0010 Seeds and planting stock
- 00.00.00.00.0040 Mineral fertilizers
- 00.00.00.00.0060 Fuel
- 00.00.00.00.0050 Petroleum products
- 00.00.00.00.0030 Plant protection products
- 00.00.00.00.0012 Costs of raw materials and supplies
- 00.00.00.00.0013 Costs of work and services performed
- 00.00.00.00.0014 Other material costs

Partner 1's grain division is called "Liliia" and, according to the Chart of Accounts, has the code 01.11.00.00.0000. The identified business processes in the production of grain by Partner 1 are shown in the reporting form in **Table 2**.

The fourth stage of reporting (Stage 4 – Notification Reports) logically completes the system of operative response to the change of economic conditions and financial and economic situations of the cooperation and participants in it.

At this stage, the operational group of reports is completed and the formation of a group of reports with a medium- and long-term perspective begins (**Table 3**).

At the same time, planning of the main environmental indicators should be carried out (**Table 4**).

Table 2. Itemized production report of Partner 1 on example of grain cultivation

Business process	Analytical cost item	Costs				Costs per 1 unit, rub.		Deviation (+/−)	Structural deviation
		Actual, thous. rub.	%	Plan, thous. rub.	%	Actual	Plan		
1. Pre-seeding tillage		41,693	21	35,390.7	19	10,845.8	9,206.4	1,639.4	2.1
2. Seeding		51,572	26	39,116	21	13,415	10,175	3,240.4	5.1
3. Crop maintenance		38,926	20	44,704	24	10,126	11,629	−1,502.9	−4.3
4. Harvesting		28,849	15	32,596	17.5	127.3	143.9	−16.5	−2.9
18 Transportation of grain		12,794	35	6,892	20	56	30	26	15
3100	Material costs	3,838	30	2,067	30.00	1.00	0.54	0.46	185.64
3200	Labor costs	4,477	35	2,412	35.00	1.16	0.63	0.54	185.64
3300	Social deductions	1,432	11	827	12	0.37	0.22	0.16	173.26
3400	Amortization	1,889	15	1,033	15	0.49	0.27	0.22	182.75
3500	Taxes, fees	1,155	9	551	8.00	0.30	0.14	0.16	209.60
3600	Insurance costs	0	0	0	0	0	0	-	-
20 Grain cleaning		23,761	65	27,567	80	105	122	−17	−15
5. Product refinement		36,555	19	34,459	18.5	161.3	152.1	9.3	0
Total		197,597	100	186,267	100	X	X	X	0

Table 3. Partner 1's detailed medium-term cost change plan for grain cultivation grain cultivation

Business process	Analytical cost item	Plan for changing costs for medium term (3 years), thous. rub.				
		1st year	2nd year	Cost change: 1–2 years, (+/−), %	3rd year	Cost change: 2–3 years, (+/−), %
1. Pre-seeding tillage		42,698	43,390.7	+1.62	44,112	+1.66
2. Seeding		32,872	31,116	−5.34	30,241	−2.81
3. Crop maintenance		37,926	38,704	+2.05	39,053	+0.9
4. Harvesting		27,749	26,596	−4.16	25,872	−2.72
18 Transportation of grain		6,794	6,692	−1.50	6,438	−3.80
3100	Material costs	3,838	3,767	−1.85	3,683	−2.23
3200	Labor costs	4,477	5,412	+20.88	5,988	+10.64
3300	Social deductions	1,438	1,827	+27.05	1,911	+4.60
3400	Amortization	1,889	1,533	−18.85	1,394	−9.07
3500	Taxes, fees	1,155	1,151	0	1,151	0
3600	Insurance costs	0	0			
20 Grain cleaning		23,761	22,567	−5.03	21,116	−6.43
5. Product refinement		36,333	34,459	−5.16	33,573	−2.57
Total		191,397	182,267	−4.77	173,541	−4.79

Table 4. Planned values of main environmental indicators for medium term

Environmental indicator	1st year	2nd year	3rd year
Wastewater discharge, m^3	1,224	1,135	1,097
Hazardous waste generation, t	2,960,048	2,683,345	2,497,635
Greenhouse gas emissions, tCO_2	6,524	6,358	6,142

Table 5. Key facts about cereals in low-income food-deficient countries (LIFDC), million tons (FAO, 2022)

Data categories		2019/20	2020/21 (estimation)	2021/22 (forecast)	Change: 2021/22 to 2020/21 (%)
Grain production (1)		189.2	196.1	185.9	−5.2
Usage	Total	239.7	249.5	253.0	+1.4
	Use in food	179.8	185.5	191.5	+3.3
	Stern	26.0	28.4	27.5	−3.2
Stock at end of season (2)		54.4	58.7	54.1	−7.9

Notes:
(1) Data refer to the calendar year of the first year shown
(2) May not equal the difference between supply and use due to differences in marketing years in individual countries

Table 6. The ratio of cereal reserves to use (FAO, 2022)

Indicator	Average values 2016/17–2020/21	2017/18	2018/19	2019/20	2020/21	2021/22
Ratio of world reserves to use (%)						
Wheat	37.0	38.5	36.4	36.7	37.3	37.1
Feed grain	25.5	27.3	25.6	24.2	23.4	22.6
Rice	36.0	35.3	37.2	36.5	36.4	36.4
Total grain	30.6	31.9	30.7	29.9	29.7	29.1
Ratio of major grain exporters to market requirements (%)	119.5	122.8	116.8	118.6	115.7	114.3
Ratio of stocks of major exporters to their total use (%) (1)						
Wheat	18.0	21.0	18.1	15.5	15.5	15.2
Feed grain	14.4	15.5	15.7	14.5	11.8	12.2
Rice	22.8	18.1	22.8	26.4	27.7	28.3
Total grain	18.4	18.2	18.9	18.8	18.4	18.6

Note:
(1) Use is defined as the sum of food, feed, and other uses and is defined as domestic use plus exports for any given season

Table 7. Annual increase in cereal production (FAO, 2022)

Indicator	Average growth rate 2011–2020	2017	2018	2019	2020	2021
Annual increase in world cereal production (%)	1.8	1.1	−1.8	2.4	2.3	0.7
Annual increase in cereal production in countries with economies in transition (%)	3.2	1.6	4.3	2.9	4.0	−2.4

Table 8. Cereal price indices (FAO, 2022)

Indicator	2018	2019	2020	2021 (average value at beginning of year)	Change from 2020 to 2021 (average at beginning of year)
Selected cereal price indices (1)					
Wheat	95.3	100.7	132.1	151.2	27.3%
Corn	94.6	100.8	144.8	156.7	12.2%
Rice	101.5	110.2	105.8	102.0	−11.5%

Notes:
Cereals refer to wheat, coarse grain (barley, corn, millet, sorghum, and NES cereals), and rice.
(1) Wheat price index is based on IGC wheat price index adjusted for 2014–2016 = 100. The coarse grain price index is based on IGC price indices for corn and barley and one export quotation for sorghum adjusted for 2014–2016 = 100. For rice, data refer to the FAO All Rice Price Index, 2014–2016 = 100, which is based on 21 rice export quotations.

Table 9. Summary table of indicators of world grain market (FAO, 2022)

Years	Production (first year), mln. tons	Production plus initial stocks, mln. tons	Consumption, mln. tons	Exports, mln. tons	Ending stocks, mln. tons	Ratio of world stocks to consumption (%)	Ratio of stocks of major exporters to their disappearance domestic consumption + export (%)
World grain market							
2016/17	2,665.2	3,454.9	2,630.1	406.9	823.8	31.0	17.8
2017/18	2,694.5	3,518.3	2,659.8	423.0	856.5	31.9	18.1
2018/19	2,645.7	3,502.2	2,687.7	411.1	832.2	30.7	18.8
2019/20	2,712.9	3,545.1	2,711.9	439.1	824.3	29.9	18.7
2020/21	2,776.7	3,601.0	2,758.8	479.0	833.0	29.9	18.4
2021/22	2,799.3	3,632.2	2,784.9	473.1	855.9	29.9	19.9
World wheat market							
2016/17	763.4	1,006.2	736.7	177.1	265.9	36.0	19.8
2017/18	761.5	1,027.4	738.7	177.8	289.2	38.5	21.0
2018/19	731.4	1,020.5	750.1	168.6	273.9	36.5	18.1
2019/20	759.8	1,033.7	749.8	183.8	280.9	37.0	15.5

Table 9. (*Continued*)

Years	Production (first year), mln. tons	Production plus initial stocks, mln. tons	Consumption, mln. tons	Exports, mln. tons	Ending stocks, mln. tons	Ratio of world stocks to consumption (%)	Ratio of stocks of major exporters to their disappearance domestic consumption + export (%)
2020/21	776.7	1,057.5	759.8	189.2	292.1	38.2	15.5
2021/22	776.6	1,068.7	765.2	191.0	304.3	39.0	17.3
World feed grain market							
2016/17	1,404.8	1,779.2	1,398.7	181.4	384.1	27.0	14.6
2017/18	1,433.1	1,817.2	1,423.1	196.7	390.4	27.2	15.3
2018/19	1,406.1	1,796.6	1,436.4	198.4	371.9	25.5	15.6
2019/20	1,450.2	1,822.2	1,460.8	209.6	357.1	24.0	14.2
2020/21	1,483.0	1,840.1	1,487.6	238.4	350.3	23.4	11.6
2021/22	1,501.9	1,852.3	1,498.9	228.7	358.9	23.0	13.4

The fifth stage (Statistical Reports) deals with statistical indicators, which calculate the model of cooperation development, taking into account the global, regional, and local trends in the environment of inter-organizational cooperation. For indicators of world trends in the external environment, data from the Food and Agriculture Organization (FAO) of the United Nations can be used (**Tables 5**, **6**, **7**, **8**, and **9**).

The sixth stage (Prognostic Reports) completes statistical research in the form of primary forecasting for the short-term period. At the seventh stage (Modeling Results Reports), factors of the external and internal environments are superimposed, taking into account cause-effect relations, and the analytical model is developed using the simulation modeling method. The final step (Stage 8 – Process Optimization Reports) is the results of the validation of the model. Several recommendations and measures to improve the existing system are developed. It needs to be noted that in the current conditions, increased attention is drawn to the issue of information risks faced by the users of the management accounting of agricultural enterprises, which are directly shaped by the risks of the management accounting system. In the study by Ramos and Ford (2011), it was found that the management accounting system serves as a tool for managing the risks of the enterprise, as well as a source of professional risks for the employees of managerial bodies. At the same time, it is difficult not to agree with Qrunfleh and Tarafdar (2013), who noted that accounting and analytical information is a resource for managing the business risk reduction system of the agricultural enterprise and that this information is formed in the implementation of three management functions: accounting, analysis, and synthesis. According to them, the current system of accounting and analytical support for the financial security of agricultural enterprises is in need of new substantive content as a complex of interacting and interrelated methods, techniques, procedures, and models designed to substantiate managerial decisions in the field of financial security of the enterprise. It has to incorporate all instruments of accounting and analysis without exception to obtain a synergetic effect from their systematic use in ensuring a stable and sustainable financial position of the enterprise, balancing financial and material flows and settlement relations,

neutralizing the influence of internal and external threats to the financial and economic conditions of the enterprise, and reducing the level of information and financial risks. The methodology of adaptive management accounting of an inter-organizational group at the operational level proposed in this study goes in line with the opinion expressed by Lin (2013). Researchers believe that the dominant aspect of the optimization of accounting and information support of the management of agrarian enterprises is the accounting of the features of inter-organizational relations in agricultural business, which indirectly and in many cases directly influence the specificity of accounting and economic parameters of agricultural business and the effectiveness of accounting and information support for management (Khan, 2022; Formentini et al., 2022). Many authors noted the need to integrate modeling into management accounting (Fadeeva and Nefedkin, 2021; Nishimwe et al., 2020). Simulation modeling of business processes is recognized as an integral element of inter-organizational management accounting (Baxter et al., 2013). The results of such modeling are actively utilized and included in reports at the seventh level. The reporting classification structure that we propose realizes in itself the possibility of comparing planned and actually incurred costs. This principle is consistent with the study by Horngren, Harrison and Oliver (2012), in which the researchers emphasized the integration of financial and management accounting combined with the possibility of autonomous functioning.

Cost planning in the Russian economy has its own peculiarities. Support of ESG principles is used by companies in Russia first of all to attract investment and to enter international markets, as well as to avoid penalties from the country's regulatory authorities. On the national scale, due to various economic, social, and political problems, among which are sanctions, high inflation, shortage of technological resources, underdeveloped legislation in the ESG sphere, and weak control over the observation of environmental norms, the ESG principles are sacrificed by agro-industrial enterprises to achieve short-term concrete benefits or the possibility of additional financial gain at the expense of saving the environment. This can occur not only at the level of individual units of an agricultural company but also at the national level. In Russia, a 2022 legislation lowered the requirements of environmental-friendliness for products and raised permissible emissions due to the introduction of external sanctions on international cooperation. The shortage of resources has forced the Russian government to change emission standards. Despite the contradictions and forced restrictions, compliance with ESG principles ensures a constant understanding of the role of agriculture in the functioning of modern society. In Russia, the agricultural sector is recognized as one of the main sectors of the economy and its stakeholders should consider the prospects and relevance of the industry for future generations.

Thus, the opinion of researchers is that the relationship between the implementation of ESG principles and the financial performance of firms has not yet been established, since the literature is full of conflicting results and paradoxes (Teh et al., 2022; Khan, 2022). However, it is believed that there is a trend toward the development of these principles at the international level, despite the difficulties in producing reports of sufficient quality, including ESG aspects (Jonsdottir et al., 2022). In the agrarian sphere, entrepreneurs are to focus on compliance with specific requirements regarding the preservation and increase of the productivity of land assets and biodiversity, the use of water resources, the limitation of the use of mineral fertilizers and chemical plant protection agents, the use of appropriate fuels by agricultural machinery and electricity in processing facilities, the ensuring of the welfare and health of farm animals, etc. (Shcherbak et al., 2020; Cong and

Khanh, 2022). Aside from the above, the principles of corporate governance and responsibility, good neighborliness of businesses with local territorial and community formations, as well as dissemination of best practices of ESG criteria compliance among suppliers and consumers of agricultural products must find their application in the operation of agribusinesses in the Russian and international markets as the basic rules of conduct and relationships. Compliance with ESG principles has to become one of the fundamental strategies for the operation of agro-industrial companies if they are focused on increasing the share of sales of goods in international markets (La Notte, 2022; Lutfi et al., 2022). Observance of ESG principles in the processing of crop and livestock products becomes the basis for the formation of a safe, nutritious system of food production, which can effectively prevent the problem of hunger. Agricultural production has historically served as a source of food production. In fact, it has followed technological innovations that could optimize and improve the use of relevant natural resources, in particular water, forests, and land, to pass them on to the next generations.

The primary goals of agribusinesses' compliance with ESG criteria should be defined as follows: 1) stability and mutual interest in the relations of large agricultural companies and farms, 2) training, consulting, and resource support for farmers; constant interconnection, assistance, and support on cost optimization; increasing productivity; product realization; resilience to climate change, etc., 3) improvement of the quality characteristics and preservation (increase) of areas of quality domestic soils, reasonable use of water resources, and increase of biodiversity, 4) consideration of territorial peculiarities and the formation of mechanisms to protect the interests of the population in the food system and the broad sphere of agro-industrial production, and 5) continuous development and implementation of innovations in the agricultural sector based on environmental strategies for the development of long-term relationships. The alignment of a project's organizational strategy with top management's expectations can be seen as more important than its apparent financial return.

5. Conclusion

The practical application of the proposed methods of forming the composition of management reporting within the framework of inter-organizational management accounting in agro-industrial enterprises will make partners' business processes more transparent, provide common approaches to management accounting, and ensure the linkage of indicators, thereby allowing to obtain reliable information on the effectiveness of an agro-industrial company. On one hand, our study contributes to the enrichment of the existing literature on management reporting within the framework of inter-organizational management accounting of agricultural formations. On the other hand, the results obtained make it possible to make partners' business processes transparent, provide unified approaches to management accounting, and obtain reliable information on the effectiveness of inter-organizational formation.

In particular, the unification of reporting forms and indicators embedded in them solves a number of problems associated with the heterogeneity of the information base of partners. This problem especially concerns the data taken into account when calculating the environmental index. The received data should be easily verifiable. Misunderstandings between partners create obstacles to the use of ESG data, i.e., lack of materiality, accuracy, and reliability.

Prospective further research works may focus on the analysis of the implementation of the

Enterprise Resource Planning (ERP) system in the management accounting of agricultural enterprises, which will facilitate the integration of business processes of inter-organizational cooperation as a single information base of the partners. Business process integration will enable the efficient development of ESG strategies. In particular, they will help increase the perception of environmental practices and help consumers and investors learn more about the performance of companies.

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