An economic approach to phytosanitary treatments with organic substances in orchards

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Abstract: *Fruit growing is of particular importance in terms of food and food security. The pest resistance against chemical pesticides and the environmental degradation imposed the research of selective and biodegradable pesticides. The paper focuses on achieving a Cost-Benefit Analysis of phytosanitary treatments in orchards by means of nonpolluting substances, using several performance indicators as: Net Present Value (NPV), Internal Rate of Return (IRR), Benefit-Cost ratio (B/C). The study found that the validation of this technology will have favorable effects on environment protection due to the gradual replacement of chemicals with green products, opening new ways in introducing high precision equipments.*

Keywords: *fruit growing; biodegradable pesticides; phytosanitary treatments; cost-benefit analysis; pest control technology.*

JEL Classification: *O33; Q01; Q16; Q57*

INTRODUCTION

Growing of fruit trees is of particular importance in terms of food and pharmacy. Fruit trees and shrubs one of the the healthiest food for human body. Through the growing of fruit trees, large areas of land are valued, such as the slope of the hills not suitable for mechanization, some sloping land in the lowlands and sandy soils of Oltenia, north-western and southern Transylvania and Moldavia. Culture

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trees are the source of the existence for a significant part of the population working in tree plantations, fruit products manufacturing and fruit trade. The wood of tree species is highly sought for furniture, floors or handicraft.

The main direction of improvement of technologies for the application of phytosanitary treatments is to increase processes quality by making clean working environment conducive to rehabilitation and obtaining healthy products. The intense use of synthetic pesticides in agriculture is one of the several factors that caused the progressive degradation of the environment over recent decades; that is why recent research has focused primarily on environmental aspects and quantities of harmful chemical residues in food, water, groundwater and soil. The pest resistance to chemical pesticides and the environmental degradation have required research and promotion of selective and biodegradable pesticides.

Pesticides, also known as plant protection substances are chemical or natural plant compounds used to destroy parasites and animal pest that attack crops. Depending upon which group of organisms, pesticides are grouped into: acaricides, insecticides, fungicides, herbicides, nematicides.

The European Union has developed a strategy for the use of pesticides and a Directive to reach the goals. In this context, the European Commission proposed a new regulation to govern the use of plant protection products. The European Commission wants to reduce the risk to people and the environment through the use of pesticides, to replace hazardous substances with safer alternatives (other than chemical substances). It also aims at reducing or eliminating the use of chemical pesticides and encouraging organic farming.

The need to increase efficiency in all sectors of the economy makes economic and financial analysis to play an increasingly role, as it can highlight strengths and weaknesses, including the effectiveness of the application of phytosanitary treatments with nonpolluting substances to combat pest in orchards. The analysis plays an important role in assessing, adjusting and improving equipment performance in this area.

METHODOLOGY

1. The objectives pursued in this paper

The main objectives pursued in this paper are:

– Evaluation of investment costs for combating by clean phytosanitary substances compared to the costs of tackling with chemical substances;

- Evaluation of operating costs and total revenues;
- Calculation of financial performance indicators;
- Calculation of economic performance indicators.

In order to achieve these objectives an Excel model of administration of phytosanitary substances will be developed, based on cost-benefit analysis, which will use as inputs investments, operating costs, residual value, etc.

2. The content of cost-benefit analysis, working instrument used in this paper

The cost-benefit analysis is the best known technique for rational allocation of resources. This method of evaluation of expenditure programs is an attempt to measure the costs and gains. Cost-benefit analysis (CBA) is an economic and mathematical tool designed to facilitate funding decisions, and hence the allocation of economic resources currently in the hope of future economic and social benefits. CBA describes and asseses, in terms of costs, alternatives and potential benefits [Florio, M., *et al.,* 2008].

At the EU level, Member States are encouraged to develop their own CBA guidelines for development, taking into account national features.

Romania has developed such a National Guide Cost-Benefit Analysis. It was prepared by the Authority for Coordination of Structural Instruments with JASPERS assistance and the Directorate-General for Regional Policy of the European Commission.

Currently, in Europe, the last document that amends the CBA methodology is the document for the implementation of the CBA methodology (Implementing Act on CBA methodology) for time horizon 2014-2020, forthcoming.

3. Data used: investment costs, operating costs, financial profitability

The first step in the financial analysis is to estimate the *investment costs*. Investment costs can be planned for an initial period and should therefore define the time horizon, *i.e*. the maximum number of years for which forecasts are provided the present value of net future income arising after any time horizon must be included in the residual value. The residual value may be defined as virtual liquidation value.

The second step is the calculation of *operating costs*. Operating costs include all information about the payments for the purchase of goods and services which

are not by nature of investment costs because they are consumed in each accounting period (consumption of materials and services, personnel, maintenance, general production costs).

Once the data were collected on the investment costs, operating costs and revenues, the next logical step is the evaluation of *financial profitability* of the investment.

Relevant indicators are financial net present value of the project (FNPV), internal rate of return (IRR) and the Benefit/Cost ratio (B/C).

The financial net present value is defined as the amount that results when the expected investment and operating costs of the project are deducted from the present value of expected revenues:

$$FNPV = \sum_{i=0}^{n} a_t S_t = \frac{S_0}{(1+i)^0} + \frac{S_1}{(1+i)^1} + ... + \frac{S_n}{(1+i)^n} \quad (1)$$

Where: S_t is the balance of cash flow at time t and a_t is the financial factor chosen for updating at time t, $a_t = (1 + i)^{-t}$, where t is time and i is the discount rate.

A positive FNPV means that the project generates a net benefit (as the weighted sum of the flows of costs and benefits is positive) and is generally desirable from a financial standpoint.

The internal rate of return (IRR) is defined as the discount rate that produces a zero FNPV:

$$VFNA = \bullet[S_t / (1 + IRR)^t] = 0 \quad (2)$$

The internal rate of return is a measure of the relative efficiency of investment. IRR contains useful information about the overall economic value. An advantage of IRR is that is a pure number, making it easy to carry by comparing similar projects.

The financial profitability on investment calculation of net income measures the ability to cover investment costs. Specifically, FNPV and internal rate of return IRR measures the performance independently of investment funding sources.

The Benefit/Cost ratio (B/C) is the financial net present value of project benefits divided by the financial net present project costs:

$$B / C = VA(I) / VA(O) \quad (3)$$

Where: I are inputs and O are outputs. If B/C> 1 the project is suitable because the benefits outweigh the costs.

Like IRR, this ratio is independent of the size of the investment, but it can not generate ambiguous cases and can complete FNPV in ranking projects. B/C can be used to assess the effectiveness of a project.

4. Assumptions and Conditionalities

By this method, non-monetary flows, such as depreciation and provisions, are not taken into account.

Working hypotheses:

- A time horizon of 10 years is envisaged;
- The economic life of the project is considered to be 20 years;
- Duration of the project is 12 months;
- Time reference point for prices is December 2014;
- The discount rate is 5%;
- Diverse and unpredicted expenses are eligible expenditure;
- Expenditures on capital revisions are made at regular intervals;
- Residual value is the value of potential sales. Given the estimated life of 20 years and the low impact of obsolescence of such equipment, a residual value of 40% of the investment can be considered.

There are three possible scenarios:

- "Without investment" is the scenario in which nothing is done;
- "Medium impact investing" which is considering a project with estimated effects moderate, but above the first type of scenario;
- "Major impact investment", which is considered to be the variant of the optimal project, both on short and medium term and long term.

"Without investment" Scenario- The application of phytosanitary treatments is done with traditional equipment that is not provided with sensors for detecting the presence of target plant mass. Active substances are chemicals used for pest control.

"Investment with medium impact" Scenario - The application of phytosanitary treatments with performant equipment, fitted with sensors. Phytosanitary substances are also synthetic.

"Investment with major impact" Scenario - The application of phytosanitary treatments is made with superior equipment and modernization is obtained by replacing sensors with cameras and by using other nozzles. Phytosanitary substances are environmentally friendly.

The analysis uses the principle of incremental investment appraisal. It will evaluate two scenarios: "Investment with medium impact" and "Investment with major impact".

RESULTS

The financial analysis

1. Investment costs

Machines for treating orchards are performing in space, not on the surface, as in field crops, representing a combination of hydraulic and pneumatic dispersion [Stahli, W., 2006]. The phytosanitary solution is dispersed by means of nozzles and air flow is generated by a fan, providing a very fine spray droplets in transport to the place of treatment. A machine with hydropneumatic dispersion is the high precision machine for the application of phytosanitary treatments in orchards, MSL, worked out by The National Institute of Research - Development for Machines and Installations designed to Agriculture and Food Industry - INMA (Figures 1 and 2) [Dumitraşcu, A., 2013].

Figure 1. The high precision machine for the application of phytosanitary treatments in orchards, MSL, in aggregate with tractor

Source: The high precision machine for the application of phytosanitary treatments in orchards, MSL, Experimentation Report, 2012, unpublished.

Figure 2. The high precision machine for the application of phytosanitary treatments in orchards, MSL. Structure

Source: The high precision machine for the application of phytosanitary treatments in orchards, MSL, Experimentation Report, 2012, unpublished.

The main components of the machine MSL are:
1 - Frame, with rolling system;
2 - Spraying system, consisting of axial fan and nozzles;
3 - Installation of liquid, composed of tanks and pump;
4 - Angular gear;
5 - Detection system for the canopy of the tree, consisting of ultrasonic sensors;
6 - Automatic control system, consisting of PLC

Investment costs are summarized in Table 1.

Table 1 - Investment costs ("Investment with medium impact" Scenario)

Nr.	Component	M.U.	Cant.	Unit price	Total price
1	Tractor	pc.	1	60,000 lei	60,000 lei
2	Frame, with rolling system	pc.	1	5,000 lei	5,000 lei
3	Axial fan	pc.	1	2,200 lei	2,200 lei
4	Nozzles	pc.	12	80 lei	960 lei
5	Solution tank	pc.	1	2,000 lei	2,000 lei
6	Clean water tank	pc.	1	200 lei	200 lei
7	Liquid pump	pc.	1	3,400 lei	3,400 lei

Nr.	Component	M.U.	Cant.	Unit price	Total price
8	Angular gear	pc.	1	120 lei	120 lei
9	Ultrasonic sensors	pc.	6	1,500 lei	9,000 lei
10	PLC	pc.	1	4,00 lei	4,100 lei
11	Accesories	pc.	1	1,500 lei	1,500 lei
	TOTAL				**88,480 lei**

Source: The manufacturer's websites and author's calculations.

The tractor is Luzhong 454.

The fan is Blauberg Axis-F 450.

The nozzles are HARDI 1299-06 White 371507.

The pump is Bosch-Rexroth PGH-25.

The angular gear is New Holland.

The ultrasonic sensors are MURATA MA40S4R.

The programmable logic controller (PLC) is IMO-iSmart.

In "Investment with medium impact" scenario ultrasonic sensors will be replaced with two intelligent cameras, such as NI 1722. Thus, detecting the presence of plant mass will be more accurate. Therefore both the amonat of administered liquid and the loss of active substance will be reduced.

Also, conventional nozzles will be replaced with electrostatic nozzles, AccuJet type. Electrostatic nozzles are superior because substances are uniformly distributed, adhering very well even on the underside of leaves and reducing losses due to drift [Koch, H., *et al*., 2000].

Investment costs resulting from the replacement of ultrasonic sensors with cameras and the changing of nozzles are listed in Table 2.

Table 2: Investment costs ("Investment with major impact" Scenario)

Nr.	Component	M.U.	Cant.	Unit price	Total price
1	Tractor	pc.	1	60,000 lei	60,000 lei
2	Frame, with rolling system	pc.	1	5,000 lei	5,000 lei
3	Axial fan	pc.	1	2,200 lei	2,200 lei
4	Nozzles	pc.	12	110 lei	1,320 lei
5	Solution tank	pc.	1	2,000 lei	2,000 lei

Nr.	Component	M.U.	Cant.	Unit price	Total price
6	Clean water tank	pc.	1	200 lei	200 lei
7	Liquid pump	pc.	1	3,400 lei	3,400 lei
8	Angular gear	pc.	1	120 lei	120 lei
9	Photo cameras	pc.	2	3,200 lei	6,400 lei
10	PLC	pc.	1	4,100 lei	4,100 lei
11	Accesories	pc.	1	1,500 lei	1,500 lei
	TOTAL				**86,240 lei**

Source: The manufacturer's websites and author's calculations.

2. Operating costs

Table 3 contains a schematic diagram of phytosanitary treatments for various species of trees and the substances used in the various development stages of the crop.

Table 3: Schematic diagram of phytosanitary treatments

Nr.	Vegetative phenophase	Phytosanitary product	Recommended concentration
1	Vegetative rest (15-28 February)	Confidor Oil Alcupral 50 PU	0 . 8 % 0.5 %
2	Swelling of the buds (1 -10 March)	Bordeaux mixture	1 %
3	The appearance of the first flowers (15-30 March)	Systhane 12 E Score 250 EC Karate Zeon	0.06 % 0.05 % 0.02 %
4	The petals shaking when over 50% of the flowers shook (10-20 April)	Folpan 50 WP Chorus 75 WG Calypso 480 SC	0.1 % 0.02 % 0.03 %
5	The corolla fall, when the fruits are formed (1-10 May)	Dithane 75 WG Cyperguard 25EC	0.25 % 0.02 %
6	Between the 10th and the 14th day from treatment 5	Topsin M70 Talstar 10 EC	0.1 % 0.04 %
7	Between the 14th and the 20th day from treatment 6	Merpan 50WP Calypso 480 SC Envidor 240 SC	0.25 % 0.03 % 0.04 %
8	After Summer logging (15-31 August)	Alcupral 50 PU	0.5 %

Source: http://gradina-fericirii.blogspot.ro/2013/11/schema-tratamente-fitosanitare-pentru.html.

The table shows, totaling periods of phytosanitary treatments, depending on vegetative phenological phase, a total of 85 days per year when the machine is used for high precision application of phytosanitary treatments, *i.e.* under 8 hours per day, a number of 680 hours per year.

The recommended concentration for chemical synthesis plant substances listed in the table is placed in the range 0.02% - 1%, while the concentration of nonpolluting substances that are expected to replace the chemical synthesis is estimated to be between 2 and 10% .

Depending on the type of plantation (extensive, the trees occupy a small share in the surface, there are large planting distances between rows of trees that are planted as ground edges alignments; intensive - plantation density of about 500-1,000 trees / ha, the aim of which itb is exclusively produce fruit; superintensive - densities over 1000-1200 trees / ha

To cover a hectare of intensive plantation with 4 m distance between trees, the tractor-equipment unit must achieve 25 passes, which is 2500 m, *i.e.* 2.5 km. Considering an average speed of 10 km/h, it follows that in an hour plant substances may be administered over 4 ha. In the 680 hours that the estimated total annual period, covered 2720 hectares of fruit tree plantation.

The operator will work 680 hours per year, *i.e.* taking into account an average of 22 working days per month or 176 hours, resulting approximately 3.85 months.

During operation three operating modes of the tractor are distinguished:
- load mode (when the tractor-equipment unit executes the actual treatment plant);
- idle displacement of aggregate, for returns at the ends of lines and movements from one work place to another;
- standstill with the engine running at low speed and stoping for servicing.

The hourly consumption and specific consumption for a 45 HP tractor, as well as those that towes the equipment are given in Table 4.

Table 4 – Fuel consumption

Standstill hourly consumption, C_g [l / h]	3
Idle displacement hourly consumption, C_n [l / h]	7
Load mode hourly consumption, C_s [l / h]	10
Load mode specific consumption, C_{sp} [l / kWh]	0.32

Source: A.Şandru – The exploitation of agricultural machines.

The largest quantity of lubricant is consumed for engine lubrication. For tractors, engine oil consumption is expressed as a percentage of fuel consumption and the range normally within 2.5 to 3.5%. Consumption of other lubricants (oil and grease transmission) is expressed also as a percentage of fuel consumption lie within 0.5 to 1.5%.

Combining the data presented above for a plot intensive average length between 600 and 800 meters and height of trees between 4 and 6 meters, the tractor has a fuel consumption of 3.2 l / ha for the nominal regime. The annual consumption of diesel for 2720 hectares is 8704 l. The average price of Standard diesel, at the main providers (Petrom, Rompetrol, OMV) is about 5 lei/l. Total cost of diesel is 43,520 lei.

The average wage of a tractor operator is 1,800 lei/month. So in the 3.85 months of working in the field of phytosanitary treatments is paid with 6,930 lei.

Chemical, synthetic plant protection substances, still widely used today, have a very wide variety. Examples of unit prices of these substances are: Alcupral PU, 50. 67 lei/kg; Confidor Oil, 305 lei/l; Systhane 12 E, 800 lei/kg; Chorus 75 WG, 585 lei/kg; Cyperguard 25EC, 114 lei/l; Topsin M70, 105 lei/kg; Envidor SC 240, 843 lei/l; Calypso 480 SC, 849 lei/l; Faster 10 EC, 125 lei/l; Mospilan, 580 lei/l; Funguran OH, 510 lei/l. The average price of those substances is about 440 lei/l (kg). Clean plant substances are of two types: non-polluting substances derived from plants (extracts, infusions, decoctions, etc.) and clean plant substances from biomass (bio-based fatty acids) [Vişan, S., 2000]. Clean plant substances are still under experimentation, not widely used, yet not sold. Estimated average price of polluting substances derived from plant biomass above is about 30 lei / l.

The amount of active chemical substance used per hectare, average normal conditions of 187 liters and an average concentration of 0.5% is 0.935 l (kg). At an average price of 440 lei / l (kg) results if treatment plant chemical substances, an annual consumption of 2,543 l, totaling 1,131,724 lei. The amount of active ingredient per hectare of clean used, under the same rules and an average 5% average concentrations of 9.35 l (kg). At an average price of 30 lei / l (kg) results if treatment plant polluting substances, an annual consumption of 25,430 l, totaling 762,900 lei.

Operating cost categories are the following:
1. The costs of fuel, lubricants
2. Personnel costs
3. The cost of the active substance

The values of the operation costs are shown in Tables 5 and 6.

Table 5 - Fuel costs, salaries, active substance ("Investment with medium impact" Scenario)

Fuel cost			**Monthly wage**		**Active substance**	**M.U.**	**Value**
	M.U.		**M.U.**	**Val.**	**Qty./ha**	**liter**	**0.935**
Specific cons.	l/ha	3.2	lei/pers.	1,800	Annual qty.	liter	2,543
Surface/year	ha	2,720			Unit price	lei/l	440
Total cons./year	liters	8,704			Substance cost	lei/l	1,131,724
Price	lei/l	5					
Annual cost	lei/year	43,520					
Annual operating costs	lei						
Fuel cost	43,520						
Salaries	6,930						
Active substance	1,131,724						
Other expenses (oil, lubricants)	2,000						
Total	**1,184,174**						

Source: Author's calculations.

Table 6 - Fuel costs, salaries, active substance ("Investment with major impact" Scenario)

Fuel cost			**Monthly wage**		**Active substance**	**M.U.**	**Value**
	U.M.		**U.M.**	**Val.**	**Qty./ha**	**liter**	**9.35**
Specific consumption	l/ha	3.2	lei/pers	1,800	Annual qty.	liter	25,430
Surface/year	ha	2,720			Unit price	lei/l	30
Total consumption/year	liters	8,704			Substance cost	lei/l	762,900
Price	lei/l	5					
Annual cost	lei/year	43,520					
Annual operating costs	43,520						
Fuel cost	6,930						
Salaries	762,900						
Active substance	2,000						
Total	**815,350**						

Source: Author's calculations.

4. Current maintenance costs are those costs of normal wear and tear of equipment. They consist of: checking tire wear; checking pump and fan performance; checking the tightness of the two reservoirs; measurements of automated command system voltages; replacing burned fuses, measurements of liquid flow through the nozzles. These costs are estimated at 13,000 lei/equipment/year ("Investment with medium impact" Scenario) and 16,000 lei/equipment/year ("Investment with major impact" Scenario).

5. Periodic repair costs are those costs incurred to replace functional components due to optimum operating time expiration and maintenance operations with complex character. Every 3 years it is required to performe a thorough check of mechanical, hydraulic, electronic components and nozzles replacement, whose mean-time operation expires. These costs are estimated at 9,500 lei/equipment/3 years ("Investment with medium impact" Scenario) and 12,500 lei/equipment/3 years ("Investment with major impact" Scenario).

6. Replacement costs of components are costs of normal wear and aging. These costs are estimated at 4,800 lei/equipment/4 years (" Investment with medium impact " Scenario) and 6,300 lei/equipment/4 years ("Investment with major impact" Scenario).

7. Diverse and unpredicted costs are caused by premature wear and vandalism and is estimated at 5% of the average annual total recurrent costs for routine maintenance, periodic repair and replacement.

These four cost categories are summarized in Tables 7 and 8.

Note: During the first year there are no revenues, no operating costs, but investment costs.

Table 7 - Current maintenance costs, periodic repair, replacement, diverse and unpredicted ("Investment with medium impact" Scenario)

Year	Current maintenance	Periodic repair	Replacement	Diverse and unpredicted	Total
0	0	0	0	0	0
1	13,000	0	0	650	13,650
2	13,000	0	0	650	13,650
3	13,000	9,500	0	1,125	23,625
4	13,000	0	4,800	890	18,690
5	13,000	0	0	650	13,650
6	13,000	9,500	0	1,125	23,625
7	13,000	0	0	650	13,650
8	13,000	0	4,800	890	13,650
9	13,000	-35,392	0	0	-22,392

Source: Author's calculations.

Table 8 - Current maintenance costs, periodic repair, replacement, diverse and unpredicted ("Investment with major impact" Scenario)

Year	Current maintenance	Periodic repair	Replacement	Diverse and unpredicted	Total
0	0	0	0	0	0
1	16,000	0	0	650	13,650
2	16,000	0	0	650	13,650
3	16,000	12,500	0	1,125	23,625
4	16,000	0	6,300	890	18,690
5	16,000	0	0	650	13,650
6	16,000	12,500	0	1,125	23,625
7	16,000	0	0	650	13,650
8	16,000	0	6,300	890	13,650
9	16,000	-34,496	0	0	-28,496

Source: Author's calculations.

3. The operating revenues

Since treatments with chemicals, synthetic pesticide at trees maturation, costs about 480 lei per hectare ("Investment in environmental impact" Scenario) and 350 lei ("Investment major impact" Scenario) and that the equipment can provide treatment to 2,720 hectares annually, as shown above, annual operating income amounts to 1,360,000 lei, respectively 952,000 lei.

4. The residual value

A residual value of 35,392 lei can be estimated at the end of the financial analysis ("Investment with medium impact" Scenario) and 34,496 lei ("Investment with major impact" Scenario).

5. The financial performance indicators

Indicators for the financial performance of the project are financial net present value (FNPV), internal rate of return (IRR) and Benefit/Cost ratio (B/C). Financial performance indicators are calculated using the Excel of Microsoft Office 2003 suite, having as input the above data. These are presented in Appendix I.

In "Investment with medium impact" scenario the financial net present value is 644,941 lei. Being positive, it does not require structural funding. The internal rate of return is 120.05%. The Benefit/Cost ratio is 1.079. Being higher than one, it means that the project is profitable, revenue generator.

In "Investment with major impact" scenario the financial net present value is 721,270 lei. Being positive it does not require structural funding. The internal rate

of return is 136.91%. The Benefit/Cost ratio is 1.126. Being higher than one, it means that the project is profitable revenue generator.

Financial indicators have higher values in the second scenario, which makes it preferable to the first.

The economic analysis

The economic analysis assesses the project's contribution to overall economic welfare and the key concept is the use of shadow (accounting) prices based on the social opportunity cost, instead of distorted prices observed in the market. This is, in principle, the solution to a problem of social planning and should be systematic. When market prices do not reflect the social opportunity cost of inputs and outputs, the usual approach is to transform them into accounting prices using suitable conversion factors [Florio, M, et *al.,* 2008].

The standard approach in accordance with the usual practice is to move from financial analysis to the economic performance of investment, regardless of its financial sources (Tables 9 and 10). To do this, appropriate conversion factors will be applied to each of the input and output elements to create a new computing model that includes also social benefits and social costs.

Table 9 - Analysis of financial profitability on investment ("Investment with medium impact" Scenario)

	Year									
	1	2	3	4	5	6	7	8	9	10
Total operating revenues	0	1305600	1305600	1305600	1305600	1305600	1305600	1305600	1305600	1305600
Total cash inflow	0	1305600	1305600	1305600	1305600	1305600	1305600	1305600	1305600	1305600
Total operating costs	0	-1197824	-1197824	-1207799	-1202864	-1197824	-1207799	-1197824	-1202864	-1161782
Total investment costs	-88480	0	0	0	0	0	0	0	0	0
Net cash outflow	-88480	-1197824	-1197824	-1207799	-1202864	-1197824	-1207799	-1197824	-1202864	-1161782
Net cash flow	-88480	107776	107776	97801	102736	107776	97801	107776	102736	143818
Internal Rate of Return (IRR)					**120,05%**					
Net Present Value (NPV)					**644941**					

Source: Author's calculations.

Table 10 - Analysis of financial profitability on investment ("Investment with major impact" Scenario)

	Year									
	1	2	3	4	5	6	7	8	9	10
Total operating revenues	0	1305600	1305600	1305600	1305600	1305600	1305600	1305600	1305600	1305600
Total cash inflow	0	1305600	1305600	1305600	1305600	1305600	1305600	1305600	1305600	1305600
Total operating costs	0	-1197824	-1197824	-1207799	-1202864	-1197824	-1207799	-1197824	-1202864	-1161782
Total investment costs	-88480	0	0	0	0	0	0	0	0	0
Net cash outflow	-88480	-1197824	-1197824	-1207799	-1202864	-1197824	-1207799	-1197824	-1202864	-1161782
Net cash flow	-88480	107776	107776	97801	102736	107776	97801	107776	102736	143818
Internal Rate of Return (IRR)					**120,05%**					
Net Present Value (NPV)					**644941**					

Source: Author's calculations.

The economic analysis is summarized in the following five steps: A. Transformation of market prices in accounting prices; B. Monetization of uneconomic effects; C. The inclusion of indirect effects; D. Updating social; E. Calculation of economic performance indicators (Economic Net Present Value, Economic Rate of Return and Benefit/Cost ratio).

A. Transformation of market prices into accounting prices

If the inputs are affected by distortions of prices it is necessary to use accounting prices to reflect the social opportunity cost of resources. When market prices are not the social opportunity cost of inputs and outputs, the usual treatment is to change their accounting prices using appropriate conversion factors.

To simplify the calculation was used as the standard conversion factor of about 0.8[1]. Given that Romania is an EU member since 2007 and that approximately 99% of the materials used in the project are produced in the EU, the conversion factor is 0.8. The conversion factor for labor is determined by the regional unemployment rate and the wage tax. For an unemployment rate of 6% and a level of wage taxes paid by the employer of 32%, the conversion factor is 0.64. In terms of fuel and lubricants, as there is not significant distortion, standard

[1] This value is an average of data taken from 30 studies in developing countries.

conversion factor SCF = 1 will be used. Conversion factors are summarized in Table 11.

Table 11: Conversion factors

Type of cost	Conversion factor	
Investment costs	0,80	
Operating costs		**Percentage**
Fuel and lubricants	1	4%
Salaries	0.64	0.6%
Active substance	0.80	94%
Current maintenance	0.90	1%
Periodic repairs	0.90	0.2%
Replacement	0.90	0.1%
Diverse and unpredictible	0.90	0.1%
Total		100%

Source: Laura Obreja Braşoveanu - Conversion factors in cost-benefit analysis of investment projects (2012) and author's calculations.

B. Monetization of uneconomic effects

One of the most commonly used methods is "willingness to pay", allowing to estimate a monetary value preference discovered or reported by users. When "willingness to pay" is not possible or is irrelevant to the assessment of outputs long-term marginal cost (LTMC) can be calculated as a default rule for counting.

C. The inclusion of indirect effects

Indirect effects are defined as changes in price or quantity appearing in the secondary markets. The circumstances in which indirect effects should be measured and taken into account depends on the existence of distortions, such as taxes, subsidies, monopolistic rents and externalities. Indirect effects should be added to the ACB only when the size distortion is sufficiently relevant and measurable.

D. The social updating

Costs and benefits occurring at different times must be updated. The discount rate in the economic analysis of investment projects - the social discount rate (SDR) - reflects the social vision of how future benefits and costs should be assessed against the present. The European Commission has proposed the use of two social reference rates: 5.5% for the cohesion countries and 3.5% for others. The RAS is based on long-term potential growth estimations and other parameters.

E. The calculation of economic performance indicators

After correcting distortions in price and choice of an appropriate social discount rate, the economic performance of the project is calculated using the following indicators:

- Economic net present value (ENPV): the difference between the discounted total social benefits and costs;
- Economic rate of return (ERR) which produces zero rate for ENPV;
- The Benefit/Cost ratio (B/C), *i.e.* the ratio of benefits to costs to date.

The difference between FNPV and ENPV is that the latter uses accounting prices or the opportunity cost of goods and services instead of imperfect market prices and include any possible social and environmental externalities. ENPV is the most important and reliable social CBA indicator and should be used as the main economic performance for project evaluation. Although ERR and B/C are significant because they are independent of the size of the project, sometimes problems occur. In special cases, for example, multiple ERR or not defined, while the benefit/cost may be affected by considering a given flow, as a benefit or cost reduction. In the present case, non-economic and indirect effects (paragraphs B and C) are not relevant. The economic analysis used the social discount rate (SDR) of 5.5% (see point D), instead of 5% financial discount rate used in the financial analysis. Economic performance indicators are set out in Appendix II. Calculations were made using also Excel.

In the "Investment with medium impact" scenario, the economic net present value is 2,299,378 lei. Being positive it does not require structural funding. Economic internal rate of return is 493.23%. The Benefit/Cost ratio is 1.352. Being higher than one, means the project is profitable.

In the "Investment with major impact" scenario the economic net present value is 1,877,967 lei. Being positive it does not require structural funding. Economic internal rate of return is 417.45%. The Benefit/Cost ratio is 1.411. Being higher than one, means that the project is profitable. Economic indicators have higher values in the second scenario, which makes it preferable to the first.

CONCLUSIONS

The use of phytopharmaceutical nonpolluting substances is an important orientation because of the advantages it offers:
Reduction of environmental food and pollution;

Avoiding the encroachment of pest populations resistant to treatments;

The possibility of using unqualified personnel under total security (both for crops and for operator);

Sustainable use of resources unexploited.

The use of these substances is a key component of organic farming. Organic farming seeks to harmonize the dynamic interactions between soil, plants, animals and humans, the environmental, economic and social development of agro-ecosystems and human needs. Being a type of sustainable agriculture, organic farming purposes can be expressed as a function of minimax - maximizing production and minimizing the negative side effects of agricultural activity.

Financial performance indicators and economic performance indicators, obtaied in the two scenarios, are summarized in Table 12.

Table 12 - Performance indicators

Financial performance indicators			Economic performance indicators		
	Investment with medium impact	**Investment with major impact**		**Investment with medium impact**	**Investment with major impact**
FNPV	644,941	721,270	ENPV	229,378	1,877,967
IRR	120.05%	136.91	ERR	493.23%	417.45%
B/C	1.079	1.126	B/C	1.352	1.411

Source: Author's calculations.

The indicators obtained in Cost-Benefit Analysis prove that technology is self-sustaining, requiring no structural funding and cost, having revenue-generating potential.

Appendix I - Financial performance indicators

"Investment with medium impact" Scenario

	Investment	**Operating costs**								
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
	88480	1184174	1184174	1184174	1184174	1184174	1184174	1184174	1184174	1184174
Overhauls	0	0	0	9500	0	0	9500	0	0	-35392
Current maintenance		13000	13000	13000	13000	13000	13000	13000	13000	13000
Replacements	0	0	0	0	4800	0	0	0	4800	0
Diverse and unpredicted	0	650	650	1125	890	650	1125	650	890	0
Total costs	**88480**	**1197824**	**1197824**	**1207799**	**1202864**	**1197824**	**1207799**	**1197824**	**1202864**	**1161782**
Financial factor	1.000	0.952	0.907	0.864	0.823	0.784	0.746	0.711	0.677	0.645
	88480	1140785	1086462	1043342	989599	938526	901278	851271	814146	748895
Revenues	0	1305600	1305600	1305600	1305600	1305600	1305600	1305600	1305600	1305600
CF	**-88480**	**107776**	**107776**	**97801**	**102736**	**107776**	**97801**	**107776**	**102736**	**143818**
FNPV	**644941**									
IRR	**120,05%**									
PV(I)	8838069									
PV(O)	8193128									
B/C	**1,079**									

"Investment with major impact" Scenario

	Investment	**Operating costs**								
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
	86240	815350	815350	815350	815350	815350	815350	815350	815350	815350
Overhauls	0	0	0	12500	0	0	12500	0	0	-34496
Current maintenance		16000	16000	16000	16000	16000	16000	16000	16000	16000
Replacements	0	0	0	0	6300	0	0	0	6300	0
Diverse and unpredicted	0	800	800	1425	1115	800	1425	800	1115	0
Total costs	**86240**	**832150**	**832150**	**845275**	**838765**	**832150**	**845275**	**832150**	**838765**	**796854**
Financial factor	1.000	0.952	0.907	0.864	0.823	0.784	0.746	0.711	0.677	0.645
	86240	792524	754785	730180	690054	652011	630757	591393	567709	513659
Revenues	0	952000	952000	952000	952000	952000	952000	952000	952000	952000
CF	**-86240**	**119850**	**119850**	**106725**	**113235**	**119850**	**106725**	**119850**	**113235**	**155146**
FNPV	**721270**									
IRR	**136,91%**									
PV(I)	6444425									
PV(O)	5723155									
B/C	**1,126**									

Appendix II - Economic performance indicators

"Investment with medium impact" Scenario

	Investment	Operating costs								
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
	70784	943954	943954	943954	943954	943954	943954	943954	943954	943954
Overhauls	0	0	0	8550	0	0	8550	0	0	-35392
Current maintenance		11700	11700	11700	11700	11700	11700	11700	11700	11700
Replacements	0	0	0	0	4320	0	0	0	4320	0
Diverse and unpredicted	0	585	585	1012	801	585	1012	585	801	0
Total costs	**70784**	**956239**	**956239**	**965216**	**960775**	**956239**	**965216**	**956239**	**960775**	**920262**
Financial factor	1.000	0.952	0.907	0.864	0.823	0.784	0.746	0.711	0.677	0.645
	70784	910704	867337	833790	790432	749238	720259	679581	650290	593209
Revenues	0	1305600	1305600	1305600	1305600	1305600	1305600	1305600	1305600	1305600
CF	**-70784**	**349361**	**349361**	**340384**	**344825**	**349361**	**340384**	**349361**	**344825**	**385338**
ENPV	**2299378**									
ERR	**493,23%**									
PV(I)	8838069									
PV(O)	6538690									
B/C	**1,352**									

"Investment with major impact" Scenario

	Investment	Operating costs								
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
	68892	648895	648895	648895	648895	648895	648895	648895	648895	648895
Overhauls	0	0	0	11250	0	0	11250	0	0	-34496
Current maintenance		14400	14400	14400	14400	14400	14400	14400	14400	14400
Replacements	0	0	0	0	6300	0	0	0	6300	0
Diverse and unpredicted	0	720	720	1282	1003	720	1282	720	1003	0
Total costs	**68892**	**664015**	**664015**	**675827**	**670598**	**664015**	**675827**	**664015**	**670598**	**628799**
Financial factor	1.000	0.952	0.907	0.864	0.823	0.784	0.746	0.711	0.677	0.645
	68892	632395	602281	583805	551703	520273	504313	471903	453887	405329
Revenues	0	952000	952000	952000	952000	952000	952000	952000	952000	952000
CF	**-68892**	**287985**	**287985**	**276173**	**281402**	**287985**	**276173**	**287985**	**281402**	**323201**
ENPV	**1877967**									
ERR	**417,45%**									
PV(I)	6444425									
PV(O)	4566458									
B/C	**1,411**									

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