THE ECONOMIC AND ENERGY EFFICIENCY OF ECOLOGICAL HOLDINGS

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Abstract

The development of the ecological agriculture sector in our country in the past decade has triggered the expansion of the research in the field, at both theoretical and experimental level. The research performed and presented in this paper contributes to the level of knowledge in this field by means of practical suggestions for economically and energetically streamlining the agricultural businesses in our country. These suggestions are materialised in projecting ecological production structures, economically and energetically viable ones. The methodology used in the projection was based on the data gathered at the level of a 700-hectare holding in the south of Romania and integrates specific calculation starting from the technological records and crop budgets. The results obtained allowed us to draw the following conclusions: the economic efficiency (profit rate of 111.1%) can be obtained with a crop rotation made up of 160 ha wheat, 300 ha sunflower, 140 ha maize, 40 ha alfalfa and 60 ha peas; the energy efficiency (energy yield of 0.171) is obtained in the case of the crop rotation made up of 340 ha wheat, 180 ha sunflower, 90 ha maize, 70 ha alfalfa and 20 ha peas.

Key words: ecological agriculture, economic efficiency, energy efficiency, holding modules

The development of ecological agriculture management is a major concern in all the European Union countries, as well as at world level. The sector's dynamics in the past decades, both in terms of the area and production and in terms of consumption have triggered the expansion of the research in the field, as well as the establishment of measures for the development of this sector within the agricultural policies. In our country, the development of ecological agriculture has been supported from a legislative point of view only since 2000, and the research in the field has been mostly experimental. The implementation of ecological technologies has been done especially by know-how transfer from abroad, at present there is no information available on the efficiency of ecological holding modules as there is on conventional agriculture. In this context, we considered it necessary to sequentially monitor the links in the ecological production technologies in order to emphasise through specific research methods the action steps to be taken in order to improve the organisation and operation of ecological holdings.

For this purpose, this paper aims at presenting the results of the research performed in order to identify efficient ecological production structures and thus to stress the way in which economic and energy efficiency can be achieved in the context of not using pesticides, fertilisers or other synthetic chemicals and of obtaining lower yields than in conventional agriculture.

MATERIAL AND METHOD

The projection of efficient holding modules for ecological agriculture was based on the data gathered in the interval 2007-2010 in a holding exceeding 700 hectares in the Calarasi County (SC Auger Petrus SRL, the fourth largest producer in the Calarasi County).

The gathered data included the basic elements required in projecting the technologies for the sunflower, wheat, maize, peas and alfalfa crops, namely: basic crop information (area, average yield, overall yield, technological links); information on the mechanised works (the work volume was monitored for each technological link); information on manual works (the number of days per capita was monitored for each technological link); information on the raw materials (the specific consumptions were monitored for each technological link); information on the specific consumptions rats and prices (the technological expenses were calculated for each technological link) (according to the recommendations in Toma E., 2008).

These data have allowed for assessing the efficiency of the researched holding by means of

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the technological records and crop budgets, respectively by assessing the profit rate and the energy yield in the interval 2007-2010. The crop budgets were established starting from the economic value of the technological process, and the energy budgets (energy balances) were established starting from the use of energy equivalence coefficients at the level of the specific production and consumption. The main formulae employed were:

- The profit rate:

$$Rpr = \frac{(PB-(CV-CF))-Imp}{CV+CF} * 100 \qquad (1)$$

where, Rpr = profit rate
PB = gross product
CV = variable costs
CF = fixed costs
Imp = taxes

- The energy efficiency [according to the recommendations in (Teşu I., Baghinschi V., 1984):

$$R_E = \frac{P_E}{C_E} \qquad (2)$$

where, R_E = energy efficiency
P_E = energy production
C_E = energy consumption

Based on the gathered data, we also started from the idea of the following crop rotation that were possible at the level of agricultural businesses exceeding 700 ha:

Table 1

Holding modules (700 ha)-ecological agriculture

Crops		A	B	C	D	E
Module type I	Ha	160	300	140	40	60
	%	22.9	42.9	20	5.7	8.6
Module type II	Ha	340	180	90	70	20
	%	48.6	25.7	12.9	10	2.9
Module type III	Ha	260	220	120	90	10
	%	37.1	31.4	17.1	12.9	1.4
Module type IV	Ha	300	250	80	30	40
	%	42.9	35.7	11.4	4.3	5.7

A=wheat; B=sunflower; C=maize; D= alfalfa; E=peas

The holding modules projection was performed using two specific methods that can be synthetically described as follows:

- method I - each analysed crop (A-E) had four technological versions (marked V1-V4), allocated to the years 2007-2010, based on which we projected the specific consumptions weighted averages; the prices used in the projection were those in 2010 – this method allowed us to monitor which of the projected modules had the highest efficiency in terms of the crop rotation under the performance conditions achieved by the case study company;
- method II – for each projected crop rotation we tested which combination of technologies applicable to the five crops triggers the highest profitability at module level, calculating the efficiency for 1024 possible rotations among each crop's technological versions V1-V4.

Projecting the holding modules using method I meant that for each crop we recalibrated the crop technologies by adjusting the specific consumptions used per hectare as an average of the four technologies implemented in the four analysed years. We also specify that we used the prices and rates from 2010 in the projection, in order to ensure the comparability of the two technologies. The calculation method for these two recalibrated specific consumptions was:

$$Cj_{Vi}\ redimensionat = \frac{\sum_{n=1...4} Cj_{Vi\,n}}{4} \qquad (3)$$

where, n =number of years (1=2007; 2=2008; 3=2009; 4=2010)
Cj_{Vi} = specific consumption of raw material of type j for the technological link Vi

Each budget allocated to a crop hectare was thus recalibrated based on a single technology. Thus we performed efficiency calculations per hectare for each crop (A-E), after which the results were used at the projected modules level (I-IV) according to the crop rotation in each of them. This allowed for obtaining a budget for each projected module, which facilitated the comparison between their efficiency both economically and energetically. To synthesise, the calculation method can be presented as follows:

$$I_{Mi} = \sum I_{ji} * S_{ji} \qquad (3)$$

where, Mi = module, I = I…..IV
Iji = indicators specific to crop j and module i budgets
Sji = the area cultivated with crop j within module i

Projecting the holding modules using method II meant using as input data the actual technologies employed in the case study holding, but whose economic form was adjusted so as to allow for the comparison among data. Thus, all the prices and rates in the interval 2007-2010 were updated in the constant prices from 2010. The projection stages can be described as follows:

- establishing the input database, namely calculating the new technological records and the crop budgets by using the following notes: **Crop A (wheat)** - AV1 the technological version of 2007; AV2 the technological version of 2008; AV3 the technological version of 2009; AV4 the technological version of 2010; **Crop B (sunflower)** - BV1 the technological version of 2007; BV2 the technological version of 2008; BV3 the technological version of 2009; BV4 the technological version of 2010; **Crop C (maize)** - CV1 the technological version of 2007; CV2 the technological version of 2008; CV3 the technological version of 2009; CV4 the technological version of 2010; **Crop D (lucerne)** - DV1 the technological version of 2007; DV2 the technological version of 2008; DV3 the technological version of 2009; DV4 the technological version of 2010; **Crop E (peas)** - EV1 the technological version of 2007; EV2 the technological version of 2008; EV3 the technological version of 2009; EV4 the technological version of 2010;
- for each projected module (I-IV) performing a comparative analysis among the four

technological versions (V1-V4) used for each crop (A-E) in order to determine which are most efficient economically and energetically; but at the level of a module, we can have any combination of the four technological versions (V1-V4) of the five crops (A-E) which led to running the efficiency calculations in 1024 combination versions (VC);

- for each combination version (VC1, ..., VC1024) projecting the economic and energy efficiency indicators; for each technology version of a crop (V1-V4) the crop budgets were recalibrated as follows: the specific consumptions were maintained as specified in the crop technologies employed in the crop years (V1 – technology 2007; V2 – technology 2008; V3 – technology 2009; technology 2010); the prices and rated from 2007, 2008, 2009 were adjusted with the Consumer Price Index (CPI: 115.4%; 105.67%; 102.33%) so as to allow for the comparison with 2010 (in other words, all the prices and rates were given in the constant prices from 2010); based on the elements above, the budget indicators were recalculated, and for each crop (A-E) this resulted in four economically and energetically comparable technological versions and also four economic budgets and four energy balances;
- by using the formula (3), we obtained the profit rates and energy yields for each Combination Version; sorting the results allowed us to identify which version allowed for obtaining the best economic and energy efficiency.

RESULTS AND DISCUSSIONS

The first projection method involved recalibrating the production technologies for each crop starting from the weighted average of the years 2007-2010, namely:

Table 2

Specific consumptions used in comparing he projected modules

Indicators	UM	A	B	C	D	E
Average yield	kg/ha	3800	2375	6750	13950	3250
Diesel	l/ha	128.5	119.5	143	146	105.4
Phosphoric rock	kg/ha	300	225	287.5	400	187.5
Seeds	kg/ha	300	170	25	20	342.5
Treatment substance	kg/ha	5.5	1.875	2.5	2	2.5
Electric power	Kw/ha	45	0	0	0	0
Manpower	Days per capita	9	7	7.25	10.75	5

A=wheat; B=sunflower; C=maize; D= alfalfa; E=peas

Using these consumptions and the prices and rated from 2010, we projected – for the identified crops – the main technical-economic indicators related to the crop budgets calculated per cultivated hectare, which led to the following results:

Table 3

Comparative projections regarding the economic and energy results at holding module level

Indicator	Module I	Module II	Module III	Module IV
Gross margin – thou lei/module	1997.3	1548.1	1776.6	1689.3
ESU*	395.4	306.4	351.7	334.4
Gross margin rate - %	59.9	46.2	50.0	54.0
Production costs margin – thou lei/ha	2715.1	2059.7	2375.1	2291.3
Profit rate	**111.1**	**63.4**	**74.0**	**88.4**
Energy balance – thou Mcal	6146.2	6821.7	6752.4	5955.0
Energy yield	0.154	0.187	0.169	0.186

* 1 euro = 4.2099, the annual average calculated by NBR for 2010Б The ESU value was obtained by translating the Gross product into Euro and dividing it by 1200 Euro (1 ESU=1200 Euro)

Using this comparison method, the results we obtained allowed us to demonstrate that the first module type achieves the highest efficiency, followed by the module types IV, III and II. In terms of the energy yield, module II is most viable, module I coming in last.

The second projection method involved recalibrating the budgets related to the four technologies for each crop (technologies used in the four years included in the study, marked as V1-V4) by updating the prices and rates in each year at the level of 2010 (their recalculation using the constant prices from 2010 based on the foodstuffs price index), which allowed for comparing the efficiency of the employed technologies.

The new calculations were used in projecting the economic and energy efficiency indicators for 1024 possible technological combinations for each module, which allowed for identifying the optimum combination for the use of the technology in ecological agriculture. Thus, for each projected module, two important efficiency indicators were calculated, namely the profit rate (economic efficiency) and the energy yield (energy efficiency).

Sorting the results allowed us to notice that for all the projected module types, the most efficient combinations were: economically, version VC265 (combination AV2, BV1, CV1, DV3, EV1); energetically, version VC899 (combination AV4, BV3, CV1, DV1, EV3). The most efficient technological combinations proved to be: economically - VC1011 (AV4, BV4, CV4, DV1, EV3) and energetically VC350 (AV2, BV2, CV2, DV4, EV2).

In the context of using this combination of technological versions, the main economic and energy efficiency results at the level of the projected 700-hectare modules are the following:

Table 4

Comparative projections of the economic and energetic results at holding module level

Indicator	Module I	Module II	Module III	Module IV
Gross margin – thou lei/module	1909.8	1706.0	1849.9	1717.9
ESU*	394.9	352.8	382.5	355.2
Gross margin rate - %	56.1	47.7	49.9	51.5
Production costs margin – thou lei/ha	2428.4	2187.7	2367.4	2177.9
Profit rate	83.68	62.80	67.86	70.67
Energy balance – thou Mcal	1778.1	1959.4	1835.2	1937.3
Energy yield	0.157	0.171	0.161	0.170

* 1 Euro = 4.2099, annual average calculated by NBR for 2010

The use of this method confirmed the conclusions drawn from the use of the first method, namely that module I is most efficient economically and module II is most efficient energetically. The current method also adds the technology types that must be employed for each crop in the crop rotation, namely:

Table 5

The technologies optimum combination version

Module I						
Indicators	**UM**	**A**	**B**	**C**	**D**	**E**
		V2	**V1**	**V1**	**V3**	**V1**
Diesel	L	20560	35850	20020	5840	6324
Phosphoric rock	Kg	48000	0	35000	16000	0
Seeds	Kg	48000	51000	3500	800	30000
Treatment substance	Kg	800	0	350	80	150
Electric power	Kw	7200	0	0	0	0
Manpower	Days per capita	1440	2100	140	440	300
Estimated yield	to	560	750	770	520	210
Module II						
Indicators	**UM**	**A**	**B**	**C**	**D**	**E**
		V4	**V3**	**V1**	**V1**	**V3**
Diesel	L	43690	23850	12870	10220	2290
Phosphoric rock	Kg	102000	54000	22500	28000	5000
Seeds	Kg	102000	30600	2250	1400	5800
Treatment substance	Kg	2040	450	225	140	50
Electric power	Kw	15300	0	0	0	0
Manpower	Days per capita	3060	1260	90	770	100
Estimated yield	to	1258	360	495	840	50

A=wheat; B=sunflower; C=maize; D= alfalfa; E=peas

CONCLUSIONS

In the context of ecological agriculture development in the Calarasi County, the projection of efficient holding modules starting from the data gathered on site at the case study level, used as standard, allowed us to draw the following conclusion for 700-hectare ecological holdings: the establishment of crop rotations of five crops, regardless of their type, ensures high profitability rates; the highest profitability rate is achieved in the case of the crop rotation made up 160 ha wheat, 300 ha sunflower, 140 ha maize, 40 ha alfalfa and 60 ha peas (Module I) and by employing the technology combination VC265, namely: wheat - V 2; alfalfa – V 3; sunflower, maize and peas – V 1; the highest energy efficiency is achieved in the case of the crop rotation made up of 340 ha wheat, 180 ha sunflower, 90 ha maize, 70 ha alfalfa and 20 ha peas (Module II) and by employing the technology combination VC899, namely: wheat - V 4; sunflower and peas – V 3; wheat and maize - V 1.

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