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Farm reorientation assessment model based on multi-criteria decision making

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ABSTRACT

Structural changes in farming present serious challenges at all spatial levels, from individual farms to the state level. The reorientation of a farm (i.e., changing from livestock production to one of horticulture or crops) represents one of these challenges. Here, a model assessing the potential for reorganizing farms to focus on horticulture is presented. The model accounts for various criteria, including: natural resources, demographic, economic, and social factors. The selection, structure, and importance of criteria and their interrelationships in the model are based on statistical data about farms, data gathered through surveys, and expert opinion groups. The model was developed using the Decision Expert method, implemented by the software DEXi, and was validated using a selection of farms. The added value of the approach is a transparent assessment of a farm's potential, which provides vital support for deciding about its reorientation.

1. Introduction

In our current changing world, farmers constantly consider alternative futures for their farms to improve economic output. The main question is usually how to reorient their activities to maximize potential. To answer this question, wide knowledge from different fields is required, such as the branch of agricultural being considered, as well as an appropriate analysis of the farm and its environment (Cardín-Pedrosa and Alvarez-López, 2012; Christensen et al., 2012; Thistlethwaite, 2013). A large number of parameters must be assessed within a given context. These parameters form the basis for conclusions, and influence the quality of suggestions. This knowledge must be acquired and presented in a way that allows a decision to be made. In our study, a component of this knowledge has been transformed into a multi-criteria assessment model to support decision-making on the reorientation of farm activities.

As an example for farm reorientation, we selected horticulture. Horticulture is an agricultural branch involving the growing of plants, such as vegetable species, herbs, flowers, and ornamental plants. It is one of the most intensive agricultural branches. It is characterized by relatively small cultivatable areas. This type of farming is often beneficial for smaller farms, which are very common in Slovenia, where our study was carried out (Adams et al., 2012; McIntyre, 2014).

Multi-criteria decision modeling is a field of operational research that includes a variety of methods that are usually supported by software solutions (Figueira et al., 2005; Ishizaka and Nemery, 2013). Their common denominator is the assessment of all alternatives according to selected criteria. For each alternative, these assessments are aggregated into a final assessment. On this basis, alternatives are compared, ranked, and analyzed. Among such methods, we have chosen method Decision Expert (DEX) because of its qualitative nature and simple logical rules which increase comprehensibility of the decision process with emphasis on explanation of decision results. Furthermore, method DEX has been successfully used in different complex decision situations in the field of agriculture (Bohanec et al., 2007; Žnidaršič et al., 2008; Pavlovič et al., 2011).

This study presents the DEX method, followed by verification and validation of the knowledge embedded in the DEX decision models. Furthermore, we use selected farms to show how to implement the model in a real environment. The results of this study are expected to demonstrate the utility of these types of decision models for different branches of agriculture.

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Attribute	Description
Reorientation	Assessment of a farm for reorientation
├─**Demography**	Demographic factors of a farmer
│ ├─Age	Farmer's age
│ ├─Education	Farmer's education
│ └─Succession	Succession of a (family) farm
├─**Farming**	Assessment of a farm, its finances and market
│ ├─**Farm**	Farm characteristics
│ │ ├─Type	Farm type
│ │ ├─**Land**	Land characteristics
│ │ │ ├─Altitude	Altitude (in meters above sea level)
│ │ │ └─Activity	Prevailing activities
│ │ └─**Machinery**	Agricultural machinery
│ │ ├─Wear	Machinery wear - wear status
│ │ └─Machine use	Percentage of land cultivation by machinery
│ ├─**Finance**	Financial status
│ │ ├─Financial structure	Financial involvement structure
│ │ ├─Income	Farming as a percentage of income
│ │ └─Ownership	Ownership status
│ └─**Market**	Attributes relates to market
│ ├─Distance	Distance from farm to market
│ └─Sale-type	Type of sale
└─**Region**	Region assessment
├─**Grounds**	Suitability of grounds
│ ├─Relief	Relief suitability
│ ├─Soil	Soil composition
│ └─Water sources	Number of ground-water sources
├─**Climate**	Climate conditions
│ ├─Temperature	Average annual temperatures
│ └─Rainfall	Average annual rainfall
└─**Energy**	Alternative energy sources
├─Solar	Solar energy
└─Geothermal	Geothermal energy

Fig. 1. Tree of attributes with descriptions of attributes.

2. Materials and methods

The methodological approach towards the development of a decision model for farm reorientation is based on a qualitative multi-criteria decision modeling approach. We used DEX methodology to model decision knowledge. The model consists of two parts: (1) criteria for assessing the region and (2) criteria for assessing a specific farm. Criteria for regional assessment are valid for all farms in the same region, while farm-specific criteria must be separately assessed for each farm.

Special emphasis is placed on verifying and validating the decision models. Both components were based on statistical data, survey data, and the opinion of a group of experts from the field of agriculture.

Table 1
Domain value for the criterion *Distance*.

#	value	description	quality
1.	**far**	75 km or more	bad
2.	intermediate	50–74 km	
3.	***near***	up to 49 km	good

Table 2
Domain value for the criterion *Sale-type*.

#	value	description	quality
1.	**poor**	intermediaries	bad
2.	good	cooperative farming	
3.	***excellent***	doorstep sales	good

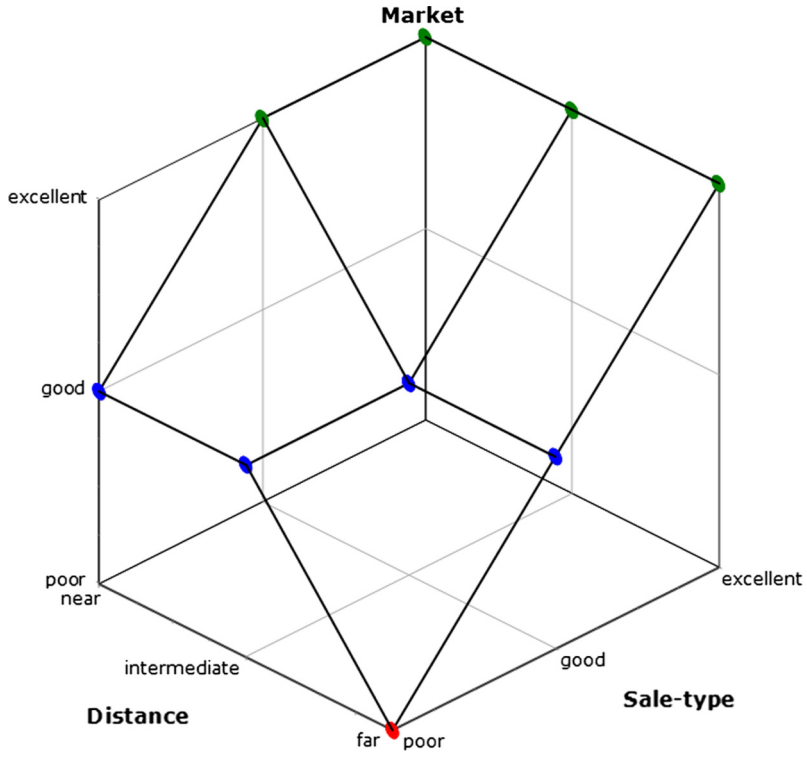

Fig. 2. Graphical presentation of the decision rules – utility function for the criterion *Market*.