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THE SIMULATION MODEL FOR COST-BENEFIT ANALYSIS ON ORGANIC FARMS

SIMULACIJSKI MODEL ZA ANALIZU TROŠKOVA I KORISTI NA EKOLOŠKIM GOSPODARSTVIMA

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ABSTRACT

The paper describes the methodology of technological and economic simulation model KARSIM 1.0 (DSM) application for decision-making support on organic farms. The model is deterministic and integrates the enterprise budget calculations for individual organic farm product and Cost-benefit Analysis. The DSM was applied on two sample organic farms for simulation of different business alternatives before and after investment into farm product processing. The simulation model results present input parameter for Cost-benefit Analysis (CBA). Two basic financial indicators were calculated: Net Present Value (NPV) and Internal Rate of Return (IRR). At presumed model input parameters (after 10 years of constant cash flow and 8% discount rate) the results show that investments into farm food processing on both sample organic farms are financially feasible. The business alternative on sample organic farm 2 (the combination of animal, fruit and field crop food processing) results with the maximal NPV value (NPV = 7 705,26 €).

Key words: simulation modelling, KARSIM 1.0, organic farming, Cost-benefit Analysis, decision support system.

SAŽETAK

U radu je predstavljena metodologija tehnološko – ekonomskog simulacijskog modela KARSIM 1.0 (DSM) za potporu odlučivanju na ekološkim gospodarstvima. Promatrani sustav je deterministički i integrira kalkulacije ukupnih troškova za individualnu preradu ekoloških proizvoda i financijsku opravdanost investicije analizu troškova i koristi. U radu DSM korišten je za simulaciju prerade gospodarskih proizvoda na dva modela ekološkog gospodarstva prije i poslije investicijskih ulaganja. Rezultati simulacijskog modela koriste se kao parametri inputa za CBA analizu. Za procjenu investicije računali su se neto sadašnja vrijednost (NSV) i interna stopa povratka (IRR). Na bazi parametara inputa za preradu gospodarskih proizvoda (doba konstantnog denarnog toka je 10 godina i interna stopa povratka je 8%), rezultati pokazuju financijsku opravdanost investiranja na oba modela ekološkog gospodarstva. Poslovna alternativa na modelu 2 ekološkog gospodarstva (kombinacija stočarstva, voća i poljoprivredne proizvodnje) rezultira najpovoljnijom NPV vrijednosti (NPV = 7 705,26 €).

Ključne riječi: simulacijsko modeliranje, KARSIM 1.0, ekološka poljoprivreda, analiza troškova i koristi, sustav za potporu u odlučivanju

INTRODUCTION

Organic farming has to be understood as part of a sustainable farming system and a viable alternative to the more traditional approaches to agriculture. During the present decade, Slovenia has experienced an increase in organic farming. By the end of 2005 the number of farms practicing exclusively organic farming or taking up organic farming system amounted to more than 1 600 (or 1, 85 % of all farms in Slovenia). The recent analysis has shown that the average size of an organic farm is 13,4 ha (MKGP, 2006).

The reason is increase of consumer knowledge about organic production methods and potential advantages and disadvantages of these. It is expected that consumer willingness to pay for organic products will increase in the future (Adamič (2000) and Mikola (2004)). On the other hand the experience has shown that in many cases the organic products must be processed in order to be sold successfully. Before making a decision to invest in food processing, an investor needs to have the basic information on which to base his decision. This information contains sufficient economic indicators to form the basis for the decision making. The decision should be based, first of all, on economic profitability of the investment. Cost-benefit Analysis is a method which provides the decision maker with the information about a number of economic indicators regarding the desired investment, from its profitability and competitiveness to the return on investment period (Cejvanović and Rozman, 2004). Investment costs for food processing equipment can be considered high.

The decision to invest in storages and equipment is complex and multi-faceted, requiring assessment of a range of economic, legislative and other factors. Estimating the investment cost can vary from a quick estimate to a carefully prepared, detailed calculation using a complete flow chart, with specifications, depending on how much is known about the organic product and how much time and effort is available to do the estimate. Computer-based simulation models in combination with financial Cost-benefit Analysis (CBA) can capture many of these factors and their interactions and, hence, can play for the farmer a useful decision support role. In the literature many authors discuss the use of CBA in combination with simulation modelling. Pažek (2003) introduced 27 different food processing alternatives on Slovene organic farms. The CBA was conducted with the use of a spreadsheet based simulation model. The recent research has also shown that processing of organic products directly on the organic farm can be financially feasible assuming that the products will be successfully sold (Pažek et al., 2004). In this article we present a KARSIM 1.0 simulation model for decision support on organic farms. The model was developed as information support system for a decision support system based on multi-criteria decision analysis (MCDA) and (Rozman and Pažek (2005), Pažek and Rozman (2005), Rozman et al. (2006), Pažek et al. (2006), Pažek and Rozman (2007), Pažek et al. (2007)). However, the DSM can also be used to conduct cost benefit analysis for organic farm food processing alternatives and preparation of farm business plans.

MATERIALS AND METHODS

Using the technological and economic simulation modelling one can obtain information about the system itself and its responses to different model input parameters (Csaki (1985), Rozman (2004)). The same method could be applied in calculation formulating, especially in the case of the deficiency of relevant data. The relationships between system elements (in this case material, home and hired labour) are expressed with a series of technological equations that are used for calculation (estimation) of input usage and outputs produced. For financial and technological analysis of the food processing on Slovene organic farms the computer simulation model KARSIM 1.0 was developed. There are two basic sub-models: the sub-model of specific farm products and the sub-model of food processing into different final organic products. The developed model enables calculation of the most important economic parameters (break even price, coefficient of profitability, financial result,…) and financial indicators for the alternative evaluation (investment costs, Net Present Value, Internal Rate of Return). The KARSIM 1.0 output data represent some of the input parameters for a specific farm business alternative in CBA analysis. The simulation model (DSM) structure can be observed in Figure 1.

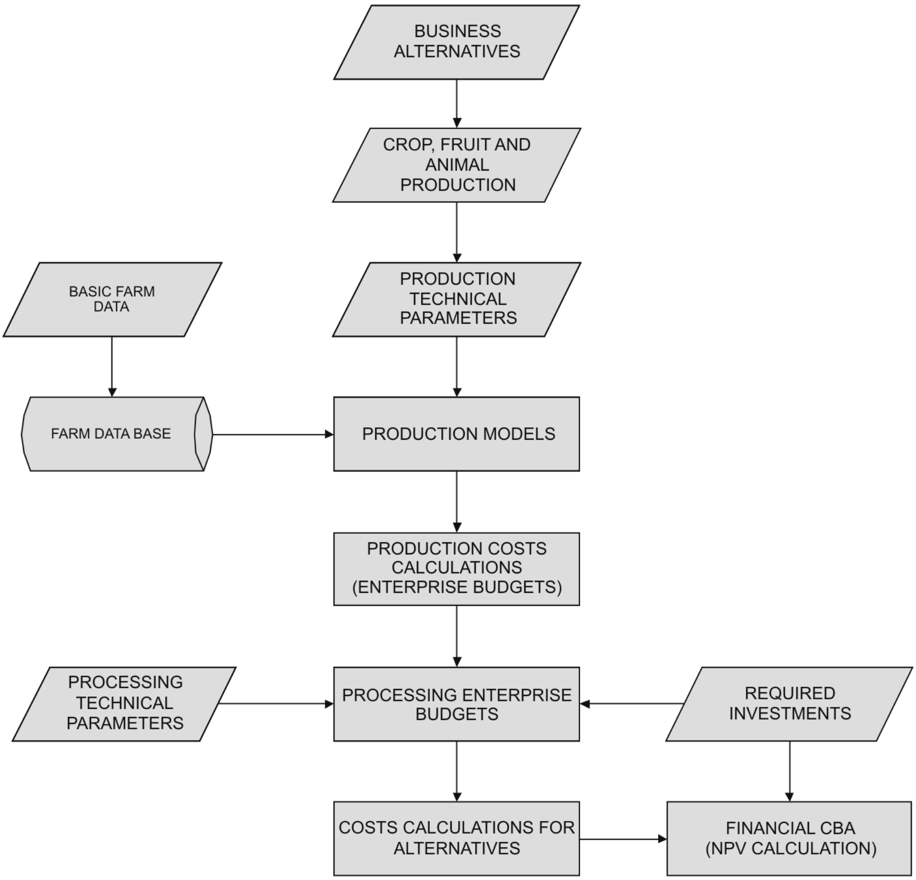

Figure 1: The structure of deterministic simulation model (DSM) for cost calculations and planning on organic farms KARSIM 1.0

For investment analysis Cost-benefit Analysis (CBA) was applied. According to the standard CBA approach, it was presumed that the maximization of the Net Present Value (NPV) of the project investment used market prices for expenditures and commodities and describes the financial feasibility. The Net Present Value (NPV) and Internal Rate of Return (IRR) criteria are most commonly used in the evaluation of investments in specific investment projects. However, the basic objective of financial analysis is the Net Present Value (NPV):

$$NSV = - I + \Sigma\ SP - SS / (1 + r)^t \qquad (1)$$

Where:

NSV	- Net Present Value (€)
I	- investment costs (€)
SP	- total revenue (€)
SS	- total costs (€)
r	- interest rate (%)
t	- time - number of years (Turk, 2002).

With isolation of cash costs from enterprise budgets the annual cash flows are estimated, which represent a basic input parameter for computing of NSV. In Equation 1, the aggregate benefits SP and the aggregate costs SS are annually summed and discounted to the present with the selected discount rate r. If the sum is positive, investment generates more benefits than costs to the project manager (in our case the farmer). If the NPV of the investment after discounting is positive then this investment is better than the alternative earnings.

The internal rate of return IRR was a second calculated criterion (IRR). IRR is the discount rate which makes the Net Present Value equal to zero and for this reason, it is also known as the break-even discount rate (Equation 2). The IRR can be interpreted as the maximum interest rate which a farmer could afford to pay for the funds to carry out the investment and not to lose any money. A decision rule is to accept investments in which the IRR is greater than or equal to the discount rate used to calculate the NPV of the investment. The IRR can also be thought of as being like the average annual return on the capital invested in the project. IRR is the discount rate r such as:

$$NSV = - I + \Sigma\ SP - SS / (1 + r)^t = 0 \qquad (2)$$

While IRR is a straightforward measure and a practical statistic which gives some idea as to whether an investment is worth undertaking, it does come in for some serious criticism at a rigorously theoretical level and should therefore be used only as supplementary to the NPV (Makeham and Malcolm, 1993). The discount rate for the financial profitability analyses was set to be 8%. The uncertainty caused by inadequate data and price information, and the influence of the selection of the discount rate was examined by sensitivity analyses.

Data processing and computer simulation model development were conducted using an Excel spreadsheet program and Visual Basic for application.

Case study

Two part time organic farms were included into analysis using the technologic-economic DSM KARSIM 1.0. The first organic farm holds 14,67 ha grassland, 1.50 ha grassland orchard and 52 milking sheep. The second farm has 10.44 ha grassland, 1.2 ha fields (spelt wheat production - (*Triticum aestivum ssp. spelta McKey*) and raises 8 suckling cows.

In order to perform the analysis business alternatives on sample part time organic farms were selected:

- *Organic farm 1:* the fruit production included apples and plums in a grassland orchard (69% apples and 31% plums) and their processing into apple cider (50%), apple vinegar (50%) and plum brandy (100%). The animal production included milking sheep raising, where 100% of milk was processed into soft sheep cheese.
- *Organic farm 2:* the fruit production (80% apples and 20% of plums) included apple and plum processing into apple cider (87%), apple vinegar (7%), apple juice (6%) and plum brandy (100). Two main products were processed from spelt wheat: spelt flour and husked spelt grain in equal share.

RESULT AND DISCUSSION

A simulation model KARSIM 1.0 has been developed to perform economic and financial analysis for two business alternatives on defined sample organic farms (SM). The immediate simulation model result is an individual organic farm product enterprise budget (Table 1, Table 2, Table 4 and Table 5). The model is deterministic and integrates the effects of technological, economical and financial parameters. The technological and economic model KARSIM 1.0 provides the operator with an ability to evaluate investment options, based on the following key criteria: Net Present Value (NPV) of the investment, Internal Rate of Return (IRR) on capital invested and direct annual net cash flow over the life of the investment. The KARSIM 1.0 model has been developed from the spreadsheet model (Figure 1). For the financial analysis the NPV is estimated for 10 years at 8% discount rate.

Table 1: Decision simulation results (DSM) for organic sample model farm 1 (SM1) before Investment

SM1 - before Investment					
Farm product	Quantity (kg,l/year)	Total revenue (€/year)	Financial result (€/year)	Coefficient of economics (Ce)	Labour (hours/year)
Apple	4 043	421,72	30,85	1,08	50
Plum	294	67,48	- 60,79	0,53	14
Sheep milk	14 573	140,34	- 237,05	0,37	1 171
Total		629,54	- 266,98		1 235

Economic calculations and estimation of some technological parameters performed in KARSIM 1.0 are based on the simulation of organic farm production and processing. The results show that on a sample organic farm before investment into specific processing equipment apple production results with the positive financial value (30.85 €) and is economical by feasible (Ce = 1,08). The sheep breeding results with the lowest financial value (- 237,05 €). This result could be explained by labour intensity of the branch (compared to presented fruit production) and consequent higher production costs (Table 1).

The analysis shows the importance of variety and share of specific food product selection (Table 2). From the economic point of view the most suitable is apple cider production (Ce = 1.65) followed by soft sheep cheese production (Ce = 1,06). Plum brandy production results with lower economic parameters, which can be explained by low production quantity and high labour intensity of the production process (distillation process).

Table 2: Decision simulation results (DSM) for organic sample model farm 1 after Investment

SM1 - after Investment					
Farm product	Quantity (kg,l/year)	Total revenue (€/year)	Financial result (€/year)	Coefficient of economics (Ce)	Labour (hours/year)
Apple wine	1 314	657,89	- 277,42	0,70	66
Apple cider	1 314	1 644,73	645,47	1,65	81
Plum brandy	33	222,94	- 125,20	0,64	40
Sheep cheese (soft)	4 736	39 572,83	18 848,44	1,06	5 104
Total		42 053,40	1 9091,28		5 291

Table 3: Financial analysis results for organic sample model farm 1 (NPV calculated at 8% discount rate)

SM1	
Year	Estimated Annual Cash flow (total) (€/year)
1	- 18 723,21
2	- 14 063,81
3	- 12 408,92
4	- 9 251,78
5	- 6 094,63
6	- 2 937,49
7	219,65
8	3 376,79
9	6 533,94
10	9 691,08

Investment costs = 22 154,07 €
Investment return period = 10 years at 8% discount rate; NPV = 925,10 €
IRR at investment return period = 9,27 %

The applied methodology should bring unequivocal clarity to the decision which business alternative should be most profitable and implemented on an organic farm on the presumption of given input data before and after investment (Table 3). The financial analysis shows that Net Present Value is after 10 years constant annual cash flow and 8% discount rate a positive value (925,10 €). Internal Rate of Return at investment return period is 9,27%. The analysis shows that the investment into analyzed business alternative on farm level is financially feasible.

Table 4: Decision simulation results (DSM) for organic sample model farm 2 (SM2) before Investment

SM2 - before Investment					
Farm product	Quantity (kg,l/year)	Total revenue (€/year)	Financial result (€/year)	Coefficient of economics (Ce)	Labour (hours/year)
Suckling cows – calf meat	1 602	6 683,36	505,48	1,08	160
Apple	8 269	862,62	269,37	1,45	87
Plum	294	67,48	- 28,81	0,70	
Spelt (husked)	1 764	920,13	- 121,32	0,88	53
Total		8 533,58	624,72		300

In order to improve the welfare of dairy cattle a number of organic farms introduced suckling systems, in which the calf is reared suckling its mother. The economic analysis shows that on the presumption of given input data the calf rearing is feasible (Ce = 1,08) (Table 4). Economically feasible is also grassland apple production (Ce = 1,45). On the other hand, plum and husked spelt wheat production are economically infeasible. The reason for economic infeasibility of spelt wheat production is the small production quantity (the sensitivity analysis shows that 1.4 ha of spelt wheat would be economically feasible; Ce = 1,04).

Table 5: Simulation results (DSM) for organic sample model farm 2 after Investment

SM2 - after Investment					
Farm product	Quantity (kg,l/year)	Total revenue (€/year)	Financial result (€/year)	Coefficient of economics (Ce)	Labour (hours/year)
Suckling cows – calve meat	1 602	6 683,36	505,48	1,08	160
Apple wine	4 676	2 341,50	592,13	0,80	245
Apple cider	376	470,99	168,54	1,56	21
Apple juice	322	403,71	157,21	1,64	15
Plum brandy	33	222,94	- 64,66	0,78	35
Spelt grain	882	2 208,34	1 047,90	1,90	66
Spelt flour	706	1 766,65	370,24	1,27	68
Total		14 097,46	1 592,58		610

The DSM results show that analysis of the selected business alternatives results with satisfactory evaluation of economic parameters. The exception are only apple wine and plum brandy production (Ce = 0.80 and Ce = 0.78) (Table 5). Relatively favourable economic parameters (Ce) after investment into specific equipment can be explained by higher selling prices and higher quality of different processed organic products (apple cider, apple juice, spelt grain, spelt flour). The economic evaluation of organic suckling cows production before (Table 4) and after investment (Table 5) shows the same results and is economically feasible (Ce = 1.08). The latter could be explained by the same selling price of the cattle despite significant differences between both production systems (animal welfare after investment).

Table 6: Financial analysis results for organic sample model farm 2 (NPV calculated at 8% discount rate)

	SM2
Year	Estimated Annual Cash flow (total) (€/year)
1	- 7 334,04
2	- 4 827,88
3	- 2 321,71
4	184,45
5	2 690,61
6	5 196,77
7	7 702,94
8	10 209,10
9	12 715,26
10	15 221,43

Investment costs = 11 052,08 €
NPV calculated after 10 years and at 8% discount rate = 7 705,26 €
Investment return period = 5 years at 8% discount rate;
NPV = 895,08 €
IRR at investment return period = 13,79%

The discounted cash flow over the 10 year period for the presented business alternative is shown in Table 6. Specific equipment in food processing means high investments cost (11 052,08 €). The Net Present Value gave in the investment return period (5 years at 8%) positive value (NPV = 895,08 €). Internal Rate of return is in the investment return period for the farmer from financial aspect very satisfactory (IRR =13,79%).

CONCLUSIONS

The presented integrated simulation model KARSIM 1.0 combined with Cost-Benefit Analysis presents s suitable methodological tool for decision support on organic farms. The results of KARSIM 1.0 model represented the input parameters for CBA of all available food processing projects (investments).

The applied methodology should bring clarity to the decision which farm production or business alternative should be favoured and implemented on an organic farm on the presumption of given input data before and after the investment (Table 3 and 6). The CBA results show the financial feasibility of organic production directly on the farm on the assumption that expected prices and yields will be achieved and that products will be successfully marketed.

The use of integrated technologic-economic simulation model KARSIM 1.0 approach can bring additional information into the decision-making framework. The application of the proposed decision support system would increase the accuracy of information needed for planning and developing farm business and that in addition it would help preventing many inappropriate decisions made on organic farms.

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