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MODEL OF ASSESSMENT OF COMPETITIVENESS AND SUSTAINABLE DEVELOPMENT OF UKRAINIAN AGRICULTURAL ENTERPRISES

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The purpose of this paper is to create an economic-mathematical model for evaluation of effectiveness and competitiveness of agricultural enterprises in all forms of economy of Ukraine in the context of sustainable development. The analysis is based on data from State Statistics Service of Ukraine, study of German system of criteria for sustainable agriculture, as well as rules of agriculture in Germany and Europe "Cross Compliance" and a system of indicators GRI. An economic-mathematical model is developed which serves for comparison of different agricultural enterprises with each other. Research results showed that agricultural enterprises can be competitive in the long run only if they pay enough attention to the impact of their activities on the environment and society.

Keywords: competitiveness, ecological and social indicators, integral index, model, sustainable development.
JELC Codes: Q12, C29, C59.

1. Introduction

In modern conditions of the 21st century there are several main forms of economy in Ukrainian agriculture. This includes peasant economies, farms, agricultural cooperatives, as well as horizontally integrated agricultural holdings (large agribusiness). Agricultural holdings have huge banks of land, easy access to resources, modern highly productive equipment. It can be assumed that agricultural holdings are the most competitive and stable form of economy and the most attractive for the sustainable development of Ukrainian agriculture. But is this large agribusiness really the most efficient, competitive, and sustainable form of economy? Maybe it is, or maybe not. A clear mathematical model is needed to answer this question. The current paper aims to demonstrate how could be compared among themselves any enterprise of Ukraine regardless of its forms of economy using the economic-mathematical model developed by the authors.

The model contains economic, social and ecological factors and is a continuation of the study of German scientists H. Eckert, G. Breitschuh, D. Sauerbeck, I. Matnes. The study provides insights into the competitiveness of agricultural enterprises in specific economic conditions. Solving the main problem, the study raised the following issues:

- definition of indicators of sustainable development for Ukrainian agricultural enterprises;
- creation of an economic-mathematical model for comparison enterprises with each other regardless of the form of economy;
- demonstration of how to evaluate the competitiveness of enterprises using integral indicators on the example of agricultural cooperative.

Object of the study is the competitiveness and sustainable development of agricultural enterprises. Subject of the study is the process of identifying more competitive and sustainable enterprises using the economic-mathematical model.

Value/originality. Regular monitoring and improvement of economic, social and ecological indicators by management and owners could allow to demonstrate the sustainable development and competitiveness of agricultural enterprises of Ukraine. This commitment to the concept of sustainable development will allow enterprises to attract cheaper and longer financial resources. Investors will receive a clear mathematically calculated indicator for comparing enterprises with each other and could decide about investments in the most competitive Ukrainian enterprises of agrarian sector. All this at the same time will allow to develop rural areas, stop the migration of the population to cities and to work abroad and more develop the industry, which is the key branch for Ukraine nowadays.

2. Research methods

In developing the model of assessment of sustainable development and competitiveness of Ukrainian agricultural enterprises we have taken as the basis that the importance (or proportion) of economic, social and ecological spheres should be of equal value. That for sustainable development of an enterprise today and in the future the management should pay due attention to solving economic, social and ecological issues.

But in our opinion, the magnitude of different indicators within each sphere should be different. Therefore, to determine the proportion of each of indicators within our sphere we decided to use the method of independent expert pairwise comparisons. We used the following scale to compare each pair: 3 grades get the more important parameter, and 1 grade is the less important; 2 points receive both parameters with the same importance.

The specific weights of each of indicators within the sphere were further determined. To do this let's use a formula:

$$Specific\ weight\ of\ the\ indicator = \frac{The\ sum\ of\ grades\ of\ the\ indicator}{The\ sum\ of\ grades\ of\ all\ indicators\ of\ the\ sphere} \quad (1)$$

The operation of calculating the specific weights of the indicators for each of the three spheres was carried out separately. The obtained specific weights of indicators were fixed for evaluation of any company.

The scale for the evaluation of each indicator has 9 levels, where a score of 1 grade is the highest score and 9 is the worst. The assessment scale is developed for each indicator individually. The enterprise assessment methodology in terms of competitiveness in all three spheres includes 4 stages:

1. Definitions of the weight (assignment of a grade on a scale from 1 to 9) to each indicator. The assessment is carried out by the analyst (expert) using *the assessment scale*.
2. The calculation of the integral indicator occurs by multiplying the weight of the indicator by its specific weight within the sphere.
3. Summation of all integrated indicators within the spheres to determine the integral indicator of the sphere.
4. The calculation of the integral indicator of the company as the sum of the integral indicators of three spheres.

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3. Results and discussion

In agriculture, the activity of enterprises caused by direct dependence on natural resources should be provided with a favorable institutional environment for sustainable economic development. This means that in agriculture the problem of resource recovery is at the forefront in modern Ukraine.

Sustainable development in agriculture is a development that reflects certain important ecological, social, and economic aspects. According to scientists the sustainable development of agriculture increases of profitability of farms and agricultural enterprises, promotes the production of basic food products in a sustainable and secure way, economic growth with the development of rural areas, safe and effective use of land and other natural resources in agricultural production (Fyliuk, 2018).

In 1999, studying the ways of efficient and sustainable development of agriculture, German scientists H. Eckert, G. Breitschuh, D. Sauerbeck, I. Matthes proposed to apply a methodical approach to assessing the level of efficiency of agricultural enterprises, which involves the definition of criteria of economic, social and ecological compatibility (Eckert, Breitschuh, Sauerbeck, 1999). According to scientists, effective and sustainable development of agriculture is possible only with the balance of economic, social, and ecological components due to the specifics of the industry.

In the 1990s, the first attempts were made by German scientists to use ecological impact on assessment indicators to establish a benchmark for ecological sustainability (Eckert, Breitschuh, 1997). Table 1 presents the KSNL system of sustainable development of agriculture, which consists from economic, social and ecological indicators.

Table 1. Criteria for sustainable development of agriculture. (Breitschuh, Eckert, Matthes, 2008)

Component	Indicators
Economic	Earnings per Employee, Profitability, Rent, Return on Equity, Compensation for Profitability, Debt Service Costs, Cash Flow, Equity, Dynamics of Equity, Net Investment, Operating Income.
Social	Share of Owners, Social Activity, Gross Wage, Working Conditions, Holidays and Sick Leave, Share of Women Involved in Production, Age Structure of Workers, Availability of Jobs.
Ecological	Nitrate Balance Area, NH3 Emissions, Phosphorus Balance, Soil Class pH, Humus Balance, Erosion of Soil, Danger of Soil Compaction, Danger of Compressibility of Soils, Intensity of Crop Protection, Part of ÖLF (ecological surfaces) , Average Field Size, Net Energy Balance, Energy Balance of Crop Production, Specific Greenhouse Gas Emissions

According to German scientists, the use of intensive farming where the main emphasis is on economic indicators leads to the destruction of humus, namely, when using artificial fertilizers and highly toxic pesticides that kill the soil and contribute to erosion (BUNZ). At the same time, organic farming involves taking into account not only economic, but also ecological and social indicators. Organic farming maintains healthy fertile soil and natural resources. According to G. Breitschuh, if organic farming was carried out throughout Germany it would provide food to the whole country (Breitschuh, Eckert, Grantzau, Korschens, 2013).

The system of evaluating the criteria of economic, ecological and social compatibility is called the KSNL (Kriteriensystem zur Analyze und Bewertung der Nachhaltigkeit landwirtschaftlichicher Betriebe), which in German means the system of criteria of the analysis and assessment of sustainable development of agricultural enterprise (Breitschuh, Eckert, Matthes, und Strümpfel, 2008). According to scientists, all criteria should have the same quantitative value and therefore to assess their indicators, they need to be converted into a single grade system. For each criterion, an admissible deviation is established, which gives an idea of whether a specific value of the criterion reaches the boundary of the deviation.

According to German scientists, the KUL system (Kriterien Umweltverträglichkeit Landwirtschaft) is the most widespread in Germany in modern conditions of the development of agriculture and involves an annual assessment of the activity of an agricultural enterprise, taking into account a set of criteria that include indicators such as: balance of nutrients in the soil, soil protection, plant protection, landscape and biodiversity, energy balance, greenhouse gas emissions, etc. in accordance with the tolerance range (Eckert, Breitschuh, Werner, Breitschuh, 2013).

Research in some of EU countries (Balkan states of Albania, Bulgaria, Greece, Romania, Croatia and Serbia) showed that increasing of regulation together with the development of ecological sustainability will lead to higher competitiveness (Marikina, 2018). According to the survey, about of 100 companies, it was found that the companies began to focus much more on the ecological and social aspects of its activities. This is a view in the context of the three P's - people - planet - profit. (Briš Svoboda, Brišová, 2013).

The research in Czech Republic showed that the implementation of corporate social responsibility (CSR, which includes environmental, social and economic factors) may influence sales positively. The findings also indicate that consumers prefer companies with CSR as well as the necessity of good implementation of CSR in the company process by managers. (Bartok, 2018).

In modern conditions, the following basic forms of economy are represented in agriculture of Ukraine:

- farms is European economic model. In Ukraine they use 100-150 ha per farm and produce only 1.9% of agricultural products (State Statistics Service of Ukraine, 2018);
- agricultural enterprises (mainly in the form of integrated structures of agroindustrial complex – agriholdings) is Latin American model of Latifundia. In Ukraine they use tens of thousands of hectares of farmland to grow the most cost-effective and technologically mechanized crops to produce high yields. They produce 44.9% of agricultural production;
- peasant economies is a special form of agriculture, inherent in post-Soviet countries and especially developed in Ukraine and Russia. Peasant economies unlike other forms, receive an income labor instant an income (Bulgakov, 1900). In Ukraine peasant economies produce 54.5% of agricultural production. Since it is difficult for peasants and farmers in an aggressive market environment to compete with large agrarian trade and industrial enterprises they are united in agricultural cooperatives. (State Statistics Service of Ukraine, 2018).

All these enterprises are different in scale and business processes but we believe that they should be compared with each other and should be found the most competitive form of economy. Due to representation in Ukrainian agriculture different models of economy no one of existing models of assessment of enterprise through economic, social and ecological performance could not be directly applied in Ukraine.

As a result, the authors based on the German model developed their own to assess the sustainable development and competitiveness of Ukrainian enterprises. In addition, this model compares one enterprise with another to determine its effectiveness.

Using the methodology described above let's create the model of assessment of an enterprise in three spheres. An example of a matrix of comparisons of economic sphere can be seen below (Table 2).

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Table 2. Estimation of the importance of indicators of the economic component

Economic Indicators	The growth rate of production	Volume of production per 1 hectare of land	Volume of production per one worker	The dynamics of the volume change of output per hectare of land	Productivity	Dynamics of changes in labor productivity	The level of self-sufficiency	Profit of 1 hectare	Profit for: 1 person	Profitability of production	Dynamics of change of profitability	Sum in grades
The growth rate of production	x	3	2	3	3	1	1	1	1	1	1	17
Volume of production per 1 hectare of land	1	x	3	3	3	2	3	1	2	1	1	20
Volume of production per one worker	2	1	x	3	3	3	3	1	1	2	1	20
The dynamics of the volume change of output per hectare of land	1	1	1	x	3	1	2	1	1	1	1	13
Productivity	1	1	1	1	x	2	2	1	1	1	1	12
Dynamics of changes in labor productivity	3	2	1	3	2	x	3	1	1	1	1	18
The level of self-sufficiency, a measure of independence from third-party resources	3	1	1	2	2	1	x	1	1	1	1	14
Profit of 1 hectare	3	3	3	3	3	3	3	x	1	3	2	27
Profit for: 1 person	3	2	3	3	3	3	3	3	x	1	3	27
Profitability of production	3	3	2	3	3	3	3	1	3	x	2	26
Dynamics of change of profitability	3	3	3	3	3	3	3	2	1	2	x	26

Source: own research

The total weight of all the indicators of the economic component is 220 (in each comparison is distributed 4 points, we have total of 55 comparisons). Then we calculate the specific weight of each individual indicator by the formula.

$$Specific\ weight\ of\ the\ indicator = \frac{The\ sum\ of grades\ of\ the\ indicator}{The\ sum\ of\ grades\ of\ all\ indicators\ of\ the\ sphere} \quad (2)$$

For example, for the indicator "The growth rate of production", the weight is: 17/220 × 100% = 7,7%. In a similar way we received specific weights for indicators of ecological and social spheres.

For social component we make 21 pairs of comparisons for 7 indicators. The total weight of all indicators of social component is 88 (in each comparison is distributed 4 grades, we have total of 21 significant comparisons, that is, 21 × 4 = 88).

For ecological component, we make 36 pairs of comparisons for 9 indicators. The total weight of all indicators of ecological component is 144 (in each comparison is distributed 4 grades, we have total of 36 significant comparisons, that is 36 × 4 = 144).

Thus, we obtained specific weights for each indicator of all three spheres. Now we will demonstrate the work of the developed model of assessment of sustainable development and competitiveness of Ukrainian agricultural enterprises on the example of “Zahidny” cooperative. Agricultural Service Cooperative "Zahidny" was created on April 2, 1999 in the village Obariv of

Rivne region in the number of 15 farms. In 2019 the cooperative has 215 members including 121 associate members.

First, an assessment was made (scores from 1 to 9 were assigned) to each indicator in each area. The integral indicator was calculated by the formula:

$$Integrated\ indicator = The\ specific\ weight\ of\ the\ indicator \times Weight\ (in\ grades) \quad (3)$$

As an example, the result of the analyst's assessment of the cooperative by using the economic assessment scale is shown in the table 3.

Table 3. Estimation of the importance of indicators of the economic component

Indicator	Specific weight	Indicator weight	Integrated indicator
The growth rate of production	7,7%	4	0,31
Volume of production per 1 hectare of land	9,1%	2	0,18
Volume of production per one worker	9,1%	3	0,27
The dynamics of the volume change of output per hectare of land	5,9%	7	0,41
Productivity	5,5%	5	0,28
Dynamics of changes in labor productivity	8,2%	6	0,49
The level of self-sufficiency, a measure of independence from third-party resources	6,4%	2	0,13
Profit for 1 hectare	12,3%	5	0,62
Profit for: 1 person	12,3%	5	0,62
Profitability of production	11,8%	4	0,47
Dynamics of change of profitability	11,8%	5	0,59

Source: own research

The sum of all integral indicators of one component is an integral indicator of a component. Thus, the integral indicator of economic factors is 4.36, social is 4.45, ecological is 3.53. The overall integral indicator of the cooperative is 12.34. Figure 1 shows the network of integral indicators of the cooperative.

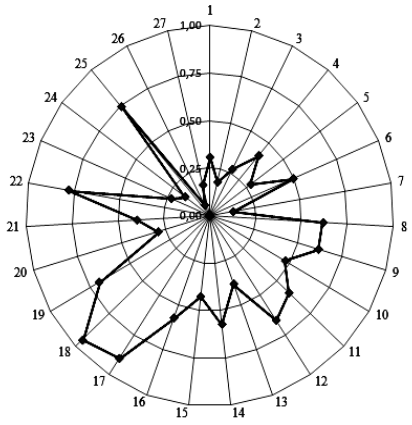

Figure 1. Network of integral indicators of the cooperative
Source: own research

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Notes:
1 The growth rate of production
2 Volume of production per 1 hectare of land
3 Volume of production per one worker
4 The dynamics of the volume change of output per hectare of land
5 Productivity
6 Dynamics of changes in labor productivity
7 The level of self-sufficiency, a measure of independence from third-party resources
8 Profit for: 1 ha
9 Profit for: 1 person
10 Profitability of production
11 Dynamics of change of profitability
12 The ratio of the average income of the employee to the average income of the country
13 The level of fatigue
14 The share of women in production
15 The share of specialists with higher and secondary specialized education
16 Workplace Warranties
17 Employee employment rate
18 The share of young people in the enterprise
19 The area of land with a high man-made load in the total area
20 The size of man-made load on the ground from the enterprise
21 The level of soil fertility is relatively average in the region
22 Variety of cultivation of crops, in number of species
23 Land area, which is processed by heavy c / g cars in the total area
24 The lands that are prone to soil erosion in the total volume of land
25 The level of fitness of the landscape is a recreational area
26 Area of land that is not cultivated in the total number of lands
27 Area of land "under the steam" in the total volume of land enterprise

It should be noted that the lower the integral indicator of the enterprise so the more it corresponds to the concept of sustainable development and as we see an enterprise is competitive. The best value for an integral indicator of an enterprise is 3 (when all the indicators get in the assessment of 1 grade), the worst value is respectively 27 (when each indicator receives 9 grades). That is the integral index of the enterprise varies from 3 to 27. As indicated above the requirement for sustainable development and high level of competitiveness is the balance of three components: economic (100%), social (100%) and ecological (100%). For example, Ginevicius wrote about country region's competitiveness: «country region's competitiveness depends on how it is adjusted their economic, social and ecological development. It's important because it could be that some of the development components are developing at other component's expenses.». (Ginevicius, 2019). For visualization authors proposes to use the equilibrium triangle. Three sides must be equal, so we have an equilateral triangle. If sides are different in size then the triangle will not an equilateral. That indicates on the imbalance. According to the cooperative each of the components turned out to be less than 100%, and the triangle turned out to be not equal, indicating the imbalance and the predominance of ecological component (71.9%). The social and economic components are balanced between themselves, but their absolute values are not high enough (61.6% and 62.7%). All this indicating that there is a potential for development (Figure 2).

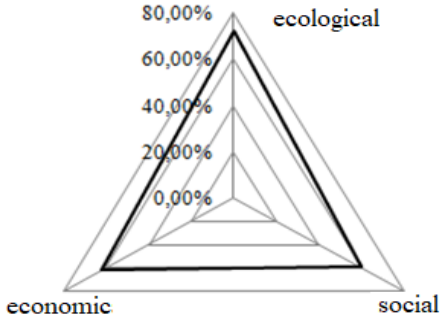

Figure 2. – Triangle of balance for cooperative "Zahidny"

Model of assessment of sustainable development and competitiveness of Ukrainian agricultural enterprises was developed by authors based on economic, social and ecological indicators. The goal and tasks of the work are completely achieved. The model can be used to evaluate any enterprises of any form of economy. Also, the model is quite flexible and can be adapted to specific conditions of any country or industry. For this purpose, it is necessary to specify the indicators and their specific weight.

We believe that in the future the model can be used to evaluate enterprises on an annual basis and indicators may be disclosed by enterprises on a voluntary (or even mandatory major) basis in non-financial reports, company websites and / or other open sources.

With respect to further research perspectives and practical interpretations, the model needs to be validated by a large number of businesses (several hundred) and can then be refined for indicators and / or specific weights within each sector.

4. Conclusion

The authors propose a model of assessment of sustainable development and competitiveness of Ukrainian agricultural enterprises which is:

- relevant today both for Ukraine and for EU as in many countries more and more enterprises pay attention to sustainable development when assessing the competitiveness.
- the logical continuation of German model of sustainable development of agriculture but is new and innovative for Ukrainian agriculture;
- universal because it actually allows to analyze and evaluate any enterprise, any form of economy, which is proved by the example of agricultural cooperative, which is a complicated form of economy;
- concise since it includes a relatively small number of indicators (27 for all three spheres) but covers all spheres (economic, social and ecological). This on the one hand does not give a complete picture of the disclosure of the activity of the enterprise but concentrates on the main and gives the opportunity to conduct a quick analysis of a large number of enterprises and compare them with each other in a short period of time;
- logical because the system itself is predominantly based on solid statistics (or derivatives of them) and which can be clearly calculated, each of the indicators has its own assessment scale. This situation reduces the impact of the human factor and the results are objective since all enterprises are evaluated by a single coordinate system;
- reliable since the proportion of each indicator within its sphere although based on the expert valuation of certain market experts (and is relatively objective), but the average value of 5 experts and a single and unchanged coordinate system neutralize the subjectivism.

The application of this economic-mathematical model to individual enterprises will allow to evaluate the enterprise. The application of the model to several different agricultural enterprises and the calculation of integral indicators for each of them will allow to compare these enterprises among themselves in a single coordinate system.

Today the responsible investment (RI) in enterprises is growing. Investors want to be confident in the security of their investments and try to invest in companies that adhere and implement the principles of sustainable development and ESG (environment, social, governance) factors in their strategies and operations. For enterprises such investors can provide longer money at a lower interest.

In conditions of Ukraine, when access to financial resources is very limited and resources are very expensive, such investors could give the impetus to the development, introduction of modern agricultural technologies and innovations. Therefore, in our opinion, the economic-mathematical model should be clarified considering the GRI indicators and add an assessment on the G-factor (governance).

All this will allow us to bring our model closer to indicators and systems that are familiar to Western investors and attract investments to agrarian sector of economy of Ukraine. On the other

hand, the application of the developed model on dozens and hundreds of agricultural companies of Ukraine on a regular basis will allow potential investors to receive the necessary and complete information about companies for responsible investment.

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