

Discriminant analysis of subsidies profitability in supporting investments in agricultural organizations in Russia

Vesta Maslakova, and Kirill Kozlov*

Russian State Agrarian University – Moscow Timiryazev Agricultural Academy, 127434 Moscow, Russia

Abstract. Agriculture is an important business of managing and working in the area of farming. It provides the population with the staple farm produce and raw materials, contributes to the development of rural areas and creates jobs. Agriculture plays a key role in achieving the sustainable development goals – poverty and hunger eradication, promoting inclusive and sustainable economic growth. The modern economic development involves the creation of sustainable industries, socially and environmentally oriented with an effective management system. All these issues require effective government financing of agriculture. Government funding should be focused not only on covering losses, but on achieving social and environmental sustainability. The discriminatory analysis of subsidies profitability in supporting investments in agriculture has been conducted according to the principles of ESG. As a result, the model allowing to select highly profitable agricultural producers which is similar to natural and climatic conditions with high potential for responsible investment in agriculture has been obtained. The drawbacks to the assessing system of public funds effectiveness have been identified. A comparative analysis between highly profitable and unprofitable organizations with use of indicator groups such as indexes of profitability, specialization, intensification, financial stability has been conducted. Research methods include effective and typological groupings, descriptive statistics, tabular and graphic methods, discriminant analysis, etc.

1 Introduction

One of the key directions in modern international practice is the concept of sustainable agricultural development, based on the idea of meeting the needs of the current generation without prejudice to subsequent generations. Achieving economic growth without causing damage to the natural environment (Environmental), solving social problems (Social) and quality business management (Governance) is the goal of implementing the principles of ESG.

* Corresponding author: kozlov.kirill@rgau-msha.ru

The application of ESG principles in agriculture is of high importance due to the fact that this type of activity, being life-sustaining for the country, is in third place in terms of greenhouse gas emissions after energy and industry [6]; contributes to an increase in methane and nitrogen oxide in the atmosphere, also this type of activity is highly resource-intensive, the huge amounts of the mineral fertilizers, pesticides, fuel and lubricants used have an adverse effect on the natural environment.

Currently, these principles are being implemented in Russia by developing national standards, reporting forms for organizations, and calculating ratings. First of all, this trend can be traced in relation to large companies, medium and small ones remaining on the sidelines [2]. In addition, the third of the country's largest banks have switched to ESG assessment of companies [2]. In other words, in Russia, the implementation of ESG standards is «top-down».

The sustainable development of agriculture in Russia is facilitated by maintaining investment processes, attracting investment resources to the industry, representing both private and public funds. We believe that the selection of investment projects and areas of investment of budgetary funds should take into account the principles of ESG. It is necessary to create sustainable agricultural enterprises focused on solving social, environmental and managerial problems.

For this reason, it is of particular value to improve the statistical assessment of public investment in agriculture; to identify the ways of increasing the effectiveness of subsidies from the perspective of sustainable agricultural development.

The aim of the research is to develop a model that allows selecting agricultural producers involved in investing and having the potential to create sustainable enterprises, according to the principles of ESG.

2 Materials and methods of research

The material for the research was depersonalized data on the aggregate of agricultural organizations of the Central Federal District for 2019 (hereinafter referred to as the Database of agricultural organizations). A sample of agricultural organizations in one federal district made it possible to level out natural and climatic differences and focus on socio-economic factors.

The main research methods were effective and typological groupings, descriptive statistics, tabular and graphical methods, discriminant analysis, etc.

3 Results and discussion

Based on the available data, a sample of 250 agricultural organizations was carried out, and an interval variation series was built according to the indicator of effective «Profitability of subsidies aimed at maintaining investment activity». The aggregate of organizations is heterogeneous (coefficient of variation 305.7%), which indicates uneven economic development of agriculture among the regions of the Central Federal District. Based on the variation series, three typological groups were identified, one of which included "unprofitable" organizations (group 1), the next group is represented by organizations with profitability up to 408 rubles of profit per ruble of subsidies, and the last includes "highly profitable" organizations (group 2), whose profitability index exceeds 408 rubles of profit per ruble the ruble of subsidies. For this research, unprofitable and highly profitable agricultural organizations are of increased interest. These two groups of organizations, with a normal distribution within the groups, were selected for subsequent analysis, a total of 32 organizations. The variation of the attribute values within the groups is small, however, there

are sharply distinguished values that will be excluded from the calculations (Fig. 1). The characteristics of the obtained groups are shown in Table 1.

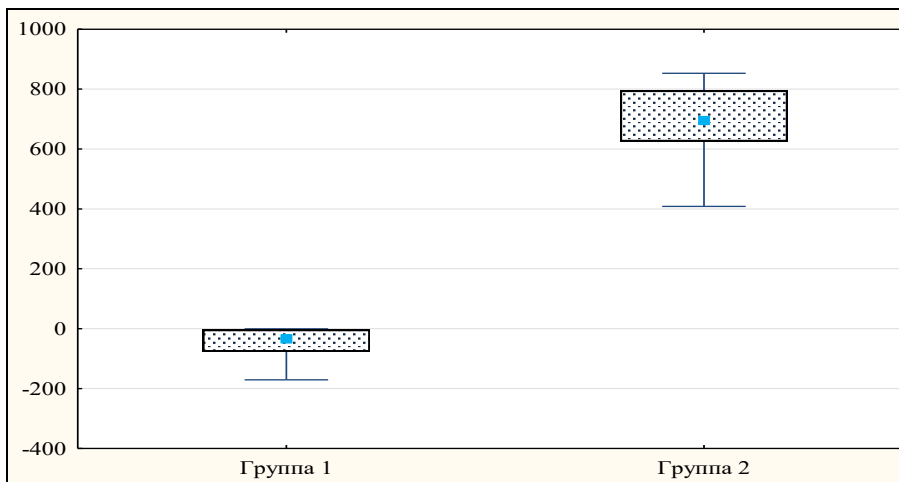


Fig. 1. The Scope Chart of the indicator "Subsidies profitability to support investments"
 Source: compiled on source "the Base of Agricultural Organizations" using the Statistica.

The highly profitable group is mainly represented by organizations whose main activity is crop production; the unprofitable group is mainly represented by livestock organizations. The highly profitable group is effective in both crop production and animal husbandry, while the first group suffers losses. It is assumed that subsidies in the first group are aimed at co-financing expenses to keep the organization afloat, but even government support would not be enough to cover all expenses. Organizations of the second group, on the contrary, have a significant margin of financial strength, are leaders in creating sustainable industries, and are able to comply with ESG standards.

Analyzing the available data, it can be concluded that in the highly profitable group, the coefficient of plowing of agricultural land is 93% (9% more than the indicator of the first group), which indicates the effective use of agricultural land. There is also a lower indicator of feed and electricity consumption, despite the fact that the resource potential of the organization of a highly profitable group is much higher: the energy capacity is 49.3% higher, the average number of employees is 56.8% higher.

Table 1. Indicators, characterizing differences between typical groups.

| The name of the indicator | Group 1 | Group 2 | Deviation | |
|---------------------------------------------------------------------------|----------|----------|-----------|--------|
| | | | +/- | % |
| 1. Profitability indicators | | | | |
| 1.1 Profitability of subsidies for financing investments, (rub per 1 rub) | -12,68 | 554,33 | 567,01 | - |
| 1.2 Profitability of sales of crop production, % | 0,37 | 55,40 | 55,03 | 14 872 |
| 1.3 Profitability of the sale of animal husbandry, % | -18,86 | 38,25 | 57,11 | - |
| 2. Specialization indicators | | | | |
| 2.1 The share of crop production revenue in total revenue, % | 26,86 | 61,75 | 34,90 | 129,94 |
| 2.2 The share of animal husbandry revenue in total revenue, % | 73,14 | 38,25 | -34,90 | -47,71 |
| 3. Indicators of production intensification, resource availability | | | | |
| 3.1 The cost of electricity per worker, thousand rubles | 46,53 | 69,47 | 22,93 | 49,28 |
| 3.2 The cost of fixed assets per worker, thousand rubles | 2 645,96 | 2 613,47 | -32,49 | -1,23 |

| The name of the indicator | Group 1 | Group 2 | Deviation | |
|---------------------------------------------------------------------------------------|---------|---------|-----------|--------|
| | | | +/- | % |
| 3.3 The cost of animal food per 1 ha of agricultural land, thousand rubles. | 15,19 | 7,06 | -8,13 | -53,51 |
| 3.4 The cost of mineral fertilizers per 100 hectares of arable land, thousand rubles. | 162,82 | 568,87 | 406,04 | 249,38 |
| 3.5 The cost of electricity per 100 hectares of arable land, thousand rubles. | 129,19 | 127,79 | -1,40 | -1,09 |
| 3.6 Average salary, thousand rubles | 21,98 | 25,42 | 3,44 | 15,63 |
| 4. Indicators of financial stability | | | | |
| 4.1 The coefficient of financial independence | -0,01 | 0,75 | 0,76 | - |
| 4.2 Financial leverage ratio | -7,84 | 0,12 | 7,95 | - |
| 4.3 The coefficient of availability of own sources of financing | -2,13 | 0,43 | 2,56 | - |
| 4.4 Financing ratio | -0,13 | 8,53 | 8,65 | - |

Source: calculated by the authors on the basis of the Database of agricultural organizations without taking into account sharply differing values.

The main indicator affecting the social component, according to the National ESG Standard developed by the Expert Center for ESG Transformation "Delovaya Rossiya", is the level of wages [2]. As we can see from table 1, the salary of a highly profitable group exceeds the same indicator of a loss-making one by 15.6%. This indicator should be compared with the average for the industry and the district, according to the National ESG Standard. It should be noted that the indicator under consideration is lower than the average for the industry (47.6 thousand rubles) [4]. It is worth concluding that it is necessary to pay attention to the social direction, since even in highly profitable organizations, the average wage level is not reached everywhere, which entails social risks and an increase in staff turnover. With low wages, the problem of a shortage of qualified personnel remains unresolved, despite the fact that the Committee of the Federation Council on Social Policy identifies this problem as one of the main ones in agriculture [3].

One of the most important criteria of the ESG principles is effective management in agriculture. The main aspect is high-quality risk management, both operational and financial, which is extremely important for agriculture, since the industry is overdrawn and lacks its own funds. Senator Lisovsky S.F. also drew attention to this, noting that the problems of low profitability and high creditworthiness of agricultural producers have not yet been solved in Russia [3].

According to table 1, as noted earlier, highly profitable organizations have a high margin of financial strength, as evidenced by financial stability indicators. The share of own funds in the total amount of financing sources is 75%, 43% of current assets are financed with their own funds, with a rate of more than 10%. The activities of highly profitable organizations are financed from their own funds, which is also indicated by a financing ratio of 8.5 at a rate of more than 1.5. Thus, they are financially stable, unlike unprofitable organizations, where a negative value of the autonomy coefficient indicates that the organization is on the verge of bankruptcy, current assets are fully financed by credit funds. The activities of unprofitable organizations are 87% financed by borrowed funds.

Unprofitable organizations are not able to participate in investment activities, their main task is high-quality internal management aimed at preventing the risk of bankruptcy, repayment of existing debt obligations.

At the next stage, discriminant analysis was conducted. The task of analysis was to determine the decisive factors, key indicators of differences between typical groups. The second task of analysis is to develop a model, that allows to make selection between agricultural organizations, based on indicator "Subsidies profitability to support investments". In other words, the analysis made it possible to select agricultural organizations

that can effectively participate in investment and contribute to the creation of sustainable industries, taking into account the principles of ESG.

Indicator “Subsidies profitability to support investments” was selected as dependent variable. Independent variables are represented by groups of indicators: indicators of intensification of production, resource availability, financial stability, profitability and specialization. The scattering diagram shows the distribution of organizations, measured in dependent variable (fig. 2).

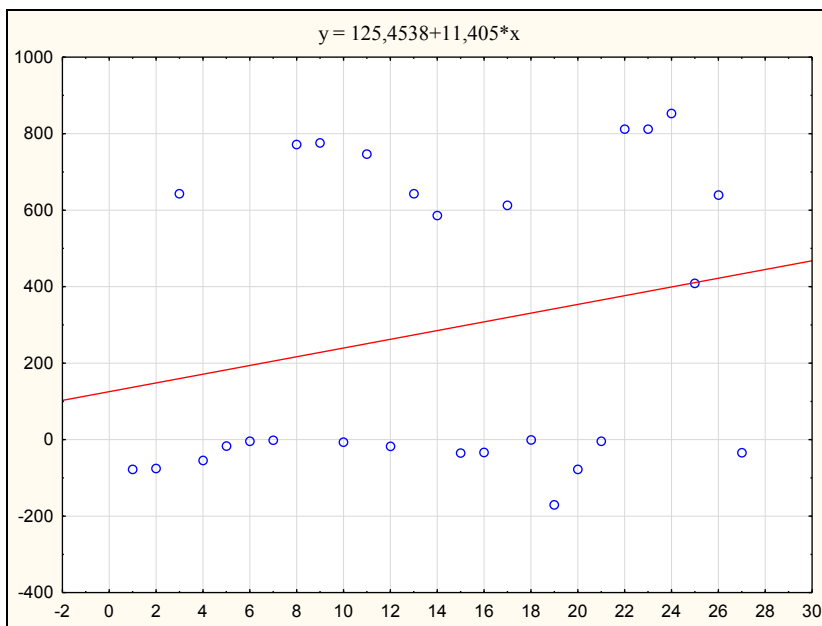


Fig. 2. Scattering Chart for subsidies profitability to support investments.
 Source: compiled on source “the Base of Agricultural Organizations” using the Statistica

The results of discriminant analysis after inclusion of variables are presented in table 2, 3. It is shown in table 3, that one discriminant function was developed, which includes indicators: profitability of livestock products sales (x1) and depreciation per 100 hectares of agricultural land (x2). According to the Chi-square criterion the function is statistically significant ($p < 0,0000$) (table 2). There are a lot of differences between groups according to the F-Fisher criteria ($p < 0,0000$) and Wilks's lambda test (table 3). Wilks's lambda test characterizes the quality of the discriminant model. The value of the criterion varies from 1.0 (no difference) to 0.0 (maximum differences among groups). The test amounts to 0.333, that is close to zero, which characterizes the high quality of the discriminant function. According to the F-Fisher criteria each of the variables included in the function is also statistically significant. The most valuable contribution in discrimination between organizations is the contribution of variable x1, as the Partial Lamba test value of variable x1 is much closer to zero (0.375). It is also worth noting, that variables, included in the model, are not redundant, their correlation with each other is low (the Tolerance coefficient value is close to 1.0), that characterizes the high quality of the model.

Table 2. Chi-squared test.

| Chi-Square test with Successive Roots Removed | | | | | |
|-----------------------------------------------|-------------|----------------|------------|----|---------|
| Eigen-value | Canonical R | Wilks's lambda | Chi-Square | df | p-value |
| 2,006 | 0,817 | 0,333 | 31,91 | 2 | 0,000 |

Source: compiled on source “the Base of Agricultural Organizations” using the Statistica

Table 3. Results of discriminant function analysis.

| Results of discriminant function analysis | | | | | | |
|---------------------------------------------------------------|----------------|----------------|------------------|----------------|-----------|----------------|
| Variables | Wilks's lambda | Partial lambda | F-include (1,29) | P-value | Tolerance | R ² |
| Profitability of livestock products sales, % | 0,887 | 0,375 | 48,29 | 0,000 | 0,921 | 0,079 |
| Depreciation per 100 ha of agricultural land, thousand rubles | 0,404 | 0,823 | 6,221 | 0,019 | 0,921 | 0,079 |
| Results of Incremental Analysis | | | | | | |
| Variables | Step | F - include | P-value | Partial lambda | F-Fisher | P-value |
| Profitability of livestock products sales, % | 1 | 44,24 | 0,000 | 0,404 | 44,24 | 0,000 |
| Depreciation per 100 ha of agricultural land, thousand rubles | 2 | 6,221 | 0,019 | 0,333 | 29,08 | 0,000 |

Source: compiled on source “the Base of Agricultural Organizations” using the Statistica. For reference: total Wilks's lambda is 0.333, the F-Fisher criteria (2.29) = 29.08

Formula 1 is a discriminant function with initial coefficients for canonical variables, formula 2 is the same function with standardized coefficients.

$$F = -0,977 - 0,086 * x_1 + 0,001 * x_2 \tag{1}$$

$$F = -1,008 * x_1^s + 0,536 * x_2^s \tag{2}$$

x1 – profitability of livestock products sales, %,
 x2 – depreciation per 100 ha of agricultural land, thousand rubles.

As can be seen from formula 2, the largest role in the discriminant function is played by the variable x1, as the absolute value of the standardized coefficient of x1 is higher. It is also confirmed by the matrix of the factor structure.

Table 4. Matrix of factor structure, correlation of variables and discrimination function.

| Variables | Root |
|---------------------------------------------------------------|--------|
| Profitability of livestock products sales, % | -0,858 |
| Depreciation per 100 ha of agricultural land, thousand rubles | 0,252 |

Source: compiled using the Statistica

At the next stage, classifying functions are developed, formula 3, 4. Classifying functions are used for calculation a classification weight for each observation. The observation is classified into the group with the highest classification weight.

$$S_1 = -3,214 - 0,173 * x_1 + 0,003 * x_2 \tag{3}$$

$$S_2 = -1,243 + 0,066 * x_1 + 0,0005 * x_2 \tag{4}$$

The classification results are presented in Table 5. According to the Classification matrix, the classification accuracy is high, out of 32 observations, only one is mistakenly classified.

Table 5. Matrix of classification.

| Group | Percent correct | Unprofitable (p = 0,563) | High – profitable (p = 0,438) |
|-------------------|------------------------|---------------------------------|--------------------------------------|
| Unprofitable | 94,44 | 17 | 1 |
| High - profitable | 100,0 | 0 | 14 |
| Total | 96,88 | 17 | 15 |

Source: compiled using the Statistica

For reference: rows – observed classification, columns – predicted classification

In conclusion, it should be noted, that the main criteria for subsidies effectiveness assessing are their accessibility, efficiency and comprehensiveness [3]. These criteria are important, but not enough for sustainable agricultural development. We believe that it is necessary to assess the effectiveness of subsidies and investments in general taking into account the ESG criteria.

According to the data of the study, the most of agricultural organizations have a low profitability of subsidies: organizations with an indicator value, that lower 2%, comprise 26.4% of the total sample.

The received discriminant model includes indicators, characterizing the scale of production and profitability. Organizations that have shown high profitability of subsidies are highly effective in both crop production and animal husbandry. This organizations have high resource and production potential.

Indicators characterizing the social side, environmental friendliness and quality of management were not included in the model. It suggests that social and environmental indicators do not have significant impact on differences between highly profitable and unprofitable organizations.

Taking into account, the most important task to increase the efficiency of each ruble, budgetary funds estimation should include the assessment of useful contribution to the solution of social, environmental and management issues. It is impossible to achieve sustainable development disregarding social and environmental issues.

An important result of the study is the practical significance of the obtained discriminant model. The model is used for selection from a set of highly profitable agricultural producers, homogeneous in terms of natural and climatic conditions, the organizations with high potential for responsible investment in agriculture. The received discriminant model and all its parameters are significant, the accuracy of discrimination equals to 96.9%. It indicates the high selection quality of the model.

4 Conclusions

Modern development of agriculture involves the creation of sustainable industries, focused on the principles of social justice and respect for the natural environment with high-quality and flexible management. The vital fact to achieve the task is responsible investment of both private and public funds. The state plays the leading role. The main task is to show the effective use of budgetary funds, solve the clue problems of sustainable development, create favorable investment conditions and improve investment climate in agriculture. The aim of the study has been achieved: the discriminant analysis of subsidies profitability to support investments of agricultural organizations in Russia has been conducted according to ESG principals. The model, that allows to select highly profitable agricultural producers, that are included in investment process, with high potential for responsible investment in agriculture, has been obtained. The applied discriminant model includes indicators, characterizing the scale of production and profitability. Indicators, characterizing the social side, environmental friendliness and quality of management are not included in the model. It suggests that ESG

criteria do not have significant impact on differences between highly profitable and unprofitable organizations.

The state policy of subsidies effectiveness assessing is not currently focused on social and environmental sustainability indicators.

During the process of differences analysis between highly profitable agricultural organizations and unprofitable ones, the following conclusions have been drawn:

First, the high potential for participation in responsible investment and promoting ESG principles of highly profitable agricultural producers is determined by the efficient use of resources, primarily agricultural land, low consumption of feed and electricity. Besides, these organizations are large and have high resource potential.

Second, the social contribution of highly profitable organizations, where working conditions and wages are better, should be taken into account. However, the social issue remains unresolved, and requires state participation.

Third, the effective financial policy of highly profitable organizations and high-quality credit policy should be noted. Highly profitable organizations have a high financial safety margin and solvency, as defined by financial stability indicators.

The characteristic feature of a high-quality credit policy is the ability to attract financing without the risk of financial stability deterioration, the main activity is mainly financed from own funds. Unprofitable organizations are not able to participate in investment activities, their main task is high-quality internal management, repayment of existing debt obligations.

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