Analysis of Business Performance

in the Case of Mixed Farm

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Abstract

The economic analysis of business process on the mixed farm in Prekmurje region in Slovenia was performed. For the assessment of farm business analysis specific technologic-economic simulation model with sub-models were developed. The analysis showed that the most economically feasible vegetable product is onion (Financial result, FR = 2 783.71 € and Coefficient of economics, Ce = 2.24). Among the analyzed field crops is economically the most interesting production of oil pumpkins (FR = 1 920.84 € and Ce = 2.13). The analysis showed that the production of analyzed crops without direct payments is economically unfeasible. Further, linear optimization program for optimization farm production plan was presented too. Considering financial results maximization, production total cost minimization, as well as other resource limitation, in the production plan, the most advantageous combination is one of barley and oilseed rape by the scenario 1. In scenario 2, early cabbage, onion and early potatoes production were suggested. By the scenario 3 barley, red onions, and silver onions is defined. By the last scenario 4 onions and pumpkin oil production is suggested.

Keywords: Economics, Simulation models, Optimization process, Vegetable farm

1. Introduction

Agricultural production is in recent years facing many problems which directly or indirectly affect the prices on the market, which has significant impact on farm operations. Agricultural production may be partly planned in line with trends of average earnings over the last or past years, assuming that the farm output depends on the ability of farm production in the prescribed time period, the available surface, and especially the performance of production in the past year, which is assessed by using indicators of economic viability.

In analyzing the farm business it is important to analyze the assortment of products, and thus it was necessary to observe a number of factors. The analysis should not focus only on the sales aspect, but also on aspects of other activities and functions on the farm. Focus on several aspects of the business brings us to the question of what to produce or offer to the market by serving the market needs. Therefore it is necessary to know farm production capacity and capability to produce with the largest financial result possible. Information is an essential element in the adoption of new business decisions (Kay et al., 2004). In this process the accuracy of data entry is vital for further work in analyzing the results of our production. In the last few decades, the agricultural decision makers have get accustomed to the use of computers and consequently to the implementation of different complex computer models for solution of various planning problems. This includes decision problems and agricultural project solutions, which have long been predominated by different types of simulation models (Rozman et al., 2002; Pavlovič, 1997). However, experiences described in literature (Hester and Cacho (2003), Recio et al. (2003), De Toro and Hansson (2003), Lisson et al. (2003), Romera et al. (2003) and Herrero et al. (1999)) emphasise that a variety of agricultural problems can be solved with computer modelling and simulation process. In this context the methodology of an integrated deterministic simulation system application for decision-making support on organic farms is described by Pažek et al. (2006). Further Berbel (1989) deals with labour managed horticultural firms in Southeastern Spain. It tries to model the decision-making processes and the conflicts between profit maximization, risk minimization, leisure and seasonal labour as decision makers' objectives. Further Hardaker and Pandey (1991) presented the complexity of modelling risk in farming systems with emphasis on stochastic efficiency criteria for analysis of systems when risk preferences of individual farmers are unavailable. Fully integrated and interactive elicitation-optimization procedure for portfolio management was presented by Duval and Featherstone (2002). Methodology for the analysis of input use in the agricultural sector was presented by Gómez-Limón et al. (2004). The novelty of the theoretical model is described by Juan et al. (1996). The authors presented the application of multi-criteria environment ("multi-attribute utility" and "multi-attribute marginal utility") in the case of water for irrigation.

With the goal to make the most of limited resources, engaged in farm and profit maximization, we analyze the performance of the farm. By model calculations of agricultural production and associated sub-models the production of respective culture was first analyzed. Results obtained from model calculations of agricultural production were then used in the mathematical model of linear programming, where we seek the optimal structure of sowing or planting crops.

This article is constructed in the following order: in the first part we present the methodology and theoretical background. The second part presents an actual example of the use of models in practice (such as business analysis on the farm) and concluded with the interpretations of the results.

2. Methodology

The computer simulation model as a decision support tool for the decision maker (i.e. farmer) was developed for the economical analysis of the farm production and in observed Slovene Prekmurje region). Individual production model consists of calculating the most important economic and parameters. After all necessary technologic and some economic input parameters (yield quantity, fertilizer, prices, human and machine labour, etc.) have been put into the developed model it estimates individual production technical parameters, production costs, annual cash-flows and ultimately the Coefficient of economics. The technical relationships in the system are expressed with a set of equations or with corresponding functional relationships. However, to analyze and chose the most suitable farm product and its combination in crop rotation two main methods were used through simulation modeling and linear programming.

Simulation modeling is a way of solving problems with the method of experimentation with the computer model in order to analyze the functioning of the whole or individual parts of the system in certain conditions.

In addition to the basic model we develop following sub-models:

- Irrigation calculation
- Machines calculation

Sub-irrigation reckon model is a model that allows us to determine the number of hours and provides us the required amount from any plant within a specified period required for the continued growth and development. The model is partially extracted from the Pintar study (2003). However, it was upgraded by adding the possibility of real-time monitoring of rainfall, irrigation, which allows us more realistic irrigation

Sub – model for machines calculation is adapted from machinery catalog costs (Dolenšek, 2008), which granted each year for the union of associations, neighborhood assistance - hardware platforms Slovenia.

Sub-model for machines calculations were upgraded in the way that we capture:

- Annual use – the number of tractor and other hours is adapted to the actual situation on the farm.
- Costs of tractor and other machinery were equal to the real situation on the farm.

Both sub-models represent the base for the main model for the calculations for agricultural production, which allows us evaluation of various indicators in following scenarios:

- Planned scenarios:
  - Without direct payments.

    o With direct payments included.
- Real scenarios:
  - o Without direct payments.
  - o With included direct payments.

The simulation model allows the monitoring of planned and realized production by the following formulas:

- Yield= reached yield at area / planned yield at area   (1)

- Revenue = reached revenue at area / planned revenue at area   (2)

- Revenue with included direct payments = reached revenue with included direct (3) payments / planned revenue at area with included direct payments

In our research following economic indicators were used, with some of these formulas being modified and used in our simulation model:

Table 1. Formulas for calculation financial results

PLANNED RESULTS		REACHED RESULTS	
Included direct payments	Without direct payments	Included direct payments	Without direct payments
FR =VPp – (TC–DP)	**FR = VPp – TC**	**FR = VPr – (TC – DP)**	**FR = VPr – TC**
FR = financial results		FR = financial results	
VPp = planned value of production		VPr = reached value of production	
DP = value of direct payments		TC = total costs	

Table 2. Formulas for calculation value of production

PLANNED RESULTS		REACHED RESULTS	
Included direct payments	Without direct payments	Included direct payments	Without direct payments
VPp= AR $\times$ pY $\times$ pCy + pY$_1$$\times$ pCy$_1$		**VPrd= rIDP**	**VPr= rI**
VPp = planned value of production		VPrd = reached value of production at area with included direct payments	
AR= area in ha;		rIDP = reached income at the area with included direct payments	
pY = planned quantity of yield		VPr = reached value of production at area	
pY$_1$ = planned quantity of side yield		rI= reached income at the area without direct payments	
pCy = planned price of product per unit			
pCy$_1$= planned price of side product per unit			

Table 3. Formulas for calculation cost price

PLANNED RESULTS		REACHED RESULTS	
Included direct payments	Without direct payments	Included direct payments	Without direct payments
CP = TC-DP/pY	**CP = TC/Y**	**CP = TC-DP/dY**	**CP = TC/dY**
CP = cost price		CP = cost price	
TC = total costs		DP = value of direct payments	
pY = planned quantity of yield		dY = reached quantity of yield	

Table 4. Formulas for calculation coefficient of economy

PLANNED RESULTS		REACHED RESULTS	
Included direct payments	Without direct payments	Included direct payments	Without direct payments
Ce = VPp/TC-DP	**Ce = VPp/TC**	**Ce = VPr/TC-DP**	**Ce = VPr/TC**
Ce = coefficient of economy		Ce = coefficient of economy	
VPp = planned value of production		VPR = reached value of production	
TC = total costs		DP = value of direct payments	

Table 5. Formulas for calculation breaking point of production

PLANNED RESULTS		REACHED RESULTS	
Included direct payments	Without direct payments	Included direct payments	Without direct payments
BPP=TC-DP/Cy	**BPP= TC/Cy**	**BPP=(TC-DP)/(rIDP/dY)**	**BPP=TC/(rI/dY)**
BPP = breaking point of production		BPP= breaking point of production	
TC = total costs		rIDP= reached income at the area with included direct payments	
DP = value of direct payments		dY = reached quantity of yield	
Cy – price of product per unit		rI= reached income	

Mathematical formulation of linear program used is:

- Maximal financial results

FR max = x1*FR1 + x2*FR2 + x3*FR3 + x4*FR4 + …+ xb*FRb   (4)
Where:
FR1…FRb   Financial results of selective crop   (€)

x1…xb   Area of production (ha)

- Machine working hours:

$$a1*x1 + …an*xb <= s1 – psdun \tag{5}$$

Where is:

a1…ab   Number of available monthly machine working hours
s1   Available machine working hours per month
Psdun   Used machine working hours per month
N   Number of months (n = 12)

- Human working hours

$$b1*x1 + …br*xb <= r1 – prdub \tag{6}$$

Where is:

b1…bb   Number of available monthly human working hours
r1   Available human working hours per month
prdub   Used human working hours per month

3. Results

In the article an example of calculation simulation model use is presented in the case of onion production. In the beginning we also show how we used the data from simulation model in the linear model program for the optimization of agricultural production.

Onion was grown up on the surface of 0.62 ha, where 23 740 kg of onion was produced, (average yield of 38 290 kg/ha). Average selling price per kilogram of onion was 0.20 €/kg, which mean 4 814 € of income at the area of production without direct payments and the 5 035.69 € with included direct payments (which in this case reach 357.11 €/ha).

Table 6. Planned and reached results for used economic indicators in onion (0.62ha)

	PLANNED RESULTS		REACHED RESULTS	
Onion	Without direct payments	Included direct payments	Without direct payments	Included direct payments
CP	0.07	0.07	0.09	0.09
VP	6 421.41	6 200.00	5 035.70	4 814.29
FR	4 169.42	3 948.01	2 783.71	2 562.30
CE	2.85	2.75	2.24	2.14
BPP	10 152.91	11 259.95	9 572.86	11 104.91

Cost price of onion with included direct payments is 0.09 €/kg. Cost price in spite of lower planned quantity of crop separates in small share. With included direct payments cost price is 0.07 €/kg.

Financial result of a produced onion with included direct payments is 27 83.71 €, and without direct payments it lowers to 2 562.30 €.

Production of an onion with included direct payments is economically viable, which is also confirmed by coefficient of economy (2.24). Without direct payments coefficient of economy is 2.14. In scenario with planed quantity of yield, this is higher than our reached coefficient of economy reached 2.85 or without included direct payments are 2.75.

In the beginning of our research we use collected data from simulation model and used in mathematical linear model program, where we predicted 4 different scenarios:

3.1 Scenario 1

First scenario includes: corn, oilseed rape, barley and fodder pea

Table 7. Limits of optimization (Scenario 1)

available number of tractor hours	500
available number of human working hours	1 000
available area (ha)	10

Table 8. Results of optimization problem (Scenario 1)

	Corn	**Oilseed rape**	**Barley**	**Fodder pea**	**Total**
Max FR	46.03	5.29	299.70	-143.33	1 676.15
Solution area	0.00	2.77	7.23	0.00	10.00

Results indicate that the best combination is sowing of oilseed rape (2.77 ha) and barley (7.23 ha).

3.2 Scenario 2

Second scenario includes: early cabbage, onions, early potatoes and silver onion.

Table 9. Limits of optimization (Scenario 2)

Available number of tractor hours	800
Available number of human working hours	5 000
Available area (ha)	10

Table 10. Results of optimization problem (Scenario 2)

	Early cabbage	**Onion**	**Early potatoes**	**Silver onion**	**Total**
Max FR	1 092.96	2 783.71	871.65	322.71	17 648.84
Solution area	1.09	5.55	1.12	0.00	10.00

Results indicate that the best combination is sowing of onion 5.55 ha, early potatoes1.12 ha an early cabbage 1.09 ha.

3.3 Scenario 3

Third scenario includes: barley, red onion, silver onion and corn.

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Table 11. Limits of optimization (Scenario 3)

Available number of tractor hours	1 000
Available number of human working hours	2 000
Available area (ha)	10

Table 12. Results of optimization problem (Scenario 3)

	Barley	**Red onion**	**Silver onion**	**Corn**	**Total**
Max FR	229.67	271.67	322.71	46.03	2 533.39
Solution area	6.26	2.18	1.56	0.00	10.00

Results indicate that the best combination is sowing of barley 6.26 ha, red onion 2.18 ha and silver onion 1.56 ha.

3.4 Scenario 4

Fourth scenario includes: early cabbage, onion, early potatoes and oil pumpkins

Table 13. Limits of optimization (Scenario 4)

Available number of tractor hours	1 000
Available number of human working hours	5 000
Available area (ha)	10

Table 14. Results of optimization problem (Scenario 4)

	Early cabbage	**Onion**	**Early potatoes**	**Oil pumpkins**	**Total**
Max FR	1 092.96	2 783.71	871.65	1 920.84	2 533.39
Solution area	0.00	5.49	0.00	4.54	10.00

Results indicate that the best combination is sowing of onion 5.49 ha and oil pumpkins 4.54 ha.

We predict four different scenarios of the optimization agricultural production plan. The results obtained that, the first and fourth scenario show the solution for only 2 of 4 growing plant, while third and the second scenario, show the solution for 3 growing plant of 4.

For use in practice, the solution for a given scenario should include all four plants assumed, to satisfy the basic requirements of crop rotation, prescribed in the system of integrated production of vegetables and crops in analyzed production system. For the optimal solution in the future it would be necessary to streamline its FR or human working hours and tractor working hours.

4. Conclusion

For successful planning of future production it is necessary first to calculate the performance of production and respective agricultural cultures, to develop a simulation model of agricultural production reckoning, using sub-models. The model calculates enables calculation of major economic indicators which show the economic efficiency of production,

and the financial result as the basis for finding the optimal structure or sowing. The results show that vegetable production is economically more justified than the crops. Regarding direct payments as the policy instrument of CAP (Common Agricultural Policy), crop production on the farm without direct payments is economically not justifiable, and on the contrary, the production of vegetables without direct payments viable. The results of the optimization of the production at the farm show that the first scenario yields with most favorable structure of sowing barley and oilseed rape; by the second scenario early cabbage, onion and early potatoes; by the 3rd scenario are barley, red onions, black onions and fourth scenario sets onions and pumpkin oil as most favorable in terms of economical performance of the farm.

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