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The use of Monte Carlo simulation in the assessment of an agricultural investment

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Abstract

The research aims to present an investment analysis model and its risk management methods, which can be commonly used to prepare the realization of any agricultural investment. Using the case study method, we guide the reader through the examination of the economic viability of an investment in cultivating per Western European standards a momentarily neglected piece of land in Harghita County, Romania, that would be suitable for agricultural purposes. We explore the risks associated with the investment and provide a detailed description of the related method.

Keywords: Monte Carlo simulation, agriculture, investment decision, business planning.

JEL code: G30.

Introduction

One of the consequences of intensified globalization is that, besides producing outstanding quality products, farms must constantly adapt to the changing environmental conditions in order to remain competitive. The continuous investment activity is a prerequisite for this adaptation, as these investments are the main drivers of innovation and production growth. In Romania, as in Central-Eastern Europe, the productivity and competitiveness of agriculture is far below the Western European level (Schimmelfennig–Sedelmeier 2005). It is essential to continue supporting, developing and reforming agriculture, as 1.3 million persons are employed in this sector in Romania (INSSE 2015) and it also plays an important role in maintaining the rural population, mitigating the disparities between urban and rural areas (Prishchepov

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et al. 2017), preserving the environment, as well as protecting nature (Schimmelfennig–Sedelmeier 2005). Thus, increasing the productivity and competitiveness of the sector is of paramount importance.

To achieve this improvement, it is not sufficient to use modern agricultural technologies, but also the various calculation methods of cost effectiveness, and making financially justified decisions, instead of the “everybody here grows potatoes, so that’s what I’m doing, too” method. The Capital's (2016) survey shows that a significant part of the Romanian farmers are already familiar with the new agricultural technologies, but their financial literacy is far behind the Western European level.

In the first part of our paper, we review the literature, then we present the research methodology and the data sources of the research. Afterwards we examine if it is possible to run a cost-effective agricultural business given the soil and weather conditions typical for the area. Finally, we describe our results and the conclusions that can be drawn.

Literature review

The literature provides two different approaches for the concept of investment, one is from the general economics' and the other is from the business economics' point of view.

Macroeconomists define investments as the increase in the fixed assets of a given economy (country). Hall and Taylor (2003. 56) define investments as “the expenses incurred by companies for their offices, equipment and stocks, as well as the expenditures incurred by households for residential purposes.” In contrast, Samuelson and Nordhaus (2005) define investments as the increase in the capital stock of a national economy by purchasing/producing buildings, machines, equipment and supplies, and sacrificing current consumption in order to increase future consumption.

By analyzing the concept of investment from the business economics point of view, we concluded that it consists of all the activities aimed at replacing and expanding the fixed assets. In the definition provided by Mátrai–Németh (1986. 87), an investment is the sum of "all the activities aimed at the replacement and expansion of the fixed assets."

Classifying investments by multiple aspects

The literature classifies investments in several ways, but we emphasize only three of them. The first classification is in terms of national economy and business administration, the second one is by the financing form, where we distinguish between investments financed from own resources and investments financed from loans, and the third one is by intended purpose.

Bálint et al. (2001) argue that the investments' purpose may be to establish a new production facility or service provider business; to increase the existing production capacity; to rationalize modernization of outdated facilities; or to replace old, outdated production equipment. Accordingly, the investment types are the following: completely new or "greenfield" investment; expansion investments; rationalizing investments or replacement investments.

Investment pre-decisions process

There are several authors who discuss the investment pre-decisions process in their research. Fekete–Husti (2005) define the decision-making and pre-decision process in nine steps:

1. initialize the investment based on the business strategy,
2. prepare a preliminary feasibility study,
3. decide on the feasibility study,
4. carry out the feasibility study for the selected version,
5. decide on further steps,
6. define the elements of the project strategy,
7. decide on the project strategy,
8. ensure the necessary implementation resources,
9. determine the availability of the necessary resources.

In contrast, Butler et al. (1993) sets forth only four major decision-making steps:

1. identify the investment possibilities,
2. develop the initial idea into a business purpose,

3. assess and select the projects,

4. analyze the projects.

In conclusion, it can be stated that the pre-decision process comprises the initial idea and the steps of transforming it into a plan that is achievable and financially viable for the company. Business investments can be manifold; hence it is difficult to define a generally valid model that applies to all types of investments.

In our article, we focus on creating a greenfield agricultural investment model in Romania. One significant impediment of the Romanian agriculture is that even though there is available capital and knowledge, the agronomists cannot foresee and calculate the return on their investment.

The methodology of calculating the cost-effectiveness of an investment

Calculating the cost-effectiveness of an investment is an essential phase of the investment pre-decision process. The calculations have a well-established methodology, with considerable importance in both foreign and domestic literature. Initially, the literature suggested using static indicators to assess the cost-effectiveness of any investment, disregarding the time value of money. However, since the 1930's, the development of the net present value’s calculation method has led to dynamic indicators, first appearing in books and articles of Anglo-Saxon authors (Markovics 2013).

Static calculation methods of investment cost-effectiveness

The static calculations of investment cost-effectiveness disregard the time factor. Because of this, they are able to compare investments with similar lifespan and fairly uniform yield distribution (Illés 1997).

Illés (2002) makes a distinction between the three types of static calculation methods:

1. Cross-sectional analysis: calculations are done for a given year.

2. Multi-annual analysis: the static calculation is done for every estimated year of the investment’s lifespan. If every year the investment works with a considerably higher profitability than the interest rate, it is quite certainly cost-effective.

3. Lifespan analysis: a static profitability indicator is defined during the calculations, which is then compared to the interest rate. The investment project is classified based on the comparison result.

Static calculations of investment cost-effectiveness are relevant because they can be performed quite easily and quickly, which is why they are most likely to be used in business practice.

Dynamic calculation methods of investment cost-effectiveness

Today's relevant literature features both the static and the dynamic calculation methods of cost-effectiveness, however, most authors agree that the time factor must be taken into account, so most often the dynamic methods are recommended. This chapter presents the three most important dynamic methods: the net present value (NPV), the internal return rate (IRR) and the discounted payback period.

According to Markovics (2013), one of the most recommended methods among all the dynamic calculations of cost-effectiveness is to determine the net present value. The NPV is a difference indicator and its general formula shows how much surplus profit (converted to net present value) the investment yields over the standard profitability (or the measure of inefficiency as compared to the expectations).

$$NPV = \sum_{t=0}^{n-1} [P_t - (k_t + E_t)] \frac{1}{(1+i)^t}$$

P_t = cash flow during period t;

k_t = non-investment costs during period t (current cost without amortization);

E_t = investment related expenses during period t (investment costs);

i = interest rate.

The reason behind the net present value's relatively frequent usage could be that the interpretation of the result is very easy: if the net present value is positive, the investment is worthwhile. The method's drawback is the high complexity of the interest rate used for discounting.

The internal rate of return (IRR) generally refers to the return rate at which the value of the revenue and expenditure is equal.

$$\sum_{t=0}^{n-1} P_t \frac{1}{(1+r)^t} = \sum_{t=0}^{n-1} (k_t + E_t) \frac{1}{(1+r)^t}$$

P_t = cash flow during period t;

k_t = non-investment costs during period t (current cost without amortization);

E_t = investment related expenses during period t (investment costs);

r = internal rate of return.

According to this method, the investment can be considered cost-effective if the internal rate of return is not smaller than the interest rate used. The great advantage of this method over the other dynamic methods is that the results are easily interpreted by business professionals, and the information itself is not subject to the uncertainty surrounding the definition of the interest rate used (Markovics 2013).

The dynamic (or discounted) payback period indicates the number of years in which the discounted amounts of the incurred investment and non-investment expenditures return from the discounted amounts of the generated revenue, given the profitability expectations for the interest rate used. It is calculated as follows: equalizing the revenue and expenditure lines, we look for the year when we first got the return of the discounted amounts of investment and non-investment expenditures from the discounted revenues, i.e. the discounted payback period can also be determined by identifying the year which zeroes out the net present value formula (Markovics 2013).

Applying risk management procedures

In practice, there are many types of investment projects, depending on the size and type of risks involved. First, the main risk factors must be identified, and the best risk management procedure that suits the type of risk involved has to be chosen from the methodology base.

The financial literature mostly recommends increasing the interest rate used as a risk management approach, which essentially means that the interest rate is corrected (increased) by the risk factor. The higher the interest rate used, the higher the return the investment is required to yield. The economic literature makes several other recommendations, such as increasing the expenditure line, decreasing the return line, calculating the payback period and making parallel calculations, such as sensitivity analyses, decision trees etc. (Markovics 2013).

This chapter discusses in more detail the three risk management methods used in the practical part of our paper, namely the sensitivity analysis, the scenario analysis and the Monte Carlo simulation.

During the sensitivity analysis, we apply several different magnitudes or a series of magnitudes and we carry out the cost-effectiveness analysis several times in such a way that different magnitudes of the given variable are used during the calculations, while the other variables remain unchanged. Thus, we get a whole series of evaluations of the applied economic criteria, a set of cost-effectiveness indicators as a result, which will show us how and to what extent the cost-effectiveness indicator reacts to the changes of the variable used in the given sensitivity analysis (Vargha 1997).

The purpose of the scenario analysis is to investigate the effects of the joint change in the parameters of the calculation model of investment cost-effectiveness on the NPV's evolution. Its possible techniques are the various statistical models (e.g. VAR, CFAT), the simulations (e.g. Monte-Carlo) and the intuitive methods. Its tacit presumption is that whatever happens in the first period is independent from what happens in further periods, and that the variables are independent for every period. During the scenario analysis, it is important to make the context as simple as possible and to not get emotionally attached to the investment (Brealey–Myers 1993).

Using the sensitivity and scenario analyses presented above, we can examine different situations, but it is obvious that we can study only a limited number of variable combinations, so we assumed a discrete probability distribution in our analyses.

The Monte Carlo simulation is an instrument that allows us to examine not only a few, but all the possible combinations, thus being able to analyze the entire distribution of the project's outcomes; therefore, we can also analyze continuous distributions, not only discrete ones (Bozsik–Fellegi 2011). Stochastic models can be used to describe randomness-influenced processes as the outcome is also randomness-influenced. In this case, the random phenomenon's simulation can be carried out using random numbers. In this context, the most prevalent method is the Monte Carlo simulation (Komlósi 2002). By modeling a problem with the Monte Carlo method, a much more complex and intricate system can be analyzed than with other methods. In present-day's interpretation, the Monte-Carlo method comprises all the techniques where statistical samples are used to approximate quantitative problems. The method's elaboration is associated with Stanislaw Ulam's name, but its computer application is the merit of John von Neumann and Nicholas Metropolis. The Monte Carlo name was given by Metropolis (Metropolis–Ulam 1949). According to Szobol (1981), the Monte Carlo method is a numerical method used for random quantity modeling of mathematical problems. From a mathematical point of view, the reason behind creating the Monte Carlo method is to set up a problem where an expected value (*M)* has to be calculated.

In order to approximate any a scalar quantity, an ε probability variable must be found such that $M\varepsilon = a$; then, after carrying out N independent observations on ε, it can be affirmed that

$$a \approx \frac{\varepsilon_1 + \varepsilon_2 + \ldots + \varepsilon_N}{N}$$

As the law of large numbers is applicable to a series of independent, equally distributed probability variables with an expected value, the ε_i values' arithmetic mean will converge to the expected value in probability: if $N \to \infty$, then $\varepsilon_N \xrightarrow{P} a$. The series of probability variables ε_1, ε_2, ..., ε_N, converges to an a constant if it is true for arbitrary h that $P(|\varepsilon_N - a|) \geq h) \to 0$, when $N \to \infty$ (Szobol 1981).

Research methodology

Our article aims to offer practical guidelines for drawing up an easy-to-create model for greenfield agricultural investments.

The first research question analyzes whether a modern agricultural investment can generate added value, given the current prices and yields in Romania:

RQ1: Can a greenfield agricultural investment be profitable, given the current prices and yields in Romania?

The second research question addresses the investment's risks:

RQ2: How can the financial effects of the volatility risks (e.g. weather conditions) specific to agriculture be effectively managed in an agricultural greenfield investment model?

In order to answer the research questions, an exploratory research is needed, so we chose the case study method that draws general conclusions from exploring past or even current events (Leonard–Barton 1990).

In our research, we use the case study companies as benchmarks in order to establish which input factors lead to which output factors in the investment model. The analyzed data was collected from two sources:

- the companies involved in the case study collected via semi-structured interviews (by processing over 50 hours of interview material conducted with 15 interviewees), from company documents (secondary business-related data), as well as from direct observation (spending three months on the analyzed sample farms);
- public statistical sources.

During our research, we collected data from the most relevant sources, because in case of an agricultural investment, not only the cost of the company's own and foreign capital and the procurement cost of various equipment, machinery and raw materials has to be determined, but the geological peculiarities of the area (soil type, average temperature, precipitation), the amount of potential subsidies and the area's crop insurance possibilities should also be taken into account.

Hereinafter we present the databases, the research and the analyses, and using the respective data, we present the financial assessment of a sample agricultural investment.

Companies subject to the case study

Due to the uniqueness of our research, we needed a lot of information that cannot be found in annual financial statements. The aforementioned data refer to fuel, fertilizer and spray consumption per hectare, the area that an employee can treat, the hourly performance of the various machinery or the damages caused by wild animals and the methods of protection against these damages.

These data can be inferred from the agricultural literature's estimations, as well as from relying on the vast experience of the field's specialists. In our article, most of the data was determined based on the specialists' (in our case farmers') experience and estimations, since there is no common method to determine these values and, in fact, we obtained different results from observing parcels located at even just a few kilometers distance.

For the above reasons, we rely on the average of three different companies' data. One of the farms' owner has agreed to provide the required information, provided that the company's name is not mentioned anywhere in the analysis; for this reason, hereinafter we call them Farm1, Farm2 and Farm3. The main features of the three companies are:

• Farm1's main activity is winter wheat, barley and oat cultivation on a 291-hectare cropland; 80-100 hectares of fallow land; permanent employees: 4;

• Farm2's main activity is wheat and barley cultivation on a 425-hectare cropland; no fallow land; permanent employees: 3;

• Farm3's main activity is wheat, barley and rape cultivation on a 700-hectare cropland; no fallow land, since they use crop rotation and they grow alfalfa on the "resting" plots; permanent employees: 6.

We can state about the three farms that the coverage of the debt stock fluctuates around 140-150%, and the share of equity within the total resources is of 50-65%. Despite the very low wages in agriculture, the employees' wages are 1.5-1.8 times the minimal wage on all three farms, because the employees often work up to 14 hours a day during summer harvest. In addition, all three farms hire seasonal workers during spring, autumn and harvesting.

Statistical data sources

The Farm Accountancy Data Network (FADN) is a database operated by the EU member states since 1965, which mainly offers information on the profitability of various agricultural business categories. The relevance of the information collected from the database is shown by the fact that the system only registers farms that perform their activity at least above 2 EUME[3]. Moreover, the database only takes into account the wider agricultural activities of the farms (basic agricultural activity, produce processing, forestry, fishing, agricultural services, rural tourism) and does not include industrial, commercial and non-agricultural activities.

The National Institute of Statistics, hereinafter referred to as INSSE, publishes the data of the country's regions, including the average yield of crops in recent years, the cereal prices or even the average wages in the agricultural sector, among others. Data is also provided on county level, which is essential for the realistic determination of the agricultural yield.

The data regarding the soil types, weather conditions (average temperature, annual precipitation) and the crops typical for Harghita County were collected from the Harghita County's Agricultural Development Strategy for 2010–2020 (Harghita Consulting 2009).

We determined the soil types using the methodology presented by Vágvölgyi and Varga (2011) to determine average temperature and precipitation quantity required for cultivating certain plants, in order to select the most suitable crops for the region's weather conditions and soil type.

We became acquainted with the types of subsidies in agriculture, their extent and the eligibility conditions, the application deadlines and the expected payments from the newsletters published by the Payments Agency for Interventions in Agriculture (APIA).

The loan granted at the beginning of the investment has been determined based on the loan offer published by the Commercial Bank of Romania (BCR) for starting small and medium businesses, taking into account the maturity, grace period, normal interest rate, commission and administration fees.

[3] An EU attribute that expresses the economic size of the farm.

We determined the insurance fees based on an inquiry, since insurance companies mostly offer customized packages based on the geographical and weather conditions, the insured risks (late spring frost, early autumn frost, hail, hurricane-like rains and drought) and the size of the land to be insured.

Data analysis methods

For calculating the investment's cost-effectiveness, we use the dynamic calculation method of investment cost-effectiveness, i.e. the net present value (NPV), which was previously presented in the literature review. We decided to use this method because a quite large fixed asset investment is required in agriculture, and what is more important, the "production" can be started only in the second year of the investment (the croplands have to be prepared in order to achieve a satisfactory yield, which can last several months), so the payback period is long, therefore it is essential to take into account the time factor and the time value of money.

We reveal the investment's risks and their effects with the help of three different risk-analysis methods. First, by using the sensitivity-analysis, we determine the factors that influence the most the cost-effectiveness of the investment, then we analyze the effects of the combined changes of these factors in different scenarios. Third, we run a Monte Carlo simulation to determine the probability of certain outcomes (the net present value of the investment), thus analyzing the investment's riskiness.

The practical calculations of our research are divided into three parts. In the first part, we present the necessary investments in real estate, building and fixed assets, and justify these choices. In the second part, we discuss the project's financing, the changes in the revenues and expenditures, and present the steps of calculating the expected net present value. In the third and last part, we present the risk-analysis methods used, and the conclusions drawn from these.

Investments in land, buildings and agricultural machinery

Our research aims to analyze the cost-effectiveness of a greenfield agricultural investment. The first step of the investment is to determine the required fixed assets and their value, so this chapter deals with the investments in land, buildings and agricultural machinery.

Land and buildings

The investment is carried out in Harghita County, and aims to improve and cultivate a 100-hectare land. The land is rented from the common land of Capalnita, Satu Mare, Badeni or Martinis, with a contract for at least eight years, so we don't have to buy it.

The agricultural work will require machinery, seeds, pesticides and fertilizers, which will have to be stored somewhere, and silos must be built for grain storage. First, a site is needed, which will also pose as the company's headquarters. Given the current market prices, the price of an 8-10 000 sqm land in the area amounts to EUR 20 000.

We build a warehouse where the seeds, pesticides, fertilizers and the machinery's spare parts can be stored. After analyzing the constructions built by the reference companies for similar purposes, we came to the conclusion that a 500 sqm warehouse would suffice. Given the current market prices, building one sqm of a warehouse costs 50 euros, so the total building cost is EUR 25 000.

The agriculture in Harghita County suffers considerable damages caused by wild animals, therefore the land has to be enclosed with electric fence. The fencing costs are presented in Table 1.

Table 1. The costs of electric fences and enclosures

Description	**Unit price (euro)**	**Quantity**	**Total amount (euro)**
Electric fence	230.00	1	230
Wiring (m)	0.35	15 000	5 250
Posts (pcs.)	1.75	1 000	1 750
Gate	163	4	652
Total (euro)			**7 882**

Source: authors' own design based on market prices

The total price of the fence is EUR 7 882, including the necessary wiring, the posts, four entrance gates and the electric fence itself. We did not include the costs associated with setting up the fence, since the company has three permanent staff members who can install the fence during the first winter.

Another key investment item is the construction of the grain silos, essential for maintaining the grain quality (and its market value) during long-term storage. In our research, we decided to build mobile silos. Consequently, the capacity of a silo does not exceed 25 000 kg of grain, but the distribution company undertakes the silos' installing, sparing us additional costs. Given the foreseeable yields, 10 such silos will be needed. With a unit price of EUR 2600, this means a total investment of EUR 26 000.

We will also need a mobile petrol station. Agricultural machinery has a hard time traveling on highways, and it would be a waste of time to spend several hours daily with refueling. Taking into account the machinery's consumption, a 2-3000 liters' petrol station would suffice. This would cost EUR 2500.

Summing up the required amounts for land and buildings (warehouse, grain silos, mobile petrol station and fence), the total investment is EUR 81 328 (see Table 2).

Table 2. The total cost of land and buildings

Land and buildings	**Unit price (euro)**	**Quantity**	**Total amount (euro)**
Land			
Land (ha)	20 000	1	20 000
Total land			**20 000**
Buildings			
Silos 25t	2 600	10	26 000
Warehouse m^2	50	500	25 000
Fence	7 882	1	7 882
Mobile petrol station	2 500	1	2 500
Total buildings			**61 382**
Total land and building costs			**81 382**

Source: authors' own design based on market prices

Agricultural machinery and equipment

Another key aspect of this investment project is the machinery pool. After determining the type of machinery needed during the production processes, by assessing their performance and taking into account the experience of those working at the case study companies, we decided to purchase the machinery listed in Table 3.

Table 3. Agricultural machinery

Machinery	Price (euro)
Steyr 9086 tractor with shovel loader	11 500
Fendt 306 tractor with shovel loader	24 000
John Deere 1055 combine harvester	25 000
Rabe Star 120 D III plough	3 600
Claas markant 41 bailing machine	4 500
Deutz-Fahr twisting machine	2 200
Pöttinger Landsberg Lion round ring harrow	4 000
Fella SM 320 scythe	3 500
Krone disc	2 500
Amazone ZA-U 1001 fertilizer spreader	1 300
Amazone UF 1000 sprayer	10 500
Amazone D7 Super S seed drill	2 850
Sonstige 8t trailer	3 900
Krone 8t trailer	3 800
Kögel 18t bail truck	2 450
Ferroni wash pump	500
Karcher high pressure washer	1 250
Jaguar grain auger	2 000
Güde GSE 2700 generator	325
Volkswagen Transporter T5	8 800
Tools	1 345
Total machinery costs	**119 820**

Source: authors' own design based on market prices and case study companies' data

While determining the required machinery's cost, we sized up the current market prices by analyzing various dealers' offers. We assume that in the case of a greenfield investment, it would not be economical to purchase new machinery as their price would increase the investment costs and would extend the payback period to at least 15-20 years. Our hypothesis is based on the following: the price of a used, 6-7-year-old tractor or combine harvester is EUR 20 000, while the price of a new tractor or combine harvester with similar performance is EUR 100 000.

We must take into account that the annual repair costs of used machinery go well beyond the costs of new machinery, and the insurance fees are also higher. Shipment fees could also apply, while in the case of new machinery, these are normally covered by the dealer. After a quick overview of the offers, we estimated the shipment fees to

RON 13 400, which covers 3000 km of transport with a 24-ton truck (4-5 shipments between Harghita County and Cluj County or Harghita County and Bucharest).

Besides the agricultural machinery, the farm also needs a car. We chose a Volkswagen Transporter minibus due to its suitability to transport both merchandise and people.

To sum up, we came to the conclusion that the total investment in agricultural machinery is EUR 119 820 and the shipment cost is RON 13 400.

Expenditures, revenues and financing

In this chapter we present the annual foreseeable revenues and expenditures determined in the article, arguing the relevance of every item. Due to the fact that the agricultural activity has been planned to be carried out on an uncultivated agricultural land, the machinery-, the building- and the soil-preparation is going to be a two-year-long process, therefore the agricultural production will begin only in 2018. Thus, the revenues and expenditures that will be presented below, will apply starting 2018. We also present the cost of external capital and equity of the investment.

Expenditures

Because of the small number of annual invoices and accounting documents, it is better to hire an accounting firm than to have an in-house accountant. However, a small office will be needed anyway. Its cost was estimated to RON 10 000, including the furniture, a computer, a printer and a restroom.

In addition to the already mentioned one-time expenditures, there are annually recurring expenditures also, as follows: wages, rent, raw materials and consumable expenditures, repair costs, insurance fees, interest and installments.

When calculating the wages, we took into account the wages at the reference companies. Although the wages in agriculture are generally lower than in other sectors, we noticed that the wages of all three companies' permanent employees are 1.4-1.5 times higher than the minimum wage. This can be explained by the fact that these employees often work up to 12-14 hours a day during the spring and autumn works and harvesting. In addition, they may also have to work on weekends during these periods. In the light of the above, we used corresponding values when calculating labour costs (see Table 4).

Table 4. Estimated labour costs for 2018

Employees	**Gross wage (RON)**	**Worked hours**	**Annual gross wage (RON)**
Employee 1	2 000	-	24 000
Employee 2	2 000	-	24 000
Employee 3	2 400		28 800
Seasonal workers	**Hourly wage (RON/hour)**	**Worked hours**	**Annual gross wage (RON)**
Worker 1	12	84	1 008
Worker 2	12	84	1 008
Worker 3	12	84	1 008
Worker 4	12	84	1 008
Worker 5	12	84	1 008
Employer's contribution (RON)			**22 387**
Total labour costs (RON)			**104 227**

Source: authors' own design based on case study companies' data

The company also hires seasonal workers to help the permanent staff during harvesting. The seasonal workers' hourly wage was set to RON 12, based on the information provided by the reference companies. According to our calculations, the total annual wage costs, including the employer's contributions payable for each employee, are RON 104 227.

The rent costs were determined based on the values stated in the lease agreements of agricultural areas lent by the common land of Capalnita, Satu Mare, Badeni and Martinis during the past years. We found that the annual rent per hectare is EUR 180, but it must be borne in mind that this land has been fallow for a long time, and bringing it to an agriculturally suitable state is quite expensive. The demand for agricultural land is also very low in the area, so no significant change can be expected in future rental rates. Another important aspect is that the plot is large, ensuring a more favorable bargaining position. To sum up all of the above, the cropland's annual rental fee is estimated to EUR 18 000.

We present below the annual expenditures incurred for raw materials and consumables necessary for the agricultural works, including the costs of seeds, pesticides, fertilizers and fuel.

Seed, pesticide and fertilizer prices will be rendered in euros, because, in most cases, they are purchased on pre-order, as most of them are not produced in Romania, and the importers set the prices in euro. Table 5 presents the required seeds, the required quantity per hectare and the purchase price.

Table 5. Estimated costs of seeds for 2018

Seeds	Quantity (bag/ha)	Unit price (euro)	Sown surface (ha)	Total (euro)
Hisseo winter wheat seed (50 kg)	3.25	19	40	2 470.00
Canberra barley seed (40 kg)	4.83	25	30	3 622.50
Legendary alfalfa (25 kg)	1.17	103	30	3 615.30
Total (euro)				**9 707.80**

Source: authors' own design based on case study companies' data

Although the seed-related costs recur every year, it should be noted that these costs will not incur in the first year, when the soil is restored to a suitable state by ploughing and fertilizing.

Table 6 summarizes the various fertilizers needed and the relevant costs. The data shown were calculated based on the interviews with the reference companies' managers, while the methodology was adapted from Vágvölgyi and Varga (2011).

Table 6. Estimated costs of fertilizers for 2018

Fertilizer	Unit price (euro/100 kg)	Quantity/ha (kg)	Worked land (ha)	Total (euro)
Kalkmononsolpeter	23.00	5.00	70.00	8 050.00
Prantkalk	9.10	1.50	70.00	955.50
Ammonsulfatsolpeter	34.55	1.00	70.00	2 418.50
BayWa Power	43.00	0.16	100.00	688.00
Total (euro)				**12 112.00**

Source: authors' own design based on case study companies' data

We summarized the pesticide-related costs in Table 7.

Table 7. Estimated costs of pesticides for 2018

Sprays	Unit price (euro)	Quantity/ha (kg)	Worked land (ha)	Total (euro)
Pacara Forte WG (l/ha)	27.00	1.00	70.00	1 890.00
Stomp Aqua WW (l/ha)	11.60	3.00	70.00	2 436.00
Lexus WW (g/ha)	1.10	15.00	70.00	1 155.00
Juwel Tap WG (l/ha)	54.70	1.00	70.00	3 829.00
Trebon 30 EC (l/ha)	107.00	0.15	70.00	1 112.50
Deeis Flüssig (l/ha)	23.80	0.15	70.00	249.90
Total (euro)				**10 683.40**

Source: authors' own design based on case study companies' data

The fuel cost is also an annual repetitive cost, since agricultural works (ploughing, sowing, harvesting) are cyclic. We presented the fuel consumption per hectare of each agricultural process type in Table 8.

Table 8. Estimated cost of fuel for 2018

Fuel	Quantity (l/ha)	Price (RON)	Worked land (ha)	Used quantity (l)	Total (RON)
Spring ploughing	25.00	5.88	100.00	2 500.00	14 691.05
Disking + harrowing	20.00	5.88	100.00	2 000.00	11 752.84
Sowing	8.00	5.88	100.00	800.00	4 701.14
Harvesting	25.00	5.88	70.00	1 750.00	10 283.73
Twisting + bailing	20.00	5.88	30.00	600.00	3 525.85
Autumn ploughing	25.00	5.88	100.00	2 500.00	14 691.05
Mowing + turning	20.00	5.88	30.00	600.00	3 525.85
Spraying + fertilizing	30.00	5.88	70.00	2 100.00	12 340.48
Transporter (l)	-	5.88	-	500.00	2 938.21
Generator	-	5.88	-	1 000.00	5 876.42
Total				**13 350.00**	**84 326.61**

Source: Authors' own design based on case study companies' data

The amount of fuel needed for every work phase was determined based on the data provided by the case companies. Based on our calculations, the annual fuel cost is RON 84 326.61.

To sum up, raw materials and consumables include seeds, fertilizers, sprays and fuel, and while determining future prices, we took into account the expected increase.

The next type of annual cost that we discuss in detail is the repair and maintenance cost. Since the company has a quite large machinery pool of second-hand machines, the repair and maintenance costs have to be taken into account when calculating the investment's net present value. Agricultural studies such as Holló (2015) suggest that the annual repair costs are 3-5% of the purchase price when acquiring new equipment, but for used machinery this value is somewhat higher. Based on the interviews conducted at the case study companies, we came to the conclusion that the annual repair costs of used agricultural machinery are up to 8-10% of its original price. Thus, we determined the annual repair costs as 10% of the machinery's purchase price. This is RON 53 919 per year.

In this following section, we present the annual costs related to machinery and crops insurance. These costs are harder to determine because the insurance companies tend to come up with new, customized offers every time, so we determined the insurance fees based on an inquiry. We can choose from several insurance companies' offers for agricultural machinery insurance, but these offers are quite alike, they set the insurance premium to 2.4-2.5% of the machinery's market price. Determining the crop insurance fees is not so simple, though. The region's characteristics (average temperature and precipitation), the crop type and the land's size to be insured are also taken into account. We decided to work with the offer sent by one of Romania's leading insurance companies. The insurance covers damages caused by late spring frost, early autumn frost, drought, hail and hurricane-like rainfalls. The premium is 5% of the insured amount for wheat and barley and 1% for alfalfa.

In addition to the above-mentioned expenditures, there are other annual administrative and energy-related costs. As stated earlier, the company does not have an in-house accountant due to their seasonal activity, so the administrative fees consist of amounts paid for the accounting firm's services. We determined its value to RON 5000 per year, based on the currently available market offer. We determined the annual energy costs (water, electricity and telecommunications) as RON 9000, with an 8% annual increase (INSSE 2015).

To sum up all the expenditures, we prepared a table (see Table 9) for every single year, summarizing all the cost types, and showing the respective year's expenditures in RON. In order to determine the following years' costs, we used the inflation-adjusted value of the costs calculated for 2018. We averaged the annual inflation to 2.5% for the following 8 years, in accordance with the forecast of the National Bank of Romania (NBR 2015).

Revenues

This section deals with the expected annual revenues determined by our calculations, explaining the aspects considered for each revenue. The revenues can be divided into two categories: revenues from crop sales and revenues from subsidies.

In order to determine the revenues from crop sales, the annual yield and the sales price should be determined simultaneously, because in agriculture when the yield is high, the price is low, and vice versa. Table 10 presents the National Statistics Institute's data concerning the wheat, barley and alfalfa yields for the 2007-2013 period.

Table 9. Estimated expenditures for 2018

Expenditures	Euro	RON
Materials + rent		
Land rental fee	18 000.00	
Wages		116 280.77
Seeds	10 199.26	
Fertilizers	12 725.17	
Sprays	11 224.25	
Fuel		87 467.52
Repair + Energy		70 155.29
Total materials + rent	52 148.67	273 903.58
Insurance + loan		
Insured crops		14 506.78
Insured machinery	3 147.15	
Interest	25 523.21	
Installments	40 080.40	
Total insurance + loan	68 750.76	14 506.78
Total expenditures for 2018	120 899.43	288 410.36
Total expenditures for 2018 in RON		**832 457.80**
Total expenditures for 2018 in EUR		**184 990.62**

Source: authors' own design

Table 10. Average annual wheat, barley, alfalfa and straw yields from 2007 to 2013

		2007	2008	2009	2010	2011	2012	2013
Wheat	kg/ha	1 542	3 403	2 423	2 690	3 664	2 653	3 469
Barley	kg/ha	1 772	3 564	2 858	3 003	3 628	2 613	3 451
Alfalfa	kg/ha	13 817	17 109	17 280	16 945	17 474	14 309	16 062
Straw	kg/ha	3 855	8 508	6 058	6 725	9 160	6 633	8 673

Source: authors' own design, based on INSSE (2015)

In order to get a more realistic picture of our 8-year investment's expected revenues, we presume that similar yields can be expected between 2018 and 2023, i.e. there will be some years with high yield and some with low yield, distributed randomly, as yield is influenced by the weather that cannot be forecasted for a 6-year period. Table 11 presents the cereal price evolution for the above-mentioned period.

Table 11. The evolution of cereal prices between 2007–2013 (at current prices)

Cereal	Unit	2007	2008	2009	2010	2011	2012	2013
Wheat	RON/kg	0.87	0.87	0.59	0.69	0.98	0.98	0.88
Barley	RON/kg	1.04	1.17	0.76	0.75	1.02	1.09	1.12
Alfalfa	RON/kg	0.66	0.65	0.61	0.62	0.69	0.64	0.60
Straw	RON/kg	0.10	0.10	0.10	0.10	0.10	0.10	0.10

Source: authors' own design based on INSSE (2015)

Table 12 shows how we built up each year's revenue, including the possible compensation granted by the insurance company.

Table 12. Estimated revenues from the sale of cereals in 2018

Cereal	Unit price (t)	Yield (t/ha)	Insurance	Land (ha)	Quantity (t)	Total value (RON)
Wheat	889.54	4.25	2.90	40.00	170.16	151 361.64
Barley	1 064.54	4.45	3.10	30.00	133.62	142 240.49
Alfalfa	675.55	20.51	17.00	30.00	615.23	415 623.09
Straw	102.50	8.71		70.00	609.55	62 478.68
Total						**771 703.90**

Source: authors' own design

Column 6 of Table 12 holds the higher value between the insured quantity (the product of columns 4 and 5) and the real (grown) quantity (the product of columns 3 and 5), while column 7 holds the revenue from the crop sales (the product of columns 2 and 6). In other words, the quantity shown in column 6 is the annual wheat, barley and alfalfa production or the minimum quantity determined by the insurance contract for low-yield years, when the difference between the harvested quantity and the minimum contractual quantity is paid by the insurance company as compensation. I.e. when determining revenues, we calculate with selling the minimum quantity set forth by the insurance contract or the harvested quantity (if the latter is bigger), and then we multiply this value at the cereal price set for the given year.

The other revenue category is agricultural subsidies. The subsidies for crop production, granted by APIA in 2015, are shown in Table 13.

Table 13. Agricultural subsidies in 2015

Type	Unit price
Direct payment (RON/ha)	1 930.00
Fuel subsidy (RON/l)	1.80

Source: authors' own design based on APIA (2015)

When determining the value of direct payments, we considered the agricultural facility's location and the crops grown, as there are several types of available subsidies, determined on the crop type and the altitude.

In the case of fuel subsidies, the law sets forth that all agricultural companies may claim the reimbursement of 31% of the fuel costs incurred during agricultural works, in form of subsidies, amounting to approximately RON 1.8 per liter. Based on the estimated fuel consumption, we can determine easily the annual value of the respective subsidy.

Financing the investment

Given the capital structure of the case study companies, as well as the capital structure of the sector based on the FADN (2015) database, it can be stated that agricultural companies obtain loans easily, provided that the loan's amount does not exceed their own equity. Based on our previous calculations the total investment cost will be approximately EUR 500 000. Therefore, the investment is financed partially by the company's own contribution (EUR 300 000) and partially by a loan (EUR 200 000). Banks offer loan packages of up to EUR 2.5 million for starting small and medium businesses, and there is a possibility for up to four years' grace period. By taking advantage of these benefits, the company contracts a 6-year loan with a 2-year grace period. Table 14 summarizes all the loan-related charges and costs, as well as the loan costs determined.

Table 14. The company's capital structure and the cost of the external capital

Equity (euro)		300 000.00
Loan (euro)		200 000.00
Charges and commissions	**Costs in %**	**Monthly costs (euro)**
Lending rate	1.00%	27.78
Credit administration charge	1.50%	41.67
Monthly account charges	0.30%	600.00
Annual loan interest	10.00%	1 666.67
Total		**2 336.11**
Loan cost	**14.02%**	

Source: authors' own design based on BCR (2015)

In conclusion, the annual cost of the EUR 200 000 loan is EUR 28 000. The grace period is indispensable for the company as in the first year the land is restored to a proper condition, and the company has no revenues during this period.

The calculation of the net present value

In this chapter we summarize the annual expenditures and revenues presented so far, calculate the investment's expected cash flow and NPV based on the annual cash flows. To calculate the cash flow we used the indirect method, and the annual data are presented in Table 15. The higher values of the last years can be explained by the fact that the company will have no loans in those years.

Table 15. Investment cash flow

2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
17 040.51	4 745.00	-108 235.79	-79 679.23	34 489.26	451 249.18	489 854.34	408 299.85	170 340.51

Source: authors' own design

To determine the net present value, we also need the value of the discount rate applicable for each year. First we calculated the expected return of the equity with the help of the CAPM (Capital Assets Pricing Model) (see Table 16).

$$r_e = r_f + \beta(r_m - r_f)$$

r_e – cost of equity,
r_f – risk free return,
$(r_m - r_f)$ – market risk premium,
β – volatility or the extent of systematic risk inherent to the market.

Table 16. The cost of equity

CAPM	2016
r_f	3.87%
ß	1.11509
$(r_m - r_f)$	9.05%
r_E	**13.96%**

Source: Damodaran (2014)

The risk-free interest rate required during the model's application is determined by the 10-year return of the Romanian government securities. The market risk premium, the r_m-r_f value, was calculated based on the data estimated by Damodaran (2014), as well as the model's other component, the beta. Table 17 summarizes the steps of calculating the beta. First, the sector beta (0.58) is corrected by the company's financial leverage, i.e. the ratio of equity and external capital. The resulted beta must also be corrected by the operation leverage, i.e. the ratio of fixed and variable costs, thus obtaining the beta used in the CAPM.

Table 17. Calculating the company specific beta

Unlevered beta	0.58
Financial leverage	0.6667
Beta corrected by financial leverage	0.9048
Operation leverage	0.2324
Fixed costs	112 300.80
Variable costs	483 179.03
Beta corrected by operation leverage	1.1150

Source: authors' own design

After calculating the cost of equity, we calculated the Weighted Average Cost of Capital, hereinafter referred to as WACC, used as a discount rate when calculating the net present value.

$$\mathrm{WACC} = \mathrm{r_D}\left(\frac{\mathrm{D}}{\mathrm{V}}\right) + \mathrm{r_E}\left(\frac{\mathrm{E}}{\mathrm{V}}\right),$$

where *D* is the value of the external capital, E is the equity, *V* is the value of the company (V=D+E), r_D is the cost of the external capital and r_E is the cost of equity. The annual weighted average cost of capital is summarized in Table 18.

Table 18. The annual weighted average cost of capital (2016-2024)

	2016	2017	2018	2019	2020	2021	2022	2023	2024
r_D (%)	14.01	14.01	14.01	14.01	14.01	14.01	0.00	0.00	0.00
r_E (%)	13.96	13.96	13.96	13.96	13.97	13.98	13.98	13.98	13.98
D/V (%)	0.400	0.400	0.373	0.311	0.222	0.087	0.00	0.00	0.00
E/V (%)	0.600	0.600	0.627	0.689	0.778	0.913	1.000	1.000	1.000
D/E (%)	0.667	0.667	0.596	0.452	0.286	0.095	0.00	0.00	0.00
WACC (%)	13.98	13.98	13.98	13.98	13.98	13.98	13.98	13.98	13.98

Source: authors' own design

The company's annual weighted average cost of capital, as shown in Table 18, has the same value year after year because the cost of equity (13.96%) is almost the same as the cost of external capital (14.02%).

Finally, we calculated the investment's expected NPV, knowing the annual cash flows presented so far and the weighted average cost of capital. According to our calculations, the NPV is RON 636 764, meaning that the investment is worthwhile. The answer to the first research question, therefore, is that it is worth investing in the Romanian agriculture because it will be profitable, despite the Romanian yields and prices.

Risk analysis

This chapter presents the risk-analysis methods applied during the investment's risk assessment, as well as the conclusions drawn from these. We used three methods to analyze the effects of the possibly occurring risks, namely the sensitivity analysis, the scenario analysis and the Monte Carlo simulation.

The sensitivity analysis determined the degree of risk inherent in each factor (Table 19).

Table 19. The NPV after the factors' value change

Case	NPV (RON)
Base scenario	636 764
Case 1a	367 998
Case 1b	890 365
Case 2a	489 754
Case 2b	803 951
Case 3	591 429
Case 4	584 457
Case 5	773 542

Source: authors' own design

1st case: we analyzed the effect of a 10% decrease (1a) and increase (1b) in the forecast cereal price on the net present value, with the constancy of the other factors.

2nd case: we analyzed the effect of a 10% decrease (2a) and increase (2b) in the forecast yields on the net present value. We noticed that if the yields increase, the net present value increases more than it decreases when the yields decrease. This can be explained by the insurance, because it eliminates some of the losses.

3rd case: we presumed a 10% increase in fuel prices. It obviously impacts the net present value, however, this effect is relatively small.

4th case: we analyzed the effect of a 10% wage growth, and the results are quite similar as in the third case.

5th case: we analyzed the case where agricultural subsidies grow 10% faster than the forecasted pace and we concluded that the agricultural subsidies influence the expected NPV quite significantly.

To sum up the results of the sensitivity analysis, we found that the investment's cost-effectiveness is mainly influenced by the cereal price fluctuations, the annual cereal yields and the agricultural subsidies.

The next risk-analysis method used is the scenario analysis. Similar to the sensitivity analysis, we drafted six different scenarios, summarized in Table 20. As the sensitivity analysis pointed out that the investment's cost-effectiveness is mainly influenced by the cereal prices and the yields, we created the scenarios with these in mind.

Table 20. The NPV for each scenario

Case	NPV (RON)
1	79 288
2	173 853
3	367 998
4	423 107
5	890 360
6	1 070 266

Source: authors' own design

1st case (pessimistic scenario): the national cereal yield is high, so the prices are low, but our company's cereal yield is low (e.g. because of the hail). In such cases, the insurance company covers the difference between the produced quantity and the secured quantity, but only at the current market price, so we analyze the revenue collected in the case of the secured quantity and low market prices, and how this influences the net present value. We also presumed that fuel prices and wage costs are going to be 10% higher than the forecast value.

2nd case: the national cereal yield is high, so the prices are low, but our company's cereal yield is low (e.g. because of the hail). It is similar to the previous case, with the difference that we presumed the stability of fuel prices and wages.

3rd case: the national cereal yield is high, so the prices are low, but our company's yield is merely average.

4th case: the national cereal yield is average, but our company's yield is low (e.g. because of the hail).

5th case: the national cereal yield is low, so the prices are high, and our company's cereal yield is average.

6th case (optimistic scenario): the national cereal yield is low, so the cereal prices are high, and our company's cereal yield is also high.

It can be seen that, although we modeled several cases, the expected net present value varies on a large scale, i.e. this method cannot provide a reliable risk analysis due to the investment's complexity and the correlations between the various factors.

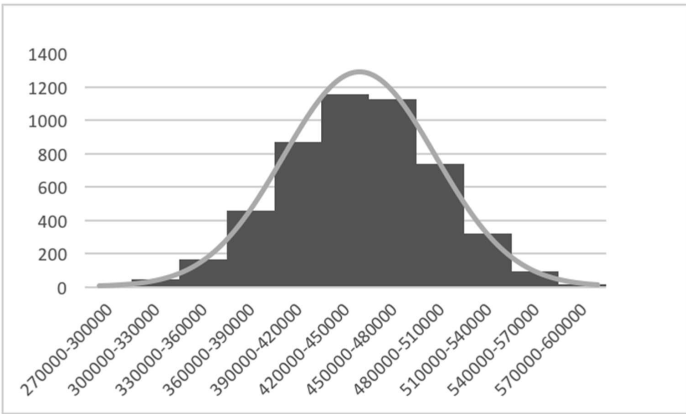
Finally, we created a Monte Carlo simulation to determine 5 000 possible net present values, and examined their distribution (Table 21), thus determining the probability of occurrence of each NPV.

Table 21. The Pivot table of NPVs

NPV (in RON)	Pcs.	Percentage
270 000-300 000	4	0.08%
300 000-330 000	46	0.92%
330 000-360 000	165	3.30%
360 000-390 000	455	9.10%
390 000-420 000	873	17.46%
420 000-450 000	1 159	23.18%
450 000-480 000	1 130	22.60%
480 000-510 000	740	14.80%
510 000-540 000	319	6.38%
540 000-570 000	95	1.90%
570 000-600 000	14	0.28%
Total amount	5 000	100.00%

Source: authors' own design

We drafted a histogram based on the Pivot table (Figure 1) and displayed the normal distribution function, assuming that the net present value has standard normal distribution.



Source: authors' own design based on the Pivot table

Figure 1. The histogram and normal distribution of the NPVs generated by the Monte Carlo simulation

The chart clearly shows that in approx. 2200 of the 5000 test cases the NPV ranges between 420 000 and 480 000, i.e. the probability of the NPV falling into this range is of almost 50%.

The correlations taken into account for the Monte Carlo simulation:

1. Wheat yield = 3.5*Rnd()[4] + 1 ton (assuming that any cropland can produce 1 ton of wheat per hectare, under any circumstances, and the maximum yield does not exceed 4.5 tons);

2. Barley yield = wheat yield + 0.2 (i.e. barley yield is similar to wheat yield, but it is always 0.2 tons more per hectare);

3. Straw quantity = wheat yield + barley yield (i.e. the quantity of straw is determined by the wheat and barley yield);

4. Alfalfa yield = 12 + 2*wheat yield (i.e. the alfalfa yield is 12 tons under any circumstances, up to 21 tons in good years);

5. Wheat prices:

• if the yield is less than 1.8 tons, the wheat price is RON 1/kg;

• if the yield ranges between 1.8 and 2.5 tons, the wheat price is RON 0.95/kg;

• if the yield ranges between 2.5 and 3.4 tons, the wheat price is RON 0.88/kg;

• if the yield is above 3.4 tons, the price of wheat is RON 0.75/kg.

6. Barley prices:

• if the yield is less than 1.8 tons, the barley price is RON 1.1/kg;

• if the yield ranges between 1.8 and 2.5 tons, the barley price is RON 1/kg;

• if the yield ranges between 2.5 and 3.4 tons, the barley price is RON 0.92/kg;

• if the yield is above 3.4 tons, the barley price is RON 0.8/kg.

7. Alfalfa prices:

• if the yield is less than 1.8 tons, the alfalfa price is RON 0.7/kg;

• if the yield ranges between 1.8 and 2.5 tons, the alfalfa price is RON 0.65/kg;

• if the yield ranges between 2.5 and 3.4 tons, the alfalfa price is RON 0.6/kg;

• if the yield is above 3.4 tons, the alfalfa price is RON 0.55/kg.

[4] Microsoft Excel's random number generator, its return value varies from 0 to 1.

8. Straw prices:

• if the yield is less than 1.8 tons, the straw price is RON 0.2/kg;

• if the yield ranges between 1.8 and 2.5 tons, the straw price is RON 0.15/kg;

• if the yield ranges between 2.5 and 3.4 tons, the straw price is RON 0.1/kg;

• if the yield is above 3.4 tons, the straw price is RON 0.08/kg.

The assumptions used while constructing the model were based on the correlations between cereal prices and yields, published by the National Statistics Institute since year 2000 (INSSE 2015).

To sum up the risk-analysis procedures, we can state that the investment's greatest risk lies in the fluctuations of cereal prices and yields, but these can be partially avoided by concluding appropriate insurance contracts. If this is met, the investment's net present value is 100% positive in all 5000 simulated cases, meaning that the investment is worthwhile. Thus, the answer to the second research question is that the risk-analysis models detailed above are essential under any circumstances, especially the Monte Carlo simulation.

Conclusions

In line with the EU policies (EP 2013), we believe that improving agricultural production and competitiveness is one of the main tasks of the coming decades, being a potential solution to unemployment, environmental and energy problems, as well as decreasing the social inequalities. For this reason, solving the agricultural problems in Central and Eastern Europe and Romania becomes increasingly imperative.

The presented methodology offers a solution to the aforementioned problems, allowing us to give answers to questions regarding the cost-effectiveness of agricultural businesses, and thus making this sector more efficient.

In this paper, we were looking for the answer to whether it is possible to operate an agricultural facility economically in the given environmental and economic conditions. Based on our calculations, we can affirm that this type of agricultural activity can be carried out economically. Moreover, by taking into account the information provided by the risk analysis, we can also affirm that, although no huge profit can be expected in this sector, it is a rather reliable industry where proper decisions can lead to financial success in the long run.

It is important to stress that we planned to purchase used machinery at the beginning of the investment, otherwise a two- or threefold capital investment would be needed, prolonging the payback time and increasing the investment risk.

We would also like to emphasize that crop insurance is indispensable for such investments, as our paper's risk analysis chapter also points out, otherwise the investment would be entirely vulnerable to weather conditions. So, one of the first steps is to find the best insurance company.

Further research may be based on the analysis of the investment's cost-effectiveness when including EU funds in the investment's financing, but relevant regulations must be taken into account in this case. In addition, it would be worth examining in a further research the relationship between the variables used in the Monte Carlo simulation, such as the cereal prices and annual yields, and modeling them in order to develop a more accurate risk prediction/analysis method.

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