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Evaluation Models for Decision Support in the Context of Organic Farming System

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Abstract

This paper presents the application of the combination of simulation model and multi-criteria decision models for evaluating investment in agricultural processing. The simulated alternatives are evaluated with multi-attribute decision tools expert system. The simulation system consists of deterministic production simulation models that enable different types of costs calculations for organic production and on farm food processing in the framework of supplementary activities. Simulation models were further evaluate by a qualitative multi-attribute decision modelling methodology using the software tool DEX-I and quantitative analytical hierarchical process (AHP). The simulation model was also evaluated by the standard financial analysis (i.e., cost benefit analysis). These results show that there was the difference before and after investment into specific processing equipment of three organic products with respect to positive financial values. The financial analysis reveals that after 10 years the farm had constant annual cash flow with an investment return at 9.43%. This showed that investments into organic farm was feasible financially. The integrated simulation model as the discount cash flow and multi-criteria decision analysis are the suitable methodological tool for decision support system on organic farms. The system takes into consideration different independent criteria and enables ranking of farm business alternatives. The model is useful in minimizing risk and inappropriate decision in investment.

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Keywords: Decision model; risk in agri-farm; farming system

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1. Introduction

The managerial tasks in agriculture are currently shifting to a new paradigm, requiring more attention on the interaction with the surroundings, namely environmental impact terms of delivery and documentation of quality and growing conditions (Dalgaard et al., 2006; Riezebos et al., 2009). This managerial changes is caused by external entities (such as government, public). This changes have been enforced by provisions and restrictions in the use of production input (e.g. fertilizers, agro-chemicals) and with a change of emphasis for subsidies to an incentive for the farmer to engage in a sustainable production rather than based solely on production (Kaufmann et al., 2009; Saysel et al., 2002). There are many factors such as farm type and soil quality, which might influence farmers' decisions. However, it is attempted to consider the complex interactions of all factors (Shi et al., 2005). Some researchers have adopted the approach of isolating parts of a system. In their research, the diffusion of organic farming practices is modeled by a generic agent model based on the theory of planned behavior for understanding and modeling the farmer's decision making process.

However, farmers constantly face decisions about whether to invest a new production process with increased risks and uncertainties or to maintain the current system without new risks and uncertainties. The possible method to evaluate a new investment opportunity is to use traditional discounted cash flow methods. Although the Net Present Value (NPV) methodology is widely used by project decision making process, a disadvantage of the NPV is that the method does not include the flexibility or uncertainty (Tegen et al., 1999; Wang et al., 2010). In fact, not all agricultural venture capital projects could make a profit immediately, because the sustainable development needs to be considered. For example, if the agricultural project of seed-improvement, as a long-term project, succeeds, it will greatly improve the food production and increase farmer's income (Skraba et al., 2003). Then a real option is defined as the value of being able to choose some characteristic of a decision with irreversible consequences, which affects especially on a financial income. Real options use a flexible approach to uncertainty identifying its sources, developing future business alternatives, and constructing decision rules.

Besides econometric modeling and mathematical programming, other approaches can also be used for the modeling of agricultural systems. System dynamics methodology can be used an alternative for modeling policy scenarios (Hadelan et al., 2009; Rozman et al., 2013). This paper presents application of simulation model for evaluating investments and combination with multi-criteria decision models in agricultural processing. The simulated alternatives are evaluated with multi-attribute decision tools as expert system.

2. Methods

The goals of this research is to develop a computer-based decision support system for the assessment of financial, technological and market impact with special emphasis on supplementary activities on organic farms. The relationships between system elements (i.e. input material, human labor) are expressed with a series of technological equations that are used for calculation of input usage and outputs produced the simulation model and decision model are used in analysis system as shown in Fig. 1.

Fig. 1 shows the processing of investment alternatives, which are further evaluated with multi-attribute decision model. A multi-attribute model is a hierarchical structure that represents the decomposition of the decision problem into sub-problems, which are smaller, less complex and possibly easier to solve than the complete model. The variants are decomposed in specific parameters (criterion, attribute, objective) and evaluated separately for each single parameter. The final variant evaluation is provided with the combine proceeding. However, the amounts of inputs are calculated as a function of given production intensity, while fruit 1 production costs are calculated as products between the models estimated input usage and their prices. For evaluation of simulated alternatives two methodological tools are applied: DEX-I expert system and AHP based expert choice. DEX-I is an expert system shell for multi-attribute decision making that combines the traditional multi-attribute decision making with some elements of expert systems and machine learning. This is traditionally carried out in a numerical way, using weights or similar indicators of attributes' importance. At the same time, attributes are organized hierarchically and connected by utility functions that evaluate them with respect to their immediate descendants in the hierarchy.

So if the net present value is negative then the alternative is unacceptable or if the labour usage in the investment project is low then the alternative is excellent. In contrast, in DEX-I modeling this can also be carried out in a numerical