

Formation of the financial policy of Russian agro-industrial enterprises in modern conditions

*E.R. Zakirova**, and *A.D. Nazarova*

Ural State University of Economics, Ekaterinburg, Russian Federation

Abstract. Financial policy plays a key role in the management of agro-industrial enterprises, especially in the context of modern economic dynamics and changes. Currently, companies in the agro-industrial sector of Russia are at the stage of active growth, which is due to the systematic support from the state. There is a steady increase in the flow of investments, an increase in the number of new projects and investor activity. The introduction of Western sanctions led to a reduction in foreign investment due to the unstable political situation, but contributed to growth through import substitution programs. This article will examine how the financial policy of companies is formed as a result of investments in various sectors of agriculture. A fuzzy model for assessing investment risks in an agro-industrial holding for technical equipment using Fuzzy Tech technologies is also provided.

1 Introduction

The agro-industrial complex of our country continues its rapid development. Several stages have been passed from the moment of formation of market relations and complete devastation to import substitution. Despite the fact that the agro-industrial complex is a rather problematic industry, it is increasingly attracting the attention of investors.

Below we will consider how investments can influence the formation of the financial policy of agribusiness companies [1, p.21].

At the beginning of the XXI century, the agro-industrial complex of Russia faced a number of problems, including worn-out machinery and low yields. This situation had many causes and consequences, and its analysis is of interest for understanding the dynamics of the development of Russian agriculture.

Low efficiency and fewer jobs have forced many rural residents to migrate to cities in search of work. At that time, agricultural holdings began to form, government subsidies and access to financing from banks became an incentive for the development of agriculture. Government support and import substitution programs have contributed to the active growth of the agro-industrial complex (AIC). Financing of agriculture was associated with high risks, so it was carried out by state-owned banks, but only for large agricultural holdings, while small farms were left without support due to lack of collateral and low efficiency.

* Corresponding author: zakirer@usue.ru

Agricultural holdings have begun to consolidate land assets and create crop production companies to provide the main business with raw materials.

This transition was accompanied by a number of negative phenomena:

Worn-out machinery: many agricultural enterprises continued to use Soviet machinery, which at that time was already outdated and required replacement or modernization.

Insufficient investments: in conditions of economic difficulties and instability, the resource provision of agriculture was limited. Insufficient investments in the development of agriculture have led to a lag in the development of infrastructure, technology and agricultural machinery.

Low yields: the use of outdated machinery and technologies, as well as insufficient attention to scientific research and agricultural technology, led to low yields and low crop productivity.

Problems with personnel: during the period of economic difficulties, many qualified specialists in the field of agriculture left the industry, which also affected productivity and quality of production.

To overcome these problems, it was necessary to carry out reforms in agriculture aimed at stimulating investment, modernizing machinery and introducing modern agricultural technologies. Important steps in this direction were the creation of state programs to support agriculture, stimulate investment in the agro-industrial complex, subsidize land use and upgrade the fleet of agricultural machinery.

Financing of the agro-industrial complex (AIC) includes working capital and investment funds. Projects in the agro-industrial complex have long payback periods, often exceeding five years, requiring long-term financing. Some banks have established investment lending units that conduct a thorough analysis of projects: they assess the prospects, the sales market, the reliability of suppliers and risks. Long-term financing is becoming more common, especially with the increasing needs of agricultural holdings. There is a need for project financing, which requires in-depth analysis, since the key is the project itself, not the business. Seasonality, lack of qualified personnel and lack of a crop insurance system increase the risks. Large enterprises seek equity financing, as work on borrowed funds becomes ineffective due to the high debt burden.

In modern economic reality, especially in the context of the agro-industrial complex (AIC), there are significant changes in the policies of companies aimed at attracting investment and increasing competitiveness. These changes affect various aspects of management and financial activities, which play a key role in the sustainable development of the sector.

One of the main aspects of the changes is the transformation of reporting. The need to move from Russian accounting standards (RAS) to international Financial Reporting Standards (IFRS) requires the creation of specialized departments that ensure compliance with international accounting standards and ensure transparency for potential investors. The creation of an effective corporate governance system is an important change in the policy of agribusiness companies. The introduction of existing boards of directors and committees promotes more responsible and transparent management, which increases investor confidence and ensures effective strategic decision-making. The restructuring of companies plays a significant role in increasing their competitiveness. The formation of an understandable and effective shareholder structure, including the division into parent and subsidiary companies, helps to optimize business processes and increases attractiveness for potential investors.

The appearance of regulatory authorities under the public status of the company is another important step in ensuring transparency and responsibility to shareholders and the market as a whole. The supervisory authorities monitor the company's activities and limit its actions in the interests of shareholders and investors. The dividend policy is becoming an increasingly

important tool for attracting investments. The establishment of a clear policy on the payment of dividends, where part of the profit is directed to shareholders, creates additional incentives for investors and increases their interest in participating in the company's capital.

The growth in the flow of investments into the agro-industrial sector indicates an increasing interest in this industry [8, p.20]. According to Rosstat, the share of investments in the agro-industrial sector amounted to 3.8% of the total investment in the economy in the first half of 2022. These investments increase the activity of investors and contribute to the implementation of new projects, which in turn contributes to the further development of the agro-industrial sector as a whole. So, changes in the policy of agribusiness companies in the process of attracting investments are aimed at increasing transparency, management efficiency and competitiveness of the sector in the modern economic environment.

2 Analysis of the financial policy of agribusiness companies during the period of increased investment

Let's look at how the financial policy of agribusiness companies has changed during the period of increased investment. The introduction of Western sanctions stimulated the growth of investor activity in the agricultural sector. Large and medium-sized agricultural complexes began to increase, and even companies not related to agriculture invested in the opening of farms and the construction of greenhouses. However, due to economic instability and excess production, investments in agriculture have declined. Despite this, the sector is showing steady growth, supported by a short production cycle, understandable seasonality and steady domestic demand [9, p.2]. Many agricultural holdings continue to expand production. Investments and projects in agriculture have become more specialized, and are most often implemented by experienced agribusiness specialists.

Russian agriculture is attracting more and more foreign investors due to the availability of resources and low labor costs, as well as the availability of untapped opportunities. For example, Chinese investors are actively investing in the development of agriculture in the Russian Far East, especially in the cultivation of soybeans. Competition in this area is relatively low, and market participants have significant potential for growth. In addition, economic and political stability, as well as prospects for growth and development, are important for foreign investors. In this context, Russian agriculture presents an attractive investment opportunity.

During 2022, experts predicted a decrease in investments in the agro-industrial complex (AIC) and the suspension of some projects. At the moment, only the figures for the first half of 2022, published by Rosstat, are available. According to the report, investments in the fixed capital of agriculture of large and medium-sized organizations, as well as enterprises with up to 15 people, amounted to 228.5 billion rubles. It is impossible to make a comparison with the same period of the previous year due to the lack of data. The article noted that investments in the first half of 2021 amounted to 220 billion rubles. According to available data from Rosstat, there was a decrease in the physical volume of investments by 7.4%. Despite the difficulties, investors continued to announce new projects. Most of the suspension reports related to projects with foreign capital. According to Agroinvestor, since the beginning of the year, about thirty new large-scale projects worth more than 185 billion rubles have been announced. However, the implementation of these projects remains questionable and depends on a number of factors, including the economic and political situation.

Organizations and entrepreneurs engaged in the processing of wild fruits, berries, nuts, mushrooms will also be given the opportunity to receive preferential loans. These changes will be made to the order of the Ministry of Agriculture of the Russian Federation, which will determine the loan terms from 2 to 12 years. It is also planned to increase the term of the investment loan from 8 to 12 years for facilities producing dairy-based baby food. These

measures are aimed at supporting the development of various sectors of agriculture and stimulating investment in these industries (figure 1).

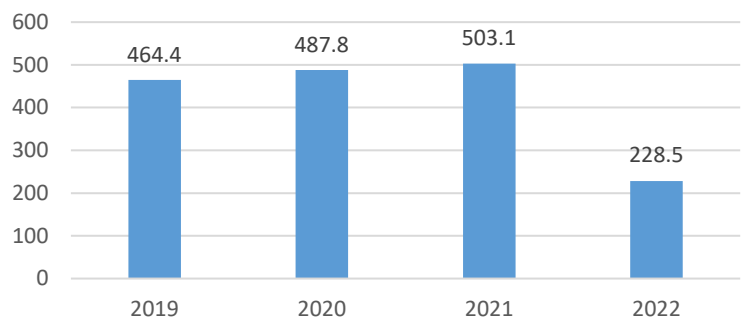


Fig. 1. Investments in fixed assets of agriculture [2].

Agriculture in Russia highlights new development prospects, especially in grain production, where investors are actively investing. Grain processing projects, logistics development and the creation of export terminals are becoming a priority. Experts identify the production of glucose and grain products, including native starch, as the most attractive for investment. Farmers are focusing on the deep processing of wheat into gluten and feed additives, which were previously imported. These projects attract the attention of investors due to the prospect of stable demand in the domestic market and export potential. Experts express confidence in the possibility of successful implementation of such initiatives and their ability to become competitive both domestically and on the global market.

According to the Federal Customs Service of Russia, about 38.1 million tons of grain crops were exported in the past 2023. The total amount of grain reserves of the federal investment fund for January 2023 is 135 million tons, totaling about 18,411.8 million rubles. The FAO forecast for global grain production in 2023 was revised upward this month by 13.2 million tons (0.5 percent) and is expected to reach a record high of 2,836 million tons. This figure is 1.2 percent (33.3 million tons) higher than in 2022. The share of wheat of the 3rd class was 23% (34% a year ago), wheat of the 4th class - 48% (44%). The share of Grade 5 wheat (forage) increased to 28% from 24% in 2022. At the same time, wheat of the 1st class (0.05%) and wheat of the 2nd class (0.04%) were also identified [2].

Raising the forecast of the gross harvest of grain crops in Russia for 2023 to 135 million tons in net weight. This forecast includes expected wheat production volumes estimated at 90 million tons. According to the Minister of Agriculture, Dmitry Patrushev, the projected harvest is considered one of the best, provided the weather remains favorable. Although this volume is slightly lower than last year's results, it is higher than the annual average. It is important to note that this year the desire to obtain a balanced harvest is a priority after the record figures of the previous period [10, p.32]. This harvest should satisfy the domestic market and contribute to the further development of grain exports. Experts predict a high grain harvest for 2023. The analytical company ProSerno estimates the total grain harvest in bunker weight at 140.2 million tons, including 90 million tons of wheat. These are significant figures, the second in terms of volume after the record harvest last year. Barley production is expected to reach 21 million tons, which is slightly less than in 2022, but still a high result. A corn harvest of at least 15 million tons is also projected, although the exact figure depends on the losses during harvesting. Record production of leguminous crops is expected - 5.8 million tons, almost 28% more than last year's figure.

The Center for Agroanalytics, subordinated to the Ministry of Agriculture, also calls the collection in 2023 the second largest in history. The record of 2022 was achieved due to an increase in the technological equipment of farmers, increased government support and favorable weather conditions (figure 2).

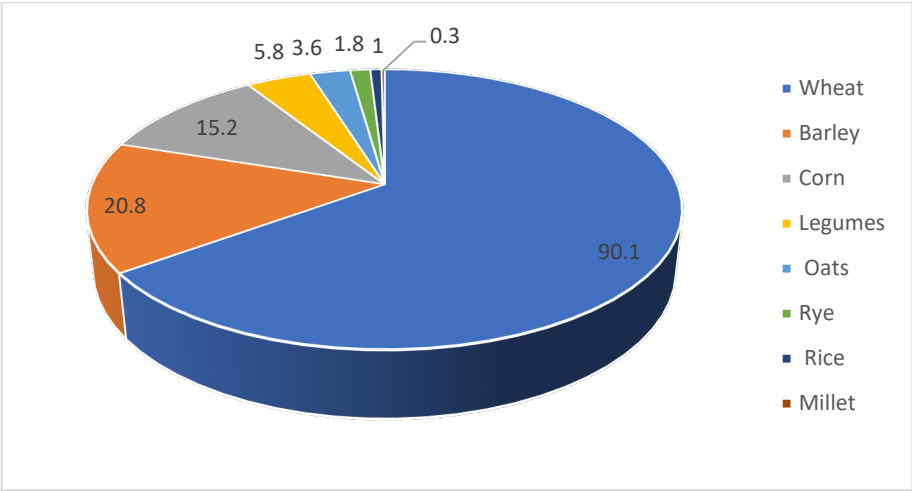


Fig. 2. Forecast of grain crops in 2023.

According to preliminary estimates of Soyuzmoloko, the production of commercial milk in 2023 increased by 4.2% to the level of 2022, to 21.7 million tons [3].

According to FGIS Argus, as of December 22, pork was exported to 14 countries, supplies increased by 6% to 154.4 thousand tons. Mutton was bought by seven countries, exports increased 11 times, to 10.3 thousand tons. Importers of Russian beef were 24 countries, exports amounted to 30.2 thousand tons. In addition, 301.7 thousand tons of poultry meat were shipped to 34 countries of the world. There is also a demand for horse meat on the world market: its exports increased 2.2 times, to 2 thousand tons. Finished meat products were delivered to 27 countries in the amount of 70.6 thousand tons. In 2023, the Russian Federation received the right to export venison to the UAE, some types of meat and dairy products to Pakistan and Afghanistan, milk and dairy products to Hong Kong, poultry meat to Algeria [4].

There are a number of areas where investments in the Russian agricultural sector are directed. In particular, a significant number of new investment projects were announced in the fields of greenhouse farming, dairy production, as well as in the field of processing oilseeds. Major projects for seed production and mushroom cultivation were also announced. New pig breeding complexes continue to be built in the country, but this is mainly carried out by major market players as part of the expansion of existing production facilities. Logistics and infrastructure remain one of the weaknesses of Russian agriculture, which makes investors' plans to launch new marine terminals for transshipment of agricultural products very attractive and still relevant. According to the press service of the Ministry of Agriculture, the federal project "Stimulating investment activity in the agro-industrial complex" provides support to agricultural enterprises through concessional lending and reimbursement of part of the costs of creating or modernizing agricultural facilities. In the first nine months of this year, 3.9 thousand investment loan agreements were concluded for a total amount of more than 3 thousand borrowers. Preferential loans are mainly aimed at the purchase of agricultural machinery. The second direction of the project (return on capital investments) also received government support. In 2022, 153 investment projects were

selected in 43 regions, for which subsidies in the amount of 7.8 billion rubles were distributed, mainly for the construction of dairy complexes.

The new state support measures proposed by the Ministry of Agriculture are aimed at stimulating the activity of investors in the agro-industrial complex (AIC). It is planned to amend the rules of preferential lending, including an increase in the loan term to 12 years for facilities producing dairy-based baby food for young children. It is also planned to increase the subsidization of interest rates on investment loans to 100% of the key rate of the Bank of Russia for the production of specialized medical nutrition products.

The financial policy of agro-industrial enterprises includes several key aspects. First, these are financing strategies that identify sources of capital for various projects and operations. Due to the instability of the global economy and the political situation, companies are forced to constantly adapt their financial strategies in order to minimize risks and maximize revenues. Agro-industrial companies should rationally allocate their investments between different business lines, taking into account potential profitability and risks. Investments in agriculture can be associated with the purchase of new equipment, development of production technologies, improvement of infrastructure and expansion of production capacities [11, p.9-8]. Working capital management includes the management of inventories, accounts receivable and payable, as well as working capital. Effective management of working capital allows companies to optimize their operational processes and ensure smooth financial flows.

3 Development of a fuzzy model for assessing investment risks

In the modern economic environment, agro-industrial holdings are faced with the need to invest in technical equipment to ensure competitiveness and production efficiency. The assessment of investment risks includes an analysis of factors such as economic instability and technological changes. The relevance of fuzzy investment risk assessment models for agro-industrial holdings is associated with the rapid development of technology and changes in the market. Traditional risk assessment methods may not be effective enough. Agro-industrial holdings face challenges such as changes in consumer demand and competition. Assessment of investment risks for technical equipment is becoming a key factor in successful business management.

The development of a fuzzy investment risk assessment model will allow agro-industrial holdings to more accurately assess and manage the risks associated with investments in technical equipment and increase their competitiveness in the market. These models are based on the theory of fuzzy sets developed by Lotfi Zadeh and provide tools for the mathematical description and analysis of fuzzy and indeterminate phenomena. Fuzzy control is based on the concepts of fuzzy logic and is used in complex process control systems [5]. Systems based on fuzzy logic are used to describe regulatory mechanisms and take part in calculating control actions [6, pp. 29-32]. Similarly, artificial neural networks are also used to solve problems of automatic control and regulation.

The model for assessing investment risks in agro-industrial holdings for technical equipment can be applied in various scenarios and situations in agriculture. Here are some specific examples:

Planning investments in new equipment: Before an agro-industrial holding decides to purchase new technical equipment, it can use a fuzzy model to assess potential risks. The model can take into account factors such as supplier stability, technical complexity of the equipment, expected volume of use and market factors, which will help manage the risks of the investment.

Optimization of equipment maintenance costs: Using the model, you can analyze the degree of risk associated with the maintenance and repair of technical equipment. This will

allow the holding to optimize budget expenditures, develop failure prevention strategies and minimize financial losses due to unforeseen situations. Evaluation of investment efficiency: After the introduction of new equipment, the model can be used to evaluate the effectiveness of investments. By comparing the planned results with the actual data obtained during operation, unexpected risks can be identified and investment strategies can be adjusted.

Forecasting market changes: The model can also help the holding company predict market changes and adapt to them in advance. This will allow you to anticipate potential risks and adequately respond to changes in the external environment. In general, the model for assessing investment risks in agro-industrial holdings for technical equipment is a powerful tool for making informed investment decisions, optimizing costs and managing risks in a dynamic agricultural environment.

Our model takes two blocks of variables as input. The variables that make up the first block characterize the risks of increased competition:

- the risk of financial instability of the holding (X1);
- the payback period for investments in equipment (X2).

The variables that make up the second block characterize the risks of problems in the market:

- the risk of erroneous pricing (X3);
- the level of economic instability, inflation, exchange rates, cost of resources and other factors that may affect the cost of technical equipment for information systems of the agro-industrial holding (X4).

The variables that make up the third block characterize the risks of capital purchases and current supply:

- the degree of dependence on external suppliers of components and spare parts (X5);
- potential risks of introducing new equipment (X6).

The risk assessment is carried out by experts who put down points from 1 to 5, depending on how the risk is assessed (Table 1).

Table 1. Risk assessment

The level of probability of risk occurrence	Very low	Low	Medium	High	Very high
Risk category assessment	1	2	3	4	5

Let's make a list of fuzzy production rules for the first block of variables. Below are some of them:

- IF X1 = "very low" AND X2 = "very low" THEN Y1 = "low";
- IF X1 = «very low» AND X2 = «low» THEN Y1 = « low »;
- IF X1 = « very low » AND X2 = «medium» THEN Y1 = « medium »;
- IF X1 = « very low » AND X2 = «high» THEN Y1 = «medium»;
- IF X1 = « very low » AND X2 = «very high» THEN Y1 = « medium ».

Let's make a list of fuzzy production rules for the second block of variables. Below are some of them:

- IF X3 = " very low " AND X4 = " very low " THEN Y2 = " low ";
- IF X3 = « very low » AND X4 = « low » THEN Y2 = « low »;
- IF X3 = « very low » AND X4 = « medium » THEN Y2 = « medium »;
- IF X3 = « very low » AND X4 = « high » THEN Y2 = « medium »;
- IF X3 = « very low » AND X4 = «very high» THEN Y2 = «medium».

Let's make a list of fuzzy production rules for the third block of variables. Below are some of them:

- IF X5 = « very low » AND X6 = « very low » THEN Y3 = « low »;
- IF X5 = « very low » AND X6 = « low » THEN Y3 = « low »;
- IF X5 = « very low » AND X6 = « medium » THEN Y3 = « medium »;
- IF X5 = « very low » AND X6 = « high » THEN Y3 = « medium »;
- IF X5 = « very low » AND X6 = « very high » THEN Y3 = « medium ».

Let's make a list of fuzzy production rules for the fourth block of variables. Below are some of them:

- IF Y1 = "low" AND Y2 = " low " AND Y3 = " low" THEN Y = "acceptable";
- IF Y1 = « low » AND Y2 = « low » AND Y3 = «medium» THEN Y = « acceptable »;
- IF Y1 = « low » AND Y2 = «low» AND Y3 = «high» THEN Y = « acceptable »;
- IF Y1 = « low » AND Y2 = «medium» AND Y3 = «low» THEN Y = « average »;
- IF Y1 = « low » AND Y2 = «medium» AND Y3 = «medium» THEN Y = « average ».

In this part of the work, all blocks of variables were described, the parameters of input and output variables were presented, and heuristic rules for creating a fuzzy model for assessing investment risks were outlined.

We will conduct a step-by-step creation and configuration of a fuzzy inference model for investment risk assessment in the fuzzyTECH environment. We have set up the variables using the Fuzzy Design Wizard. To begin with, we specified the number of input, intermediate, and output variables, as well as the number of terms for each type of variable (Figure 3).

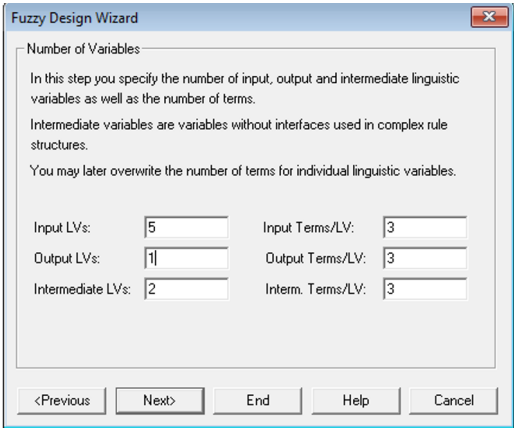


Fig. 3. Entering the number of variables

Next, we configure all types of variables, specifying the name of the variable, the minimum and maximum values, the number of terms and the linguistic values of the terms (Figure 4).

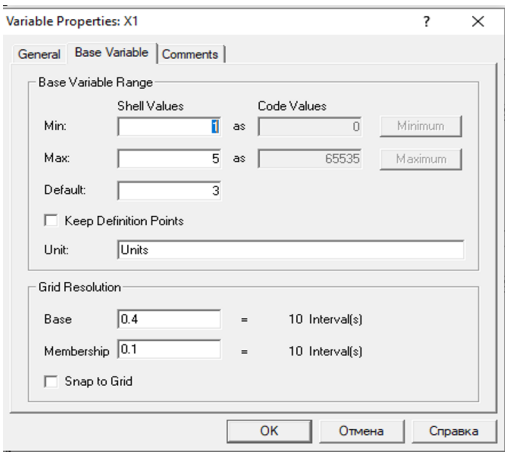


Fig. 4. Setting the input variable X1.

The variables X2-X6 were configured in a similar way. The settings of the output variable Y are shown in Figure 5.

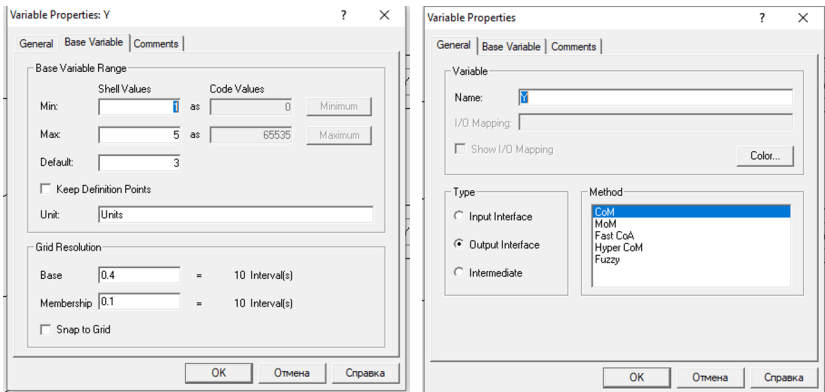


Fig. 5. Setting the output variable Y.

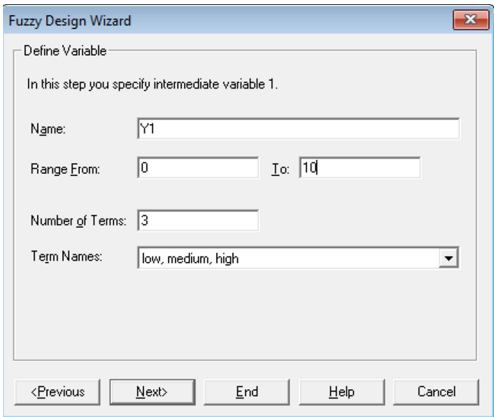


Fig. 6. Setting the output variable Y1.

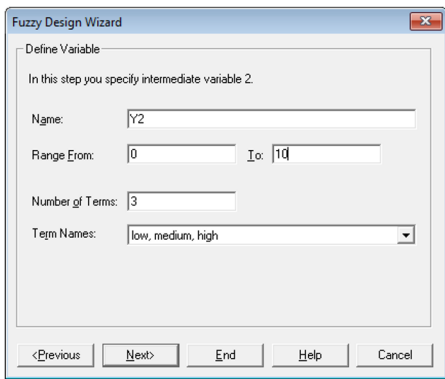


Fig. 7. Setting the output variable Y2

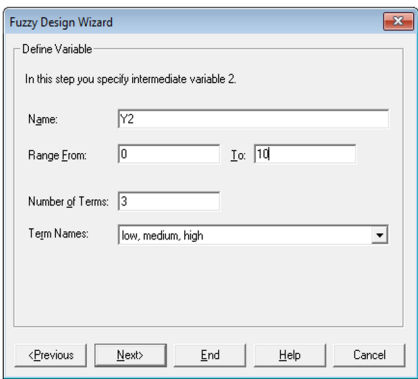


Fig. 8. Choosing the number of rule blocks

Then we set up the rule blocks, specifying the input and output variables and got the following model (Figure 9).

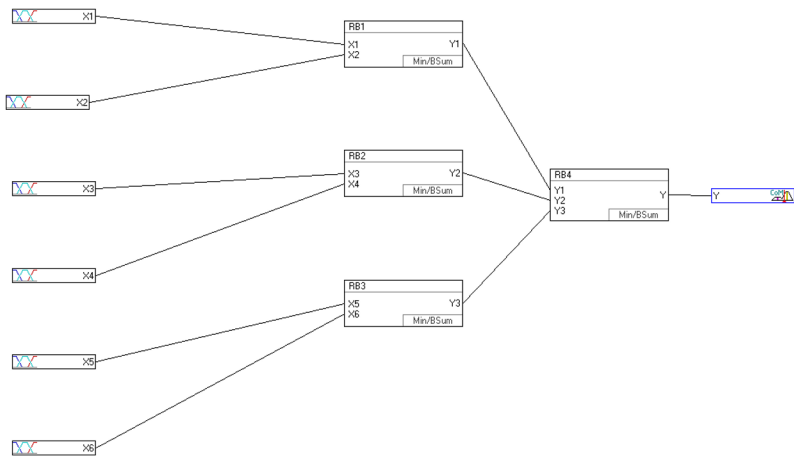


Fig. 9. The final scheme of a fuzzy model for assessing investment risks in an agro-industrial holding for technical equipment

Then we set up the membership graphs for each variable (Figure 10).

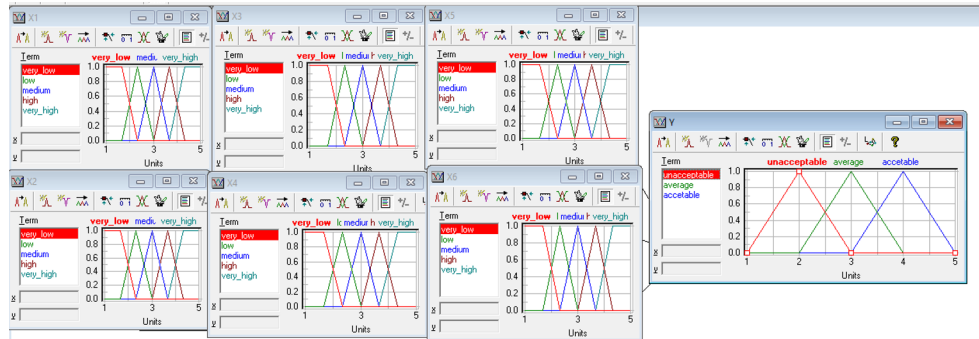


Fig. 10. Variable Editor Windows.

And they prescribed vague rules for each block (Figures 11-14).

Spreadsheet Rule Editor - RB1				
#	IF		THEN	
	X1	X2	DoS	Y1
1	very_low	very_low	1.00	low
2	very_low	low	1.00	low
3	very_low	medium	1.00	medium
4	very_low	high	1.00	medium
5	very_low	very_high	1.00	medium
6	low	very_low	1.00	low
7	low	low	1.00	medium
8	low	medium	1.00	medium
9	low	high	1.00	medium
10	low	very_high	1.00	medium
11	medium	very_low	1.00	medium
12	medium	low	1.00	medium
13	medium	medium	1.00	medium
14	medium	high	1.00	medium
15	medium	very_high	1.00	medium
16	high	very_low	1.00	medium
17	high	low	1.00	medium
18	high	medium	1.00	medium
19	high	high	1.00	medium
20	high	very_high	1.00	high
21	very_high	very_low	1.00	medium
22	very_high	low	1.00	medium
23	very_high	medium	1.00	medium
24	very_high	high	1.00	high
25	very_high	very_high	1.00	high

Fig. 11. RB1 Rule Block

Spreadsheet Rule Editor - RB2				
#	IF		THEN	
	X3	X4	DoS	Y2
1	very_low	very_low	1.00	low
2	very_low	low	1.00	low
3	very_low	medium	1.00	medium
4	very_low	high	1.00	medium
5	very_low	very_high	1.00	medium
6	low	very_low	1.00	low
7	low	low	1.00	low
8	low	medium	1.00	medium
9	low	high	1.00	medium
10	low	very_high	1.00	high
11	medium	very_low	1.00	low
12	medium	low	1.00	medium
13	medium	medium	1.00	medium
14	medium	high	1.00	medium
15	medium	very_high	1.00	high
16	high	very_low	1.00	low
17	high	low	1.00	medium
18	high	medium	1.00	medium
19	high	high	1.00	high
20	high	very_high	1.00	high
21	very_high	very_low	1.00	medium
22	very_high	low	1.00	medium
23	very_high	medium	1.00	medium
24	very_high	high	1.00	high
25	very_high	very_high	1.00	high

Fig. 12. RB2 Rule Block

Spreadsheet Rule Editor - RB3				
#	IF		THEN	
	X5	X6	DoS	Y3
1	very_low	very_low	1.00	low
2	very_low	low	1.00	low
3	very_low	medium	1.00	low
4	very_low	high	1.00	low
5	very_low	very_high	1.00	medium
6	low	very_low	1.00	low
7	low	low	1.00	low
8	low	medium	1.00	medium
9	low	high	1.00	medium
10	low	very_high	1.00	medium
11	medium	very_low	1.00	medium
12	medium	low	1.00	medium
13	medium	medium	1.00	medium
14	medium	high	1.00	medium
15	medium	very_high	1.00	medium
16	high	very_low	1.00	medium
17	high	low	1.00	medium
18	high	medium	1.00	medium
19	high	high	1.00	high
20	high	very_high	1.00	high
21	very_high	very_low	1.00	medium
22	very_high	low	1.00	high
23	very_high	medium	1.00	high
24	very_high	high	1.00	high
25	very_high	very_high	1.00	high

Fig. 13. RB3 Rule Block

Spreadsheet Rule Editor - RB4				
#	IF			THEN
	Y1	Y2	Y3	DoS Y
1	low	low	low	1.00 unacceptable
2	low	low	medium	1.00 unacceptable
3	low	low	high	1.00 unacceptable
4	low	medium	low	1.00 unacceptable
5	low	medium	medium	1.00 average
6	low	medium	high	1.00 average
7	low	high	low	1.00 average
8	low	high	medium	1.00 average
9	low	high	high	1.00 average
10	medium	low	low	1.00 unacceptable
11	medium	low	medium	1.00 average
12	medium	low	high	1.00 average
13	medium	medium	low	1.00 average
14	medium	medium	medium	1.00 average
15	medium	medium	high	1.00 average
16	medium	high	low	1.00 average
17	medium	high	medium	1.00 accetable
18	medium	high	high	1.00 accetable
19	high	low	low	1.00 average
20	high	low	medium	1.00 average
21	high	low	high	1.00 average
22	high	medium	low	1.00 average
23	high	medium	medium	1.00 accetable
24	high	medium	high	1.00 accetable
25	high	high	low	1.00 accetable
26	high	high	medium	1.00 accetable
27	high	high	high	1.00 accetable

Fig. 14. RB4 Rule Block

Thus, in this section, a fuzzy model for assessing investment risks in an agro-industrial holding was implemented in the fuzzyTECH software environment.

4 Checking the operation of the model based on specific indicators

After implementing the model, we will analyze it, consider several cases of the resulting model based on specific indicators. But first of all, let's check the fuzzy output at the extremes (Figure 15).

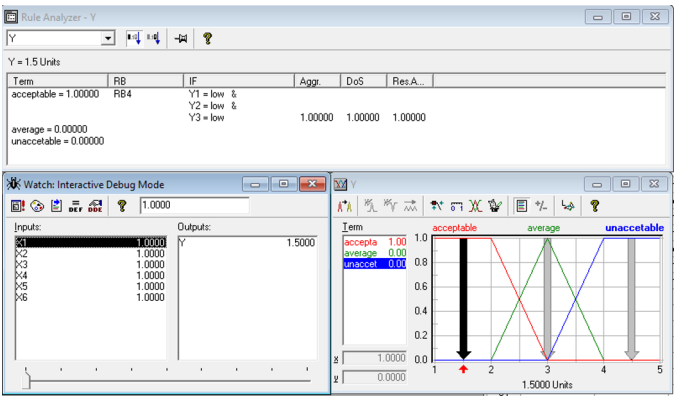


Fig. 15. Operation of a fuzzy model with minimum values of input parameters.

In our study, we found that we had reached an absolutely minimal level of risk, which is considered unacceptable. Imagine a situation where the input parameters are set to the maximum possible values (Figure 16).

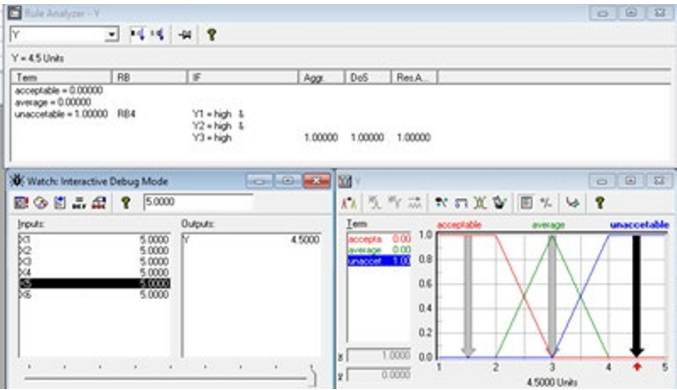


Fig. 16. Operation of the fuzzy model at maximum values of input parameters.

We have received the highest possible risk value. Let's consider a case where there is a risk of problems with suppliers, potential risks of introducing new equipment, but with careful analysis we correctly determined the level of economic instability (Figure 17).

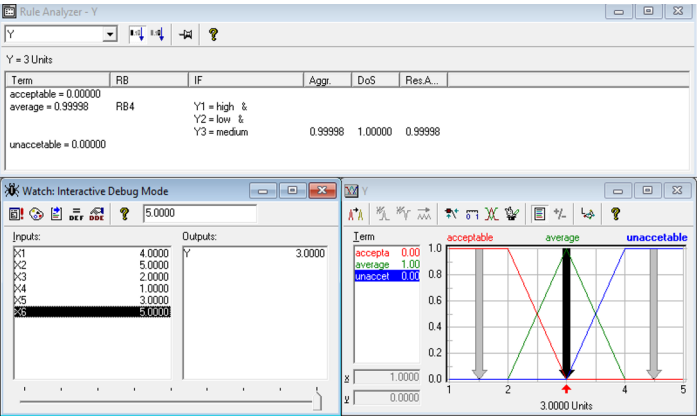


Fig. 17. Assessment of investment risks under specified parameters

We have received an investment risk assessment equal to 3 units, which corresponds to an acceptable risk value, despite the fact that 50% of our indicators have a high risk value, since the most important indicator in assessing investment risk for an agro-industrial holding is a competent definition of economic instability in the market. Now let's consider the case when this indicator was determined incorrectly, but reliable suppliers were selected and payback periods were calculated (Figure 18).

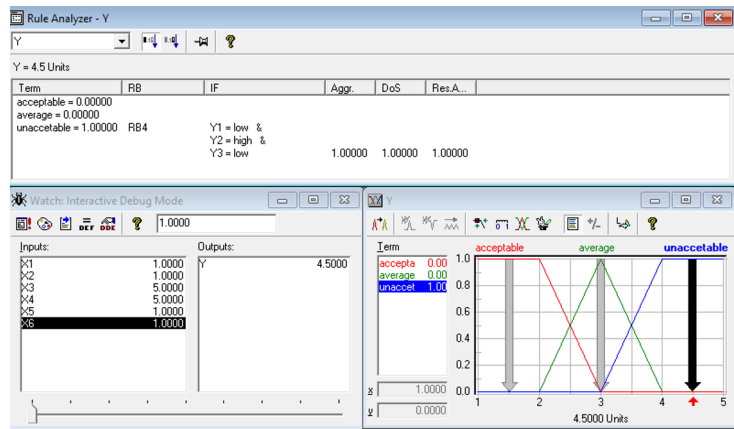


Fig. 18. Assessment of investment risks under specified parameters.

5 Conclusions and recommendations

Thus, investors are showing significant interest in companies of the agro-industrial complex (AIC), including foreign ones, thanks to the support from regional and federal authorities in the development of this sphere [7]. However, the imposition of Western sanctions has created financial difficulties due to policy uncertainty. Nevertheless, the infusion of foreign investments into the Russian agro-industrial complex continues: local agricultural holdings are actively modernizing production and increasing turnover. To strengthen this trend, companies must have a high level of resources, which directly depends on financial support and attracting investments. A fuzzy model for calculating the cost of technical equipment using fuzzyTECH technologies is an effective tool for optimizing financial decisions in this sector. For implementation, having selected the factors influencing investment risks, having studied the basics of fuzzy logic, having considered various software for fuzzy modeling, we chose fuzzyTECH as the most effective for our work. At the next stage, after defining the input, intermediate and output variables, as well as heuristic rules for their interaction, we implemented a fuzzy model. To verify the reliability of the model results, we tested the model on various parameters.

The developed assessment model satisfies the need for a qualitative conclusion on the assessment of investment risks and meets the requirements. The analysis showed the efficiency of the fuzzy model. Thus, the purpose of the work and, accordingly, all its tasks have been completed.

Acknowledgements

The study was carried out with financial support from the Russian Science Foundation as part of a scientific project № 23-28-00911, <https://rscf.ru/project/23-28-00911>.

References

1. N.Yu. Kozhenchikova, Investments in the agricultural sector of the region, Bulletin of Rural Development and Social Policy (2017).
2. The Ministry of Agriculture estimated the export of agricultural products in 2023 at \$43.5 billion, Access mode: <https://www.agroinvestor.ru/markets/news/41894-minselkhoz-otsenil-eksport-produktsii-apk-v-2023-godu-v-43-5-mlrd/>
3. Overview, The dairy industry in Russia in 2023, Access mode: <https://milknews.ru/longridy/Molochnaja-otrasl-23-v-grafikah.html>
4. Russia increased exports of livestock products in 2023, Access mode: <https://www.interfax.ru/russia/937918>
5. D. M. Nazarov, L. K. Konyshcheva, *Intelligent systems: fundamentals of the theory of fuzzy sets*, A textbook, 3rd ed., ispr. and add., (Moscow, Yurayt Publishing House, 2020) 1.
6. S. Zufarova, Fuzzy logic and its possibilities, *Science, education, innovations: topical issues and modern aspects*, materials of the International Scientific and Practical Conference (Penza, 2020) 29-32. Access mode: <https://www.elibrary.ru/item.asp?id=42582799>
7. S. A. Kulmamirov, Buldirshin Batyl., Young Scientist: electronic scientific journal, 50 (2020). URL: <https://moluch.ru/archive/340/76529/>
8. D. R. Grigorieva, G. A. Gareeva, R. R. Basyrov, *Fundamentals of fuzzy logic: an educational and methodological guide to practical classes and laboratory work*, (Naberezhnye Chelny, Publishing House of the NCI KFU, 2018) 42.
9. *Encyclopedia of Financial Risk Management*, Edited by A.A. Lobanov, A.V. Chugunov. (M., Alpina Business Books, 2007).
10. H.A. Abduzhalilov, F.Sh. Kamilov, S.Yu. Khut, S.K. Chinazova, New Technologies, **4/2016**, 75-82 (2016).
11. L. V. Kudryavtseva, A. K. Shulga, *Legal regulation of state support of the agro-industrial complex in the Russian Federation*, textbook (Krasnodar, KubGAU, 2020) 98.
12. T. Kussaiynov, A. Bulasheva, S. Tokenova, G. Mussina, Journal of Eastern European and Central Asian Research, **10(7)**, 1112–1120 (2023).
13. T. Kussaiynov, G. Mussina, S. Tokenova, S. Mambetova, WSEAS Transactions on Business and Economics, **20**, 2457–2465 (2023).