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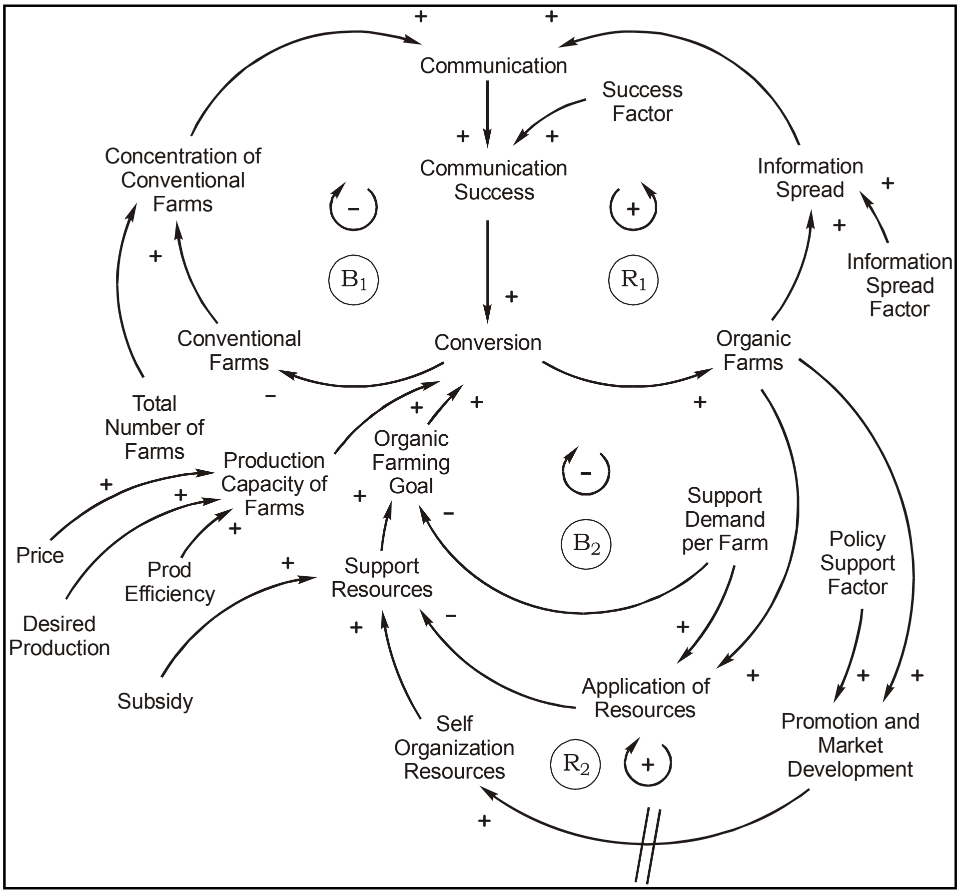

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FOREWORD

Chair for Agricultural Economics and Rural Development was established in 2003 and is about to celebrate its 10th anniversary in the ensuing year. This was clearly one of the main reasons to spur us on to publish a special issue of Agricultura, which is otherwise the official scientific journal of the Faculty of Agriculture and Life Sciences of the University of Maribor.

Our Chair, which consists of solely six members, has been running three study programmes: 1st level degree study programme of Farm Management and Rural Development, 2nd level degree study programme of Agricultural Economics and 3rd level degree study programme of Agricultural Economics. It is especially noteworthy to emphasize that we have been undertaking MSc programme of Agricultural Economics since 2000, which together with the current Ph.D. programme in Agricultural Economics, to date remained two only postgraduate study programmes in agricultural economics in Slovenia. The same holds true also for the 1st degree study programme of Farm Management and Rural Development. It does not come as a surprise, therefore, to acknowledge that our Chair members are the authors of the first Slovene university textbook in agricultural economics (1998), and are also among the authors of the first genuine textbook at the university level of Farm Management (2009). The pedagogical work in last ten years resulted in sufficient number of graduates and postgraduates who are well-trained individuals and skilled professionals.

The members of our Chair are engaged in numerous research activities. They extend from the enrollment in some fundamental and applied research concerning the theoretical aspects and modeling in agricultural economics, to the discussion and empirical investigation of the issues at stake in farm management, agricultural marketing, rural development and farm policy. We have been taking part at several international research projects emanating from various schemes and sources; most notably Framework Programmes of the EU, some small domestic applied research projects with, however, dwindling resources, bilateral programmes, etc. All these efforts have brought about very decent publication records (e.g., many articles published in highly rated peer review journals, a growing number of quotations) which motivates us even further.

The special edition of our review is devoted to broad areas of agricultural economics and rural development. The authors of articles are the members of our Chair, together with some prominent researchers in their specific scientific field and expertise. Amongst them also our first M.Sc. and Ph.D. students who completed their postgraduate study programmes run by our Chair by successfully defending her M.Sc. thesis (Pažek) and his Ph.D. thesis (Rednak) in 2003, respectively.

The agricultural economics research has undergone some formidable progress in its scope and complexity in recent years. A bewildering array of empirical tools enables scientists to tackle effectively various aspects in the ongoing agricultural economics research. This special edition of Agricultura is designed to attract attention on the part of scholars, students and others interested in agricultural economics and related disciplines. Papers presented here examine a wide range of different research topics by using appropriate methodological framework. Articles concentrate on the principles, techniques and applications primarily related to farm management, agricultural marketing, rural development and policy aspects. They highlight underlying issues, effectively combining academic rigor and topicality with a concern for practical application. Our joint effort undertaken here could be perceived as a small contribution to make the subject of agricultural economics comprehensive enough and even more popular than is the case nowadays.

Head of Chair, and
President of the Slovene Association of Agricultural Economists

Professor Jernej Turk

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Economic bases for a cooperative business in Slovenian agriculture

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ABSTRACT

Slovenia's agriculture is essential for the economic livelihood of rural areas as it continues to act in accordance with a market-oriented agriculture, which includes cooperative businesses structures. One solution for improving the marketing and profit margins for so many farm enterprises in Slovenia is the formation of a cooperative business. The cooperative form of business can serve both small and large producers by providing a business structure that can grade, process, sell, and distribute products with the best interests of member-patrons in mind. In other sectors of an economy, the impetus to gain economic efficiencies often leads to a horizontal expansion of the firm. Instead of expanding their business horizontally, farmers are sometimes motivated to form a cooperative in expectations of increased economic efficiencies from vertical expansion. Understanding the economic justifications for starting a cooperative business and the economic strategies that cooperatives can use to compete in the market to remain in business is an important prerequisite for making wise business decisions. Eight economic justifications for cooperative organization are provided for consideration which includes; market failure, economies of size, profits from another level, provide missing services, assure supplies or markets, gain from coordination, risk reduction, market power, the competitive yardstick.

Key words: cooperatives, economic justification, Slovenian agriculture

INTRODUCTION

Slovenian agriculture has and will continue to have a major impact on Slovenia's economic future. Although agriculture only contributes around 2% to the GDP of Slovenia, it plays a more significant role in the rural framework of Slovenia since 50% (CIA Factbook Slovenia 2012) of Slovenians reside in rural regions of the country. According to the OECD criteria for regional subdivision, Slovenia comprises twelve regions, eight of which are mainly rural, and four principally rural. The four principally rural regions account for nearly a third of Slovenia's territory, and are home to 38.5 per cent of the entire population (RDP 2007-2013).

A foundation of a rural economy is small farms which produce of variety of commodities for sale. Slovenia's agriculture is essential for the economic livelihood of rural areas as it continues to act in accordance with a market-oriented agriculture, which includes cooperative businesses structures. Cooperative businesses can play a role in improving the effectiveness of marketing agricultural products and buying agricultural production inputs. In addition, the capacity to increase its agricultural production is grounded in both the agricultural resources of the country and the capability of its people to both work hard and make wise decisions about the use of these resources. Western-style cooperative businesses offer farmers an opportunity to capture profits from the next market tier through the addition of value to their products. However, in all cases, a prerequisite for establishing a cooperative business is a strong rationale or justification for the cooperative.

There are constraints that limit the ability of Slovenia to realize the full potential of its capacity to increase agricultural production. The average farmer does not have enough capital to reach the optimum level of intensification of his/her farming operations. Other factors that complicate the current situation are the average age of farmers and their average education level. An additional constraint is imposed by Slovenia's agribusiness sector, which the Slovenian government seeks to improve.

One solution for improving the marketing and profit margins for so many small farm enterprises is the formation of a cooperative business. The cooperative form of business can serve producers by providing a business structure that can grade, process, sell, and distribute products with the best interests of member-patrons (producers) in mind. Within producer associations, it is expected that there is some resistance to the term "cooperative" itself, but also to the previous working principles of cooperatives that were promoted during the socialistic period when Slovenia was a part of Yugoslavia. Family farms find it difficult to give up a form of independence, which can be understood as justifiable based on the result of experiences in the past. Presently,

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Slovenian law provides for western-style cooperative formation as a legal business. Now there is support from the European Commission for operating a cooperative with the intention to gain a profit and serve to benefit the member-owners. These circumstances raise questions regarding the legal frameworks, financial obligations (taxes, privileges etc.), business decision-making, and economic justification that are inherent to the cooperative form of business.

At the end of 2005, 497 cooperatives were registered in Slovenia, 145 of which were registered in the field of agriculture (RDP 2007-2013). Although progress has been made, Slovenia's farmers lack access to efficient markets for both the farm inputs they buy and the production they offer for sale. If existing markets do not allow farmers to capture the full market value of the commodities they sell, their incentive to increase production will fall short of the price level needed for the optimum level of Slovenia's agricultural production.

Increased farm production means enhanced food security. It means an increase in Slovenia's national well-being by expanding both the country's GNP and the number of jobs generated by Slovenia's agribusiness sector. It means increased net foreign exchange earnings by either substituting domestic food for more expensive food imports or by expanding agricultural exports. The full range of new wealth generated by farmer-owned cooperatives is a sustainable increase in wealth. It is sustainable not only for farmer members, but also sustainable for rural community development, increased food security, higher GNP, expanded agribusiness employment and more favorable foreign exchange balances. It is clear that promoting farmer-owned cooperatives cannot only increase the well being of Slovenian farmers, their promotion can also assist in the sustainable development of the country. Only through a process of justifying a new cooperative business can the organizers of the cooperative realize success in the form of economic benefits to the owner-members.

WHY START A COOPERATIVE BUSINESS?

Why would farmers be interested in forming a cooperative which involves their management, risk, and investment? What is there about the cooperative form of business that would lead farmers to carry out all of the tasks involved in organizing, using, and financing a cooperative rather than relying on other businesses for marketing, buying products, or providing services? Once established, what strategies can a cooperative employ to stay in business, compete and strengthen its market power? In other sectors of an economy, the impetus to gain economic efficiencies often leads to a horizontal expansion of the firm. Instead of expanding their business horizontally, farmers are sometimes motivated to form a cooperative business in expectations of increased economic efficiencies from vertical expansion. Understanding the economic justifications for starting a cooperative business and the economic strategies that cooperatives can use to compete in the market to remain in business is essential for making wise business decisions.

Early 20th century justifications for cooperatives emanated from two American leaders, Sapiro and Nourse, who justified a cooperative business from different perspectives. Sapiro was a lawyer from California who justified cooperatives as a means to alter imbalances in grower treatment and improve marketing coordination by using cooperatives to achieve more orderly marketing (Sapiro 1920). Sapiro thought that by organizing a cooperative that had significant market power and emphasized grading and pooling techniques, agricultural products could be sold to buyers in a measured fashion that circumvented the unfavorable results of discarding products at harvest on the market all at one time. Sapiro's vigorous support for cooperative development because of the market power it gave farmers remains a contemporary reason for the economic justification of cooperatives.

The other macro economic justification for cooperatives was developed by Professor E.G. Nourse and has become known as the competitive yardstick school. (Nourse 1922, 1995). Nourse developed his justification as a response to Sapiro's promotion of marketing cooperatives. Nourse believed in the type of cooperative structure that originated from locally organized service cooperatives representative of the farm supply and grain elevator cooperatives in the United States. He argued that cooperatives could be organized to represent a limited share of marketing activity and still serve a 'yardstick' role by which members could measure the performance of other firms dominating the marketing channel. According to Nourse, this function would force other businesses to be more competitive. If markets became more competitive due to the role of cooperatives, Nourse conteded from an economic viewpoint, their function was fulfilled and they could cease to exist. In reality, perfectly competitive market conditions were never going to be permanently established. Because he was in opposition to the Sapiro form of cooperatives, which embraced a democratically controlled and dominant commodity associations, Nourse advocated that cooperatives could achieve economies of scale by affiliating through purchasing or marketing federations which preserved a bottom-up structure rather than a more centralized, top down one.

More contemporary cooperative schools of thought have sought to explain the place of cooperatives in the agriculture economy because of reduced transaction costs and the lack of a business hierarchy at the family farm level compared to other types of production enterprises, broadly defined. Staatz (1987) explained the choice of cooperative form of business organization in terms of its ability to economize transaction costs. Hansmann (1996) complemented Staatz's work by explicating the existence of cooperatives to be connected to the high costs of market contracting and low costs of ownership for cooperative members. In addition, Valentinov (2005) argued that agricultural cooperatives are needed because they partially perform the coordination functions ineffectively delivered at the family farm level due to the lack of conventional hierarchical and market types of economic organization. All three authors noted that agricultural production system contains particular elements that make it conducive to the formation of cooperatives for the benefits of member-owners. Finally, Valentinov (2007) traced the origins for cooperative organization back to the lack of a farmer's realization of economies of scale at the farm level and the ability of a cooperative business to develop market power comparable to that of their up and downstream trading partners.

The economic bases for cooperatives, therefore, is found in the fact that economic efficiencies gained by producing agricultural commodities using a family farm model are difficult to realize at the processing level. One solution to this farm problem is the organization of a cooperative. At the farm level, there are frequent reasons why farmers seek to form a cooperative in order to promote their economic well-being. The fundamental motivation for forming and sustaining a cooperative is to improve the well-being of every member. The cooperative does this by reducing costs or increasing profits at the farm level through marketing commodities or purchasing products for its membership. The following eight economic justifications (adapted from Schrader 1989) describe the more common reasons why farmers may want establish and use a cooperative.

MARKET FAILURE

Market failure is a situation in which markets do not efficiently organize production or allocate goods and services to consumers. Markets work best when there is open competition among businesses and the businesses work with the intention of making a profit. Business practices and market prices react to competition. When a market fails to provide fair prices for buyer or seller, the buyer and seller will become motivated to seek other business arrangements that are more advantageous to them such as the formation of a cooperative. On occasion, this situation does not exist within the agriculture sector of the economy. Farmers may find themselves in a difficult business situation when, for various reasons, they cannot sell or buy a product or service. For example, if individual farmers can only sell a commodity to a few buyers, they must take the price offered. However, when farmers form a cooperative, they can extend their business forward one level or backward one level and thus gain a competitive advantage in the marketplace. When farmers market a perishable product such as fruit or milk, they have few other selling opportunities because of the relatively short shelf-life of their product. In other cases, farmers may have little information about what is a fair price in the market place. A cooperative can benefit farmers by representing them in the marketplace to give them an advantage in negotiating the price and terms of the sale.

ECONOMIES OF SIZE

Economies of size have been achieved when a cooperative business reduces costs and increases production compared to that of each individual farmer. In most cases, this means that when a cooperative grows and production units increase, a cooperative will decrease its costs to a certain point. But for more traditional (small to medium) cooperatives, size does have its limits, so after a point, an increase in size (output) actually causes an increase in production costs. For example, economies of size gives large cooperatives access to a larger market by allowing them to operate with greater geographical reach, but this reach has its limits. After a certain distance from the cooperative facility, production costs go up due to additional transportation costs and fewer customers. However, a larger economy of size can allow a cooperative business to enter another market level because of the volume of business it represents. By creating an economy of size, fixed costs can be distributed over a larger number of units produced thereby reducing the costs per unit sold. Therefore, a cooperative can be much more efficient when compared to all farmers who try to perform the same functions individually. This is because of the size of the cooperative's facilities, marketing volume, supply, or other services it conducts.

PROFITS FROM ANOTHER LEVEL

A cooperative may perform functions that extend the processing or marketing of a farm commodity to another level. Individual farmers would rarely engage in such extensive marketing or processing activities. Nor would they normally manufacture their supplies. When a cooperative captures economic benefits from these business activities, benefits are realized by farmer members. This benefit typically coincides with economies of size.

PROVIDE MISSING SERVICES

Is there a reason that farmers as a group can provide a service that entrepreneurs cannot? Yes, when profit margins are not high enough for entrepreneurs to invest in the business, a cooperative business may provide a feasible alternative so missing services or products may be available to farmers who need them in order to improve the success of their farm-level business. When farmers are owners and members of the cooperative, the cooperative places needs of the farmer first. In this case, a cooperatives first purpose is to provide a service that is needed by its membership.

ASSURE SUPPLIES OR MARKETS

The assurance of a service (supply source or market) is just as important as the service itself. Farming requires a dependable supply and a dependable market. Farmers who must rely on undependable supplies or buyers face serious risks of financial failure. For example, a supplier of fertilizer who suddenly discovers it can get a better price in a foreign market, may sell in that market, leaving local farmers without fertilizer to purchase in a timely manner. Similarly, if a buyer temporarily refuses to purchase a perishable farm commodity for some reason, the farmer is at risk and may lose income. In the farming business, such uncertainties are detrimental to planning and reliance on farm income. Farmers benefit from cooperatives whose sole purpose is to serve their needs, and that will take steps necessary to be dependable suppliers and buyers of farm products.

GAIN FROM COORDINATION

The system of agricultural production from the creation of supplies for the farming business through processing and marketing requires coordination. In a properly function market economy, this coordination is performed by the combination of all buyers and sellers working independently to supply business services in response to prices. However, many problems can interfere with this coordination. Cooperatives can potentially provide this system coordination better than individual participants in the supply, production, and marketing chain because of their objectives and close relation to the farming sector. Effective coordination increases the efficiency of the system as a whole, increases returns to farmers, decreases uncertainty and risks of farming, and permits better business planning and investment at all levels.

RISK REDUCTION

A cooperative can combine and lower the market risks of all farmers who are members. This may take place in marketing, for example, where the cooperative pools products it markets for farmer members. A drop in price during a particular period could harm farmers selling during that period. However, the price paid the farmer in a pooling situation would depend upon the prices received throughout the entire marketing period. Cooperatives may also be able to decrease price fluctuations over a longer period by contracting the price of a commodity for delivery at a future date.

MARKET POWER

If a significant number of farmers purchase or market through a cooperative, it is possible that the volume of business done by the cooperative will give it more market power to improve prices. It may be able to bargain for a lower price paid for supplies or bargain for a higher price when it sells members' production. Economic limits exist on the power a cooperative can exercise and unreasonable use of market power may result in public criticism.

THE COMPETITIVE YARDSTICK

Private businesses' major objective is to maximize profit. In part, maximizing profit comes at the expense of the customer. One cooperative objective is to make an adequate profit so the cooperative can remain in business in order to meet the needs of the farmers who own and use the cooperative. Because cooperatives do not try to make a profit for themselves as businesses but only for their members as farmers, they should not try to profit by decreasing prices to farmers as might other buyers or charge more for supplies. Thus, cooperatives afford a measure of regulation when they begin to perform marketing functions in which other businesses have received excess profits. This market regulation is sometimes called a "competitive yardstick" because it sets a standard of reasonable prices paid or received and makes the entire market work more effectively.

CONCLUSIONS

A culminating reason for starting a cooperative comes down to economics. Will the cooperative increase the profits of the producers at their business level? There are substantial economic advantages to the cooperative form of business. Any one of these advantages may be a reason enough for forming agricultural cooperatives in Slovenia. Understanding the economic benefits of a cooperative is a precondition to making wise business decisions. The ideas presented in this article provide much for Slovenian farmers to consider in regard to the way they may conduct business now and in the future. Fortunately, the entrepreneurial nature of these producers along with the demand for their products gives these business men and women the fundamental ingredients to establish a successful cooperative business venture that has the potential to deliver more profit at the farm level in Slovenia.

Farmers organize and use a cooperative for practical purposes under specific circumstances. Economic theory does not justify cooperative formation unless the benefits to farmers are real. Members who use the cooperative must realize benefits from using it.

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Methodology of system dynamics for decision support in agriculture

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ABSTRACT

The sustainable development of complex systems, and therefore agriculture as a relevant part of ecology, should be the permanent development paradigm of mankind. Conditions should be provided so that nature could regenerate itself by allowing for only a reasonable impact of human activity and presence on nature and in such a way preserve resources for the next generation. In this article, we discuss system dynamics as a holistic research methodology in the support of dynamic complex problems. Our goal is to demonstrate the usefulness of System Dynamics (SD) methodology in research and its implementation for public decision support. We briefly discuss the fundamentals of SD methodology models and causal loop diagrams (CLD) as well as model validation. Some examples of modelling for public decision assessment of sustainable development using SD have been demonstrated. The advantage of SD is in its natural language problem definition, which can be easily transformed into a directed graph that is convenient for qualitative and quantitative analysis in computer programs. System Dynamics enables studying the behaviour of complex dynamic systems as the feedback processes of reinforcing and balancing loops.

Key words: system dynamics, modelling, complex systems, decision assessment, systems approach, agriculture

INTRODUCTION

In this article, we discuss the research methodology of system dynamics (SD) application in agriculture. Agriculture is highly relevant for the human race and its survival; its problems are very complex; therefore, a variety of research methodologies addressing this field has been developed. This variety of approaches is conditioned by the context of the users and the perspectives and methodological abilities of the scientists. Agriculture as part of ecological systems (biological) and organisational systems (human-made) has the main purpose of providing food and, as such, it is an inseparable part of ecology and society. For research purposes, it should be considered as the part of the whole with the goal of providing functionality of the whole. When we refer to agriculture as a process, we have in mind a research methodology that considers all relevant aspects of the whole system. For example, one of the established methodologies is the Systems Approach (SA). SA methodology was discussed in greater detail in (Ackoff 1998, Kljajić and Farr 2010) and its philosophical implications in (Bounias et al. 2002). SA as the paradigm of holistic methodology to complex problem solving is not very new. Humanity has already solved several "big picture" problems in previous historical periods but in a simplified way. However, scientific approaches to solving problems in social systems were started with the first and second industrial revolutions. In first industrial revolution, the main agent was the machine, and manpower was replaced by machine; the knowledge and understanding of the processes to be mechanised were called "industrial engineering." This period of human development Ackoff termed "the Machine Age" (Ackoff 1998).

The second industrial revolution brought about many important technological achievements, which affected organisational development and management. Of these achievements, computer and information technology was most important one, with which a new epoch of society organisation and management research started. Many repetitive and primitive human operations have been replaced by automata and, more recently, with artificial intelligence. Mechanisation of this particular type of mental work required from scientists and engineers an interdisciplinary approach, which resulted in information theory, decision theory, control theory, cybernetics, general systems theory, and operation research and systems sciences. According to Ackoff, the methodology to cope with complex systems is called "the Systems Age" (Ackoff 1998).

This means, that every part of the concrete system is a part of the larger system. For example, the agricultural system is a part of social system and also of ecological systems; thus strategic decision making about the functioning of agriculture has long-term consequences and has to take in consideration ecology and the social implication in coming generations. Nowadays, such requirements are known as

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"sustainable development". It seems that System Dynamics SD (Forester 1958) represents a proper methodology for the behaviour of complex sustainable systems. As a methodology, applying SD in analysing complex system behaviour is very important for several reasons: it is simple, because it is based on the natural laws of Rate and Storage that describe relations between elements in quantitative/qualitative relations; it is transparent, because it allows unique discussion about elements relations defining problem; it is coherent, because it consists of simulation tools harmonised with methodology. The advantage of SD as a part of SA is in the fact that a problem defined in natural language can be easily transformed into a directed graph convenient for qualitative and quantitative analysis in a computer program. In this case, the user can always check the validity of the stated problem and the model developed. SD enables studying the behaviour of complex dynamic systems as a feedback process of reinforcing and balancing loops. As such, it provides testing of dynamic hypotheses about the anticipated properties of any systems: Life Cycle Development, Quality of Systems and assessment in the decision process.

Although the system dynamics (SD) modelling method (Forrester 1958, 1971, 1973 and 1982) was promising in dealing with complex research questions, there is only a modest amount of articles using SD methods in researching agriculture and ecology, in comparison to other methodologies. As far as the most well-known model for the modelling of complex systems, there was World Model 1 (Forrester 1971) and World Model 2 or The Limits to Growth of Meadows (1972) as well as Mankind at the Turning Point, by Mesarovic and Pestel (1974). All three models were developed within so-called Club of Rome and considered global behaviour from the perspective of certain development policies. In the Web of Science (WOS Expanded 2012), there are 1400 articles published in last 10 years on the topics of agriculture, but just a few using SD methodology, i.e. one of the most powerful trans-disciplinary methodologies.

SD methodology (Forrester 1958) can be used as an alternative to the econometric and mathematical programming approaches (Bockermann et al. 2005, Elshorbagy et al. 2005, Saysel et al. 2002) for policy modelling. Recently, there have been many important SD applications in the field of agriculture and environment: Nalil (1992) describes the conceptual development of FOSSIL2, an integrated model of U.S. energy supply and demand, which is used to prepare projections for energy policy analysis in the U.S. government's Department of Energy Office of Policy, Planning, and Analysis. Guo et al. (2001) presented an environmental system dynamics model for supporting an environmental planning task. The model consists of dynamic simulation models that explicitly consider the information feedback that governs interactions within the ecosystem. Such models are capable of synthesising component-level knowledge into a system behaviour simulation at an integrated level. Shen et al. (2009) presented an SD model for sustainable land use and urban development in Hong Kong. The model is used to test the outcomes of different development policy scenarios and to make forecasts. It consists of five sub-systems, including population, economy, housing, transport and urban/developed land. Yin and Struik (2009) reviewed recent findings on modelling genotypes and environmental interactions at the crop level, moving from system dynamics to system biology. However, the most important works in the field of simulation of development policy scenarios are presented by Shi and Gill (2005), who developed a system dynamics-based simulation model for ecological agriculture development for Jinshan County (China), and by Kljajić et al. (2002 and 2003), who developed an integrated system dynamics model for development in the Canary Islands, where interactions between agriculture, population, industry and ecology were taken into consideration. The preliminary investigations into SD simulation of organic farming development were conducted by Rozman et al. (2007) and by Škraba et al. (2008).

The goal of this article is to highlight the present state and perspectives of the theory and practice of decision assessments based on SD and simulation models. In the following section on the general approach to the system modelling paradigm, we discuss the principle of SD and Causal Loop Diagrams (CLD), and its appropriateness for research methodology in agriculture. Some examples from the authors and from the literature of development of DSS based on SD and simulation, and its success will be demonstrated. System dynamics is a computer-based approach to complex policy analysis and design for decision-making assessments. Our motivations were to bring to the attention of agriculture researchers the usefulness of SD methodology for more intensive applications in agriculture.

MATERIAL AND METHODS

System dynamics conception

The fundamentals of System Dynamics were defined by Jay Wright Forrester in the mid-1950s (Forrester 1958) as a method for the modelling of industrial dynamics. At the beginning of the 1980s, the dawn of the information era, the method was renamed "System Dynamics" (SD). The method is straightforward in its essence, based on the principle of conservation of mass. Nevertheless, the genius of Forrester is that, as a pioneer of computer science, he noticed that the power of computers could be used in business systems, not only for collecting, processing and storing data, but also for strategic decision making. For this purpose, dynamic models of systems were needed. Consequently, the method of modelling was developed: one which is clear, straightforward, user friendly and holistic. Forrester developed the methodology and simulation tool, i.e. the program. The idea of modelling is based on the supposition that every real system (S), including business systems, could be described by the system of equations, which is represented by the interconnected flows, or rates (R) and storages or levels (L):

$$S = (L_j, R_i, A_r)\ j = 1,2,\dots n,\ i = 1,2,\dots m,\ r = 1,2,.l \qquad (1)$$

Here L_j represents the set of Levels (stocks) and R_j the set of R (flows) and A_r the Auxiliary expression by which we can express arithmetic relation among L and R. Each level L or state element has its own input, i.e. input rate Rin and its own output rate, *Rout* as is shown in Figure 1.

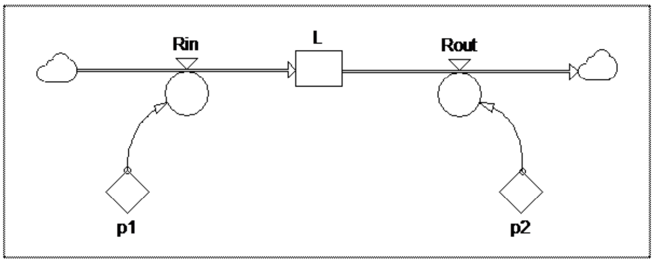

Figure 1: Basic elements *L* and *R* in System Dy namics

The principle of conservation of mass for the above model could be described by the dynamics equation in the form of difference equation:

$$L(k+1) = L(k) + \Delta t(R_{in}(k) - R_{out}(k)) \quad k = 0,1,2,...n \quad (2)$$

Where k represents discrete time, Δt is the time interval of computation. Each entrepreneur understands that the value of Level element L(k+1) increases if Rin(k) > Rout(k); it is unchanged if Rin(k) = Rout(k), and decreases if Rin(k) < Rout(k). For example, in Figure 1, squares represent Level elements (Population, Natural Resources, Environment Degradation), circles symbol represent Rate elements (e.g., Regeneration, Consumption etc.) while P1 and P2 represents decision parameters by which one regulates flow in and out from elements. The clouds at the beginning and at the end represent the environment of the model. This is, therefore, our boundary of modelling of the addressed model. From a formal viewpoint, this method is indeed straightforward and clear, as well as understandable. In Table 1, possible meanings of L and R elements for different classes of systems are given.

The methodology of solving problems by the principles of System Dynamics could be concisely described by the following steps:

- Definition of problem
- Determination of goals
- Concept of investigation
- Formulation of mathematical model
- Coding of computer program
- Validation of model
- Preparation of experiment (simulation scenarios)
- Simulation and analysis of results

When defining a problem, one addresses the parts with which one is not satisfied or those that demonstrate undesirable dynamics. Usually, these are the values of Level elements of the addressed process, L, and the interconnections between them, R. The goal of the research is to determine the goal states that should be achieved. Here, the question "How?" emerges. With the application of the dynamic hypothesis, the dynamics of the system is determined as the consequence of key feedback loops in the system. In this phase, with complex problems, the key role is played by a team with an interdisciplinary approach. State elements and their relations are nonetheless the main part of the analysis, which could be performed in several different ways. In the end, the validated model is the tool for the testing of the dynamic hypothesis at the different visions (scenarios). In order to address complex problems, one has to apply systematic and team approaches (Škraba et al. 2003, 2007) in the process of solution.

Causal loop diagrams and system dynamics models

The determination of model structure and its parameters is the most important part of the assignment. There are several methods and tools to aid in the articulation of the model structure. An exceptionally practical one is the method of Causal Loop Diagrams; these are directed graphs with polarity. Each Level and Rate element has a directed arrow assigned, so that one element represents the cause and the other the consequence. Directed arrows from cause to consequence have the "+" sign if the cause and consequence have the same direction and "-" if the opposite direction exists.

Table 1: Describing different systems with Level, Rate and Desired state

System	Level	Rate	Desired state
Population	Population	Birth, Death	Sustainable Growth
Warehouse	Inventory	Delivery, Consumption	Desired level of inventory
Cash balance	Cash	Income, Expenses	Positive level of cash
Room heating	Room temperature	Temperature input flux, Temperature loss	Desired room temperature
Knowledge	Knowledge level	Learning, Forgetting	Appropriate level of knowledge
Information system	Information system capacity	New technology, Technology decay	Adequate IS for controlling real system

Another very important aspect of the SD methodology is the feedback loop. When several arrows in the CLD return to one element, a closing path or a loop is created, which gives some feedback to the original element; therefore, it is called a feedback loop. There are two kinds of feedback loops: a positive feedback loop (reinforcing loop) and a negative feedback loop (balancing loop). Reinforcing loops tend to grow or decline without limits and make the system unstable. Balancing loops tend to adjust themselves to some intended value. Hence, they tend to stabilise the system and guide it to the goal.

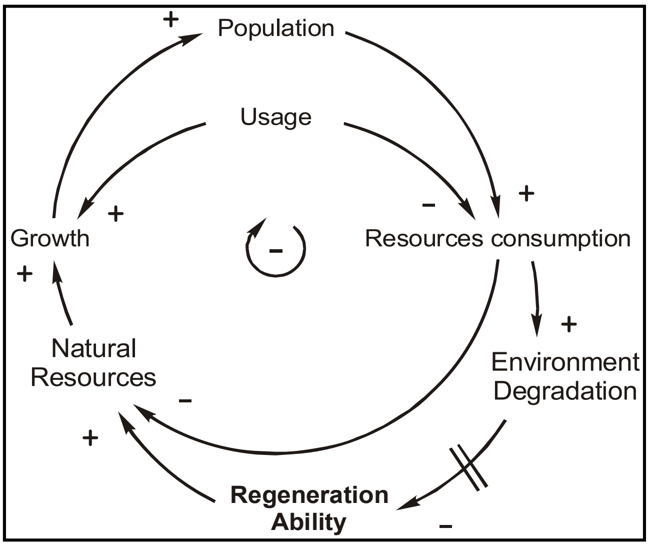

Figure 2: Causal Loop Diagram of Population ~ Natural resources

The following simplified case of a Causal Loop Diagram for a paradigm of sustainable development is shown in Figure 2. Here we consider the extent and growth of population as well as the exploration of natural resources. The higher population level results in a higher usage of natural resources. The volume of natural resources is dependent on the intensity of regeneration. The higher volume of natural resources consequently provides better conditions for the development of the population, which positively influences the growth of the population. The important factor is the efficiency of the natural resource usage, which both negatively influences resource consumption and positively influences the population growth. In this case, the negative feedback loop is considered, which has the property to converge to the goal state, i.e. the reference value. In our case, the goal state is determined by the regeneration of the natural resources, which is the key message of the described structure. In this manner, one could conclude that the growth of the population over the longer time frame is not dependent on the volume of the natural resources stock, but rather on the regeneration of natural resources. Regeneration in the sense of System Dynamics is represented as the Rate element, i.e. the element that represents the change, rather than the stock.

In the model analysis, one has to start with the model equilibrium. Special care should be taken for the definition of the user-defined functions that are applied in the model. Figure 3 shows a model of sustainable development, in which the regeneration is taken into account as the Rate element. The model has three (3) Level elements: Population, Natural Resources and Environment Degradation. The user-defined function "Limits of natural resources" is applied as the limiter of the consumption of population members in the case that

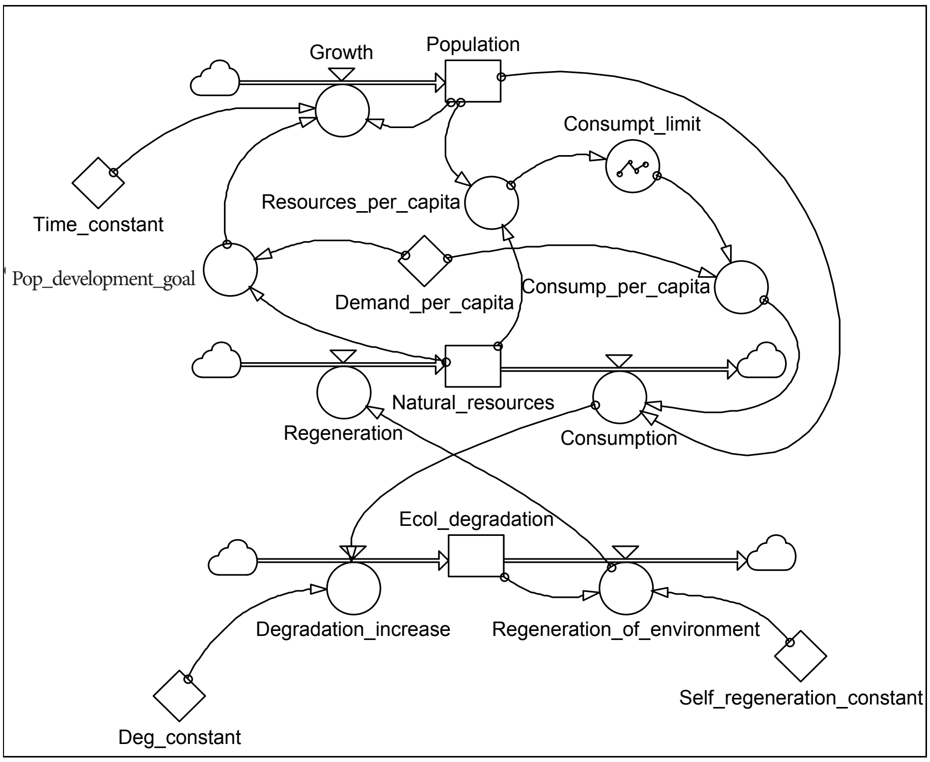

Figure 3: The model of sustainable development ~ natural resources

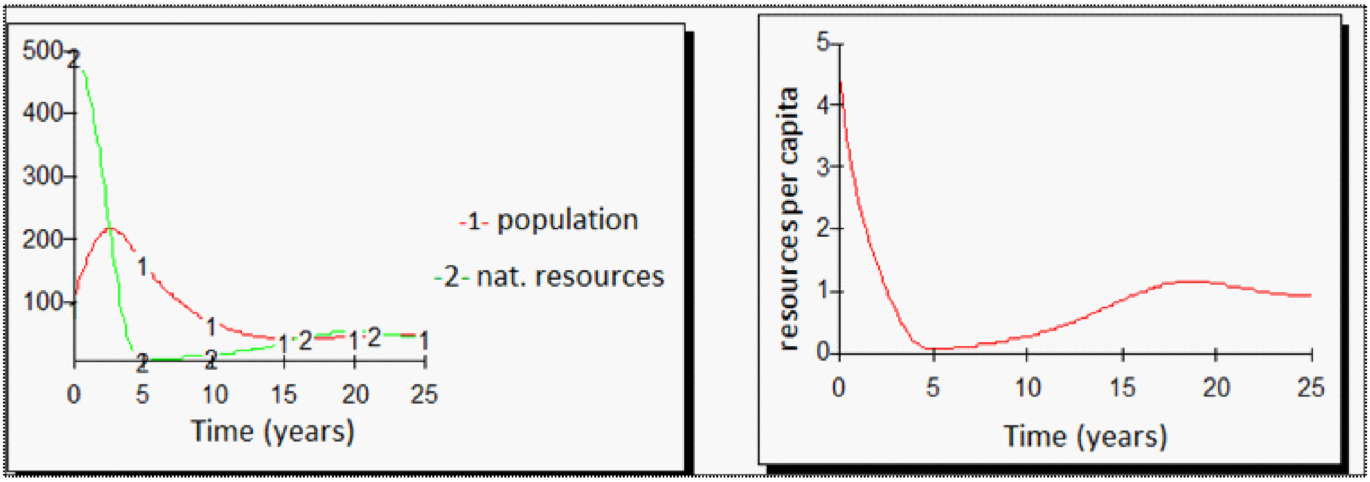

Figure 4: Time course of population and Natural resources as function of resources consumption per capita

the supply of natural resources would shrink below the normal level. This function also considers that (in the case of increased volume of natural resources above the normal level) the consumption would increase for a certain, rather small, part. The goal of the population development is determined by the volume of natural resources and the demand of natural resources with respect to the population. The growth is therefore limited by the stock of natural resources and by the consumption "Per capita". The dynamic response of the system with regard to the goal is determined by the rate element "Regeneration", which could be dependent on the investment in new technology, shown in Figure 4.

In order to demonstrate the usefulness of the SD method for the qualitative analyses of economic growth, we will analyse the partly generic model shown in Figure 5. Investment in new production caused Employment opportunities, which increased Workforce demand and consequently engaged new workers. This loop will be called "Economic growth", which has a positive loop or reinforcing loop denoted with "A". However, for new factories and the new working force, we need new industrial land, which cause losses of Available land, which restricts Economic growth. This loop denoted with "B" represents a balancing or regulation loop. Further, the lessening of Available land (agriculture land) causes decreased capability for food production (Self-supportability). Let us suppose that we invest in high technology: we need less agriculture land, but more knowledge as consequence of better education and research, and the gain of loop A is higher. In this case, contribution to GDP and well-being is higher with preserved available land, for food production or preservation of ecology. The CLD model of GDP, Research, Production and Education was analysed in greater detail in (Kljajić 2009). In contrast, in the case of the investment in less-sophisticated technology, one needs more land and economic growth is diminished. The gain of A is lower and land and the ability to produce one's own food decreases. All this activity has remains constant over a long time and requires careful long-term planning. (Note that land is constant and conversion from agricultural land to industry is an almost irreversible process. Reverse conversion is possible but price is too high). In next paragraph, we will describe the same case in greater detail.

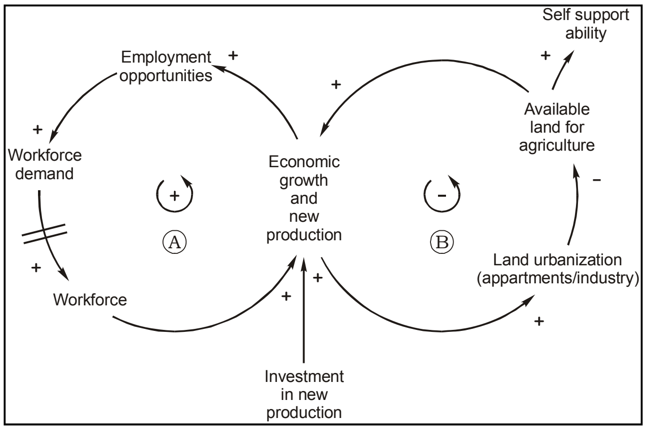

Figure 5: Generic model of investment in new technology, economic growth and ability to produce sufficient food

Simulation-based decision support systems based on sd

A simulation-based decision support system (DSS) is an important part of the Management Information Systems (MIS), which support business or organisational decision assessment. The simulation model is used as an explanatory tool for better understanding of the decision process and/or for defining and understanding learning processes. The advantage of the simulation model as a part of DSS is in the fact that a problem defined in natural language can be easily transformed into CLD convenient for qualitative and quantitative analysis in computer programs. In this case, the user can always check the validity of the stated problem within a certain theory as well as its translation to computer programming. This is especially important in cases of complex problems in which feedback loops and stochastic relations are present, regardless of the process being a continuous or discrete event. Big picture presentations and simulating the process make this technique flexible and transparent for testing a system's performance in all phases of system design and deployment. This has made it possible to examine the projected performance of systems through wide-ranging investigations of design and environmental assumptions very early in the development process, when key resources are committed.

RESULTS AND DISCUSSION

System dynamics model for the public decisions support

The SD model for public decision support in the Canary Islands (Kljajić et al. 2003), particularly as related to strategic issues, involves qualitative and quantitative aspects of social systems. Quantitative variables are often crucial for strategic decisions. In addition, qualitative information is provided by a social actor and decision maker (DM) with an implicit character of uncertainty (Legna and Rivero 2001, Legna 2002). The main pillars of our approach are the following:

• the building of qualitative models that integrate qualitative and quantitative information;

• the application of system dynamics that is particularly useful in determining the interrelations between the subsystems, building scenarios and running strategic simulations;

• the analysis of the leading forces that help to identify the role of the variables, their leverage potential and, consequently, to highlight key areas of the social system to implement policies.

This approach is based on the building of qualitative models and the application of system dynamics for the development of a simulation model. Variables were identified that affect the sustainable improvement of the quality of life in the Canary Islands. The relationships between the variables are expressed as an influence square Matrix M with dimension n = 53×53, of which 12 are exogenous. Consequently, it has 41 state variables. More about the influence matrix can be found in (Kljajić et al. 2002).

To move to a quantitative model capable of cause-consequence analysis of decision makers' impacts on the long-term behaviour, the influence matrix must be transformed to SD methodology. In this way, a direct connection between scenario planning (as a consequence of DM) and variable behaviour is possible. Fifty-three variables represent a rather demanding problem, especially with regards to model validation. In this case, it is necessary to specify the initial value of variables, parameters and other functions necessary for model implementation. Therefore, we developed a procedure of influence matrix transformation into a Causal Loop Diagram (CLD). The influence diagram is obtained from the influence matrix. Next, we analyse the interconnection between the main variables relevant for the causal loop diagram CLD as shown in Figure 6. Feedback loops and interactions of particular subsystems are shown in the causal loop diagram. The locations, which are defined with variables, represent the system state element, while arrows show the direction of influence between a particular pair of elements. In the simulation process, an expert group in the form of a suggested policy heuristically determines key parameters. The causal loop diagram in Figure 6 represents interactions in the context of regional development and its influence on regional prosperity and quality of life.

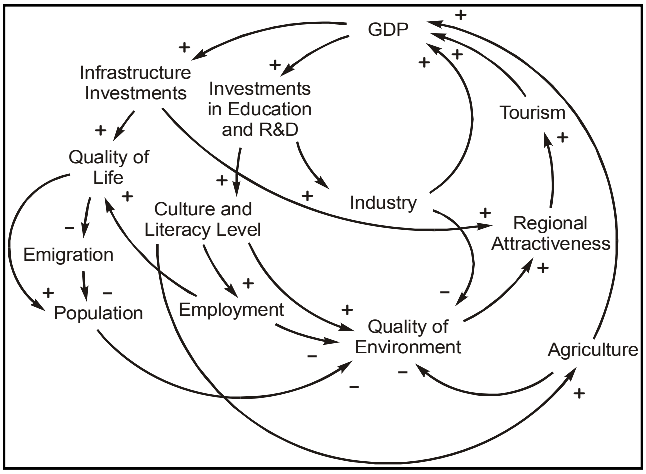

Figure 6: Causal Loop Diagram of the Canary Islands case

The structural analysis of the system is of great significance, since mental models of various kinds can be captured using the proposed methodology. For example, if Gross Domestic Product increases, the Investments in Education and R&D production increase above what they would have been and vice versa; therefore, the arrowhead is marked with the "+" symbol. If the Investments in Education and R&D production increase, the Economic volume increases above what it would have been, which is also marked with the "+" symbol. If the Population increases, the Quality of Environment decreases and the cause effect is marked with the "-" symbol. All other causal connections are marked in the same manner. After the aggregation of variables, i.e. the joining of similarities, the next step is the determination of levels and rates according to system dynamics methodology.

With the proposed methodology, the system can be entirely determined by the System Dynamics models that form the general simulation model for the regional development of the considered case. Such decomposition allows for a multilevel approach in modelling, which facilitates the process of model validation. A preliminary sub-model was developed for population dynamics, which incorporated 150 parameters (Kljajić et al. 2003). The model enables changes for the different population variables that are relevant for decision makers. Users have the opportunity to actively participate in the decision process by defining relevant criteria and their importance, in spite of the large number of different simulation scenarios. The decision process is clear and creative. The preliminary model is built using the Powersim simulation tool (www.powersim.com), which provides results for the real application of the organisational strategy. Simulation also enables an internal view of system behaviour for the selected scenario. The system makes it possible to analyse different situations, which is the basis for achieving the consistent formulation of a policy. The building of the model is still in progress (Legna and González 2005, Legna and Škraba 2010).

Model of organic farming in Slovenia

This case presents the system dynamics model of organic farming development in order to support decision making. The model seeks answers to strategic questions related to the level of organically utilised area, levels of production and crop selection in a long-term dynamic context. The model will be used for the simulation of different policy scenarios for organic farming and their impact on economic and environmental parameters of organic production at an aggregate level. Using the model, several policy scenarios were performed.

The preliminary investigations into SD simulation of organic farming development were conducted by (Rozman et al. 2007, Škraba et al. 2007, Rozman et al. 2011) This case is a survey of the previous model and presents a system dynamics model for the development of organic agriculture in Slovenia. The goal was to identify key variables that determine conversion dynamics and to propose development policy. First, we present the main flows and feedback loops within the systems and the development of the system dynamics model. The results present scenarios (different policies in organic farming) and their evaluation through application of the developed SD model. The simulation model should consider the key variables that influence the development of organic farming, such as:

- the number of conventional farms,
- the number of organic farms,
- conversion process,
- subsidies,
- the promotion of organic farming (marketing, market development, education),
- the organisation of a general organic farming support environment,
- a system of self-awareness, and
- the delay constants of process change.

A key variable in the model is the number of organic farms. These are the farms that are under the control system of one of the control organisations. The growth in the number of organic farms was initially (in 1998) almost linear; however, in the years from 2003 to 2005, the growth moderated to approximately 4%, despite an increase in subsidies of 20% to 30%.

During the development of the CLD diagram (Figure 7), the following key variables were identified as the first steps

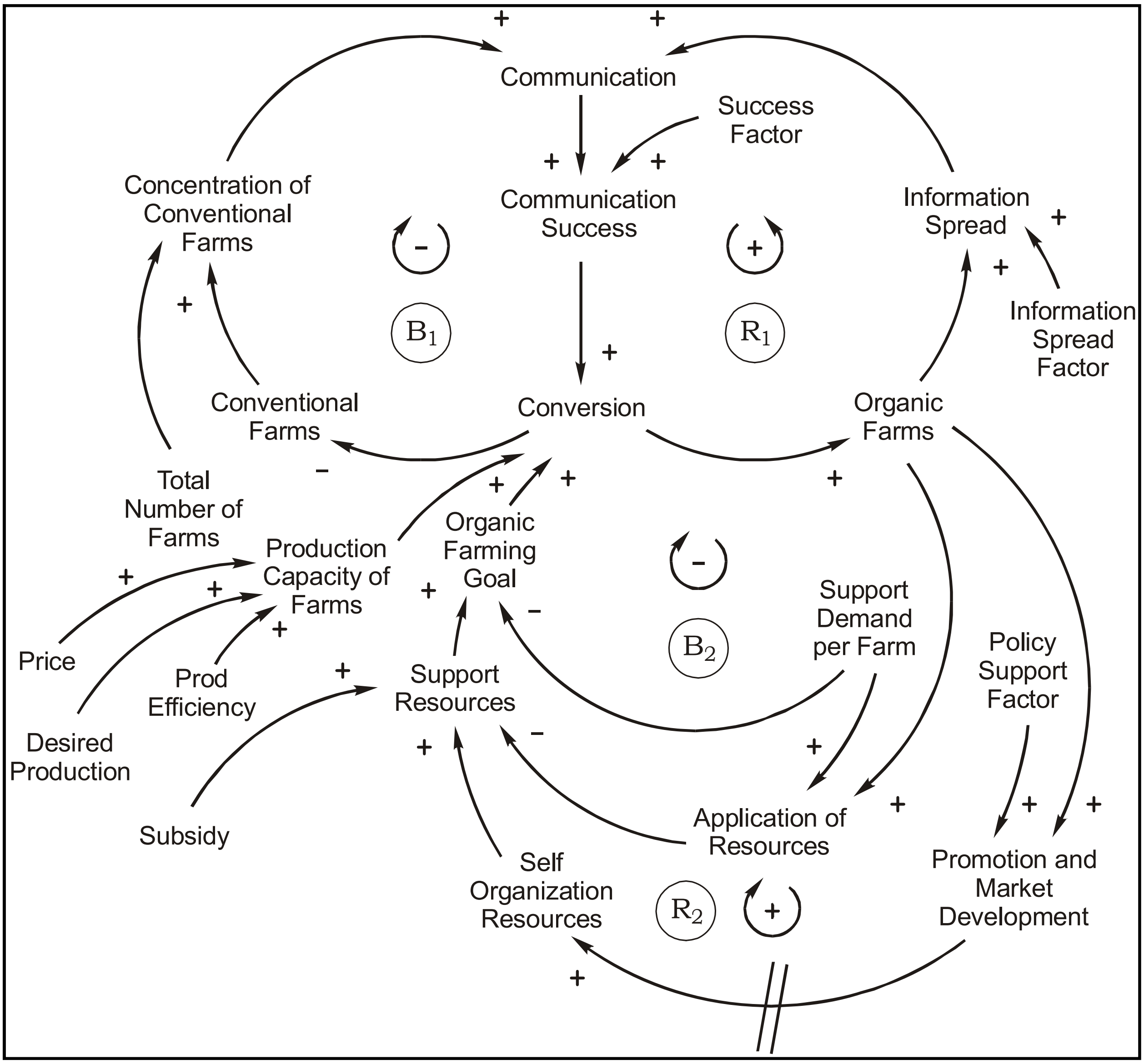

Figure 7: Causal Loop Diagram (CLD) of conversion process to organic farming

toward the development of the SD model:
(1) the number of potential candidates (farms) for conversion to organic farming,
(2) the number of farms already converted to organic farming, and
(3) the flow between (1) and (2): conversion rate (transition).

Loop B1 represents a negative loop, with a goal value of 0 (depleting the number of "Conventional Farms"). The number of "Conventional Farms" divided by the "Total Number of Farms" yields the "Concentration of Conventional Farms", which is initially high, meaning that there should be a high initial preference for "Conversion". "Concentration of Conventional Farms" positively influences the "Communication". This variable represents the general communication between the conventional approach members and the organic approach members. "Conversion" positively influences the number of "Organic Farms". If the number of "Organic Farms" increases, the "Information Spread" increases above the level that it would otherwise have been. "Information Spread" by "Organic Farms" members is positively influenced by the "Information Spread Factor" which could be, for example, increased by marketing campaigns. "Information Spread" positively influences "Communication". The number of "Conversion" farms is determined by the "Success Factor", which determines the "Communication Success", yielding the number of convinced conventional members that decide to make a "Conversion". Loop R1 is a reinforcing feedback loop compensated for by the initial balancing feedback loop marked with B1. If the number of "Organic Farms" increases, the "Promotion and Market Development", supported by the "Policy Support Factor", increases as well. Higher "Promotion and Market Development" positively influences the "Self Organisation Resources", which contribute positively to the "Support Resources" on which the "Conversion" is dependent.

There is a delay mark between the "Promotion and Market Development" and "Self Organisation Resources". Longer delays should be expected here, since a significant amount of time is needed in order to promote both the organic farming idea and the marketing channels that will support organic farming.

The "Support Resources" are significantly dependent on the government "Subsidy". Furthermore, the higher the "Organic Farming Goal" is set, the more "Support Resources" should be available, meaning that a larger number of organic farms can be supported. If the "Organic Farming Goal" increases, the "Conversion" increases above the level that it would otherwise have been.

The interconnections marked with "R2" have the characteristics of reinforcing feedback loops. According to government policy, the growth in the number of "Organic Farms" should be properly supported in order to promote an increase in self-organisation of, for example, organic food marketing and promotion. Thus, the reinforcing feedback loop R2 should serve as a growth generator in the system.

Loop B2 represents a balancing loop. If the number of "Organic Farms" increases, the "Application of Resources" increases above the level that it would otherwise have been. The "Application of Resources" is also dependent on the resources needed per farm, i.e. "Support Demand per Farm". Higher "Application of Resources" can cause the depletion of the "Support Resources". The "Organic Farming Goal" is dependent on the "Support Demand per Farm". If more resources are needed per farm, fewer organic farms can be supported, and therefore lower numbers of "Conversion" should be expected. In considering a real case, the negative loops B1 and B2 are dominant, leaving the system in an undesirable state of equilibrium. This would mean that the number of organic farms is constant and well below that desired. In order to move the system away from the equilibrium, one should consider the policies that would raise the impact of the reinforcing feedback loops R1 and R2, which should move the system state, i.e. the number of "Organic Farms", to the higher equilibrium values. "Price", "Desired Production" and "Production Efficiency" are also important factors that impact the intensity of the transition.

There are two levels to the elements applied in the upper part of the model: The variable "Conventional_farms" represents the number of conventional farms. With the flow of "Conversion", the "Conventional_farms" become "Organic_farms".

This structure is commonly known as the market absorption model. "Conversion" is dependent on the "Organic_farming_goal". The goal is set by the "Support_resources" available, modelled as a level element. The desired conversion can be achieved only if there are enough "Support_resources" present in order to make a "Conversion". The "Support_resoures" are not only the financial means. Here, the support of society is also considered; for example, education should create positive attitudes in relation to organic farming. In this category, the market development, as well as the demand, should also be considered. However, at present, the "Support_resources" are mainly dependent on subsidies from the government. The important variable "Self_organisation_resources" is driven by the impact of the policy and the level of societal support, which will intensify with increasing numbers of "Organic_farms". This represents the application of a reinforcing feedback loop which should be augmented. The "Development_limit" represents the function that considers the variable of the consumption of the resources. If the resources are scarce, the usage is lower than in the case of abundance. Resources are consumed by the "Organic_farms". The prosperity of the "Organic farms" therefore depends on the "Support_resources", which are not only financial means. Here, the social impact of organic farming represents the supportive environment that should sustain such an activity, which in the world of consumption is counterintuitive. The "Conversion" is also dependent on the total food production and "Food demand".

The model is used in order to simulate different scenarios that enable the assessment of policy scenarios with respect to the development of organic farming.

Scenarios 1, 2 and 3 (Figures) represent the increase of the subsidies and the impact on the transition rate. Scenario 4 shows the impact of the increased promotion factor, which would yield the higher limit conversion to the organic farming. The impact of the increased delay in providing self-support resources is shown by Scenario 5. Here, one assumes that this delay is increased from two to four years on average. Scenario

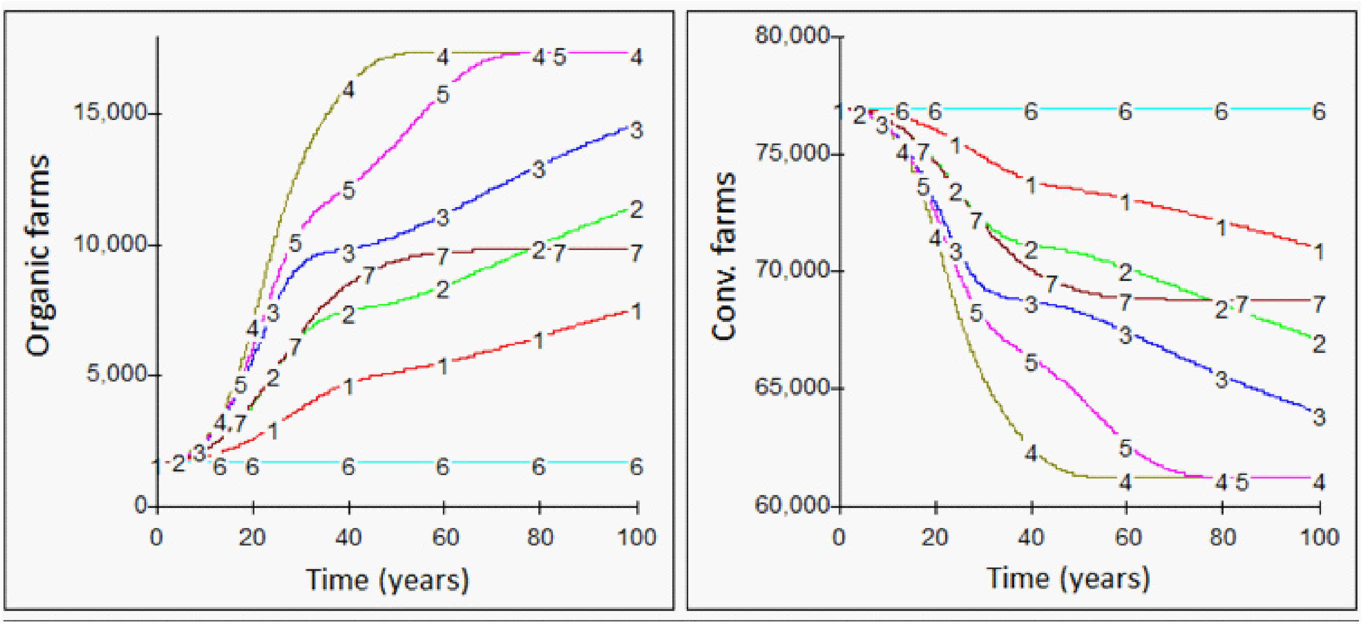

Figure 8: Number of organic farms

6 represents the increase in the population that would lead to the status quo in the number of Organic and Conventional farms. It is supposed that the transition in this case would not occur due to the increased food demand. In this case, the negative conversion could also be considered; however, this is the limitation of the proposed model. Scenario 7 shows the transition to organic farming if the coefficient of food demand decreased, which would be the case if, for example, the imports of food increased.

However, the system dynamics model does not provide numerical forecasts. It is rather a policy tool that examines the behaviour of key variables (number of organic farms) over time. Historical data and performance goals provide baselines for determining whether a particular policy generates the behaviour of key variables that is better or worse when compared to the baseline or other policies. Furthermore, models provide an explanation for why specific outcomes are achieved. Simulation allows us to compress time so that many different policies can be tested, the outcomes explained, and the causes that generate a specific outcome can be examined by knowledgeable people working in the system before policies are actually implemented.

CONCLUSIONS

In this paper, we discuss SD methodology as a proper tool for research in agriculture and ecology. Our goal was to highlight the usefulness of SD methodology in research and its implementation in agriculture, suggest that the methodology be applied in research in agriculture. We briefly discuss the fundamentals of SD methodology, models and CLD, as well as model validation. The advantage of the SD as a part of the Systems Approach is in the fact that a problem defined in natural language can be easily transformed into a directed graph that is convenient for qualitative and quantitative analysis in a computer program. In this case, the user can always check the validity of the stated problem and the model developed. SD enables studying the behaviour of complex dynamic systems as a feedback process of reinforcing and balancing loops. As such, it provides testing of dynamic hypotheses about anticipated properties of the IS: Life Cycle Development, Quality of Systems and Information System Success. As a methodology, applying SD in analysing complex system behaviour is very important from several reasons: it is simple, because it is based on natural laws of Rate and Storage that describes relations between elements in quantitative/qualitative relation; transparent, because it allows unique discussion about elements relations defining problem; and coherent, because it consists of simulation tools harmonised with methodology and the problem to be solved. SD is a trans-disciplinary methodology, because it provides complex problem solving from different perspectives in interconnection with R and L elements.

Simulation, together with the Systems Approach, has become ever more central to the development of complex systems. Human knowledge and the simulation methodology combined in a decision support system offer new levels of quality in decision making and research in the field of agriculture. The utility of SD methodology of complex agricultural process modelling for public decision assessment for sustainable development has been positively demonstrated.

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A review of the EU hop industry involvement within a beer brewing sector

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ABSTRACT

The aim of this paper is to give an overview of the EU hop industry structure, production characteristics and its economic position within the world beer industry. This article is based on authors' research results, activities within the International Hop Growers' Convention (IHGC) and a review of the literature available. The results demonstrate that the production structure in the hop industry sector varies greatly across EU countries. Furthermore, the structure is changing due to a market-driven structural adjustment aimed at being more competitive. The number of farms growing hops in the main hop-producing countries in the EU declined significantly during the 2000-2008 period. As a result, the average farm size increased in almost all EU member states. The rate of specialization of hops farms is generally increasing. Hop farmers are stepwise becoming entrepreneurs, trying to achieve a farm size that creates production more lucrative.

Key words: hop industry, beer markets, production structure, competitiveness

INTRODUCTION

A formal link between brewing and hop industry was already acknowledged by the Purity Law in 1516 and lasts for centuries. Brewing industry requires traditionally its raw materials of a high quality. Beer brewing is an intricate process encompassing mixing and further elaboration of four essential raw materials, including barley malt, brewing water, hops and yeast. Particularly hops determine to great extent typical beer qualities such as bitter taste, hoppy flavor and foam stability and storage potential of beer.

Beer continues to be a popular beverage, worth more than any other drink type (in sales value), despite a reduction in the consumption of alcohol across the EU population. A maturing market reveals a need to develop products to attract new consumers, and understanding their perception is paramount to success. Factors affecting beer quality include ingredients, processing parameters and packaging. Factors influencing consumer perception are much more complex and include interactions between the main flavor components (Clark et al. 2011).

To remain globally competitive, hop and brewing industry must respond to the ever-changing needs of consumers by providing appropriate new types of beer. Since a brewing industry depends on hops to provide distinctive and proprietary characteristics to beer, a stable supply of high-quality hops is a high priority (Forster 2001).

Furthermore, to suit various brewing industry requirements, research programs in hop breeding, hop physiology and processing of hops into hop products, used to be intensified during the last few decades. However, in spite of many improvements such as development of new hop varieties, modern growing techniques, implementation of new plant protection measures, nowadays even some of the biggest and the most respectable hop research organizations are faced with the plain endurance and share the future of farmers.

GLOBAL LINK BETWEEN A HOP SUPPLY AND A BREWING INDUSTRY

Let us have an overview of main global beer market statistics. Figure 1 demonstrates a world beer production from 1999 to 2010. In 2010 for example (with a beer output of 1.8 billion hl), on the basis of a reported output of 28.8m hl and taking the adjusted figures for the previous year into account, beer output rose by 1.6% (Table 1). While a virtually unchanged volume of beer was produced on the American continent, the negative trend in Europe continued for the third year in succession. All the other continents registered rising output. Russia was replaced by Brazil in third place in the rankings of the top beer-producing nations. China remains unchallenged in first place, followed by the USA, Brazil, Russia and Germany. In Europe, output decreased by 11.9m hl. A decline of more than 1m hl was registered for five countries: Russia (-5.6m hl), Germany (-2.4m hl), Romania (-1.9m hl), Czech Republic (-1.5m hl) and the Netherlands

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(-1.4m hl). The only significant growth in Europe was achieved by Poland (+1.7m hl). On the American continent, Brazil almost made up for the decline in Venezuela and the USA (both -3.1m hl) and Mexico (-2.4m hl) with an increase in output amounting to 7m hl. In Asia, the beer market boom continues (+34.1m hl). The greatest increase of all was in China, which has also been a global leader in a brewing industry output since 2003. 24.7m hl of beer was brewed there, raising its share of output growth worldwide to 86%. But also Vietnam managed to achieve an impressive increase of 3.5m hl. Output growth of 7.2% (+7.2m hl) in Africa meant that this was the continent with the highest growth rate (Barth 2011; IHGC 2012).

Hops are essential for the brewing industry, as they supply considerably to the organoleptic qualities of beer.

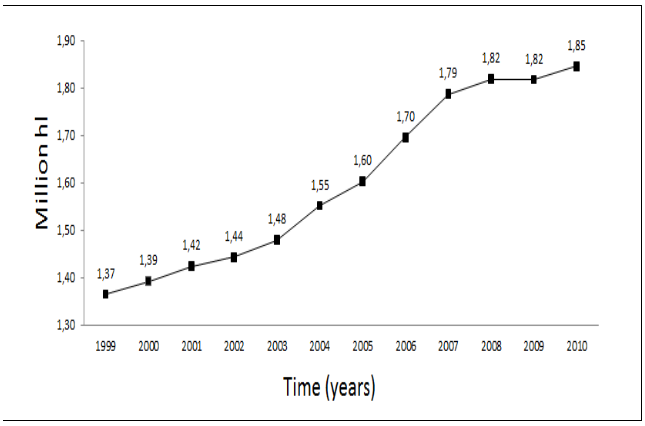

Figure 1: Global beer production 1999 – 2010 in m hl

Table 1: Beer output development 2009 – 2010

	2009 (1.000 hl)	2010 (1.000 hl)	2009 (+/- % rel.)	2010 (+/- % rel.)
European Union	381.945	375.264	-5,5%	-1,7%
Rest of Europe	171.671	166.475	-4,9%	-3,0%
Europe total	**553.616**	**541.739**	**-5,3%**	**-2,1%**
North America	335.656	329.927	-0,3%	-1,7%
Central America/ Caribbean	15.504	15.468	-2,4%	-0,2%
South America	193.744	198.840	1,6%	2,6%
America total	**544.904**	**544.235**	**0,3%**	**-0,1%**
Asia	**597.858**	**631.978**	**3,4%**	**5,7%**
Africa	**99.612**	**106.810**	**8,9%**	**7,2%**
Australia/Oceania	**21.576**	**21.631**	**0,0%**	**0,3%**
WORLD TOTAL	**1.817.566**	**1.846.393**	**-0,1%**	**1,6%**

Approximately 48,000 ha of hops were grown in 2012 worldwide at 20 countries in all five continents. This production supplied the majority of the domestic market, as well as exports to a range of overseas breweries and hop retailers. The main hop growing countries Germany and the USA have over two thirds of global hop acreage and produced in 2011 more than 80% of alpha-acid quantities worldwide. These two countries are followed according to hop acreage significance by Czech Republic, China, Poland, Slovenia, etc (IHGC 2012).

The hop industry is one of the highest capital- and work-intensive types of agricultural production. It is estimated that on EU competitive hop farms (more than 10 ha of hops) the initial capital investment required for hop fields with wirework is more than 15,000 €/ha. Additional investments for specialized mechanization such as spraying and picking machines as well as a hop kiln with all necessary equipment would require at least an additional 25,000 €/ha. The amount of machine and labor hours varies related to the level of mechanization. The amount ranges between 60 and 80 machine hours and 200 and 350 labor hours per hectare. Based on the production costs model, 39% of the variable costs in hop production involve hop picking and drying, 26% stringing and training of hop bines, 13% plant protection, 12% winter and spring activities in hop fields, etc. with 10 ha of hops and an average yield of 1,800 kg/ha (Pavlovič 1997).

Hop plants are grown on a wire and cable trellis usually suspended about 6 to 7 meters above the ground on a regular arrangement of wooden or concrete poles. Anchors, attached to trellis cables, surround the yard and hold the trellis upright under the weight of the developing crop. Plant spacing depends mostly on hop variety and growing area, with 2.4 to 3.2 m between rows and about 1.1 to 1.7 m between plants within rows (Friškovec et al. 2002). Once established, the hop rootstock will produce indefinitely although industry practice is to rotate plantings every 15-20 years. The timing of the rootstock replacement is influenced by declining yield caused by insects, disease and pests (Dolinar et al. 2002) and by merchants', i.e., brewers', demand for specific varieties (Barth 2011). The major production practices used annually to produce hops include pruning, stringing, training, irrigating, protecting plant against pests and diseases, harvesting, drying as well as processing and packing according to market demands (Pavlovič 1997; Srečec et al. 2004).

The European Union is the main player in the world hop market. Hops are produced by fourteen EU member states although together Germany and the Czech Republic account for more than 80% of the total EU production by volume.

Poland is the only other member state to account for more than 5% of total EU production. Traditional hops production areas can be found within each hop-producing member state, including Bavaria, Saxony, and Bitburg in Germany; Bohemia in the Czech Republic; the Lublin region in eastern Poland; Savinja Valley, Ptuj, and the Koroška region in Slovenia; the Kent and Hereford area in England; the León area in Spain; Alsace in France; the Horna Streda region in Slovakia; the Poperinge area in Belgium, the Velingrad area in Bulgaria, etc (Barth et al. 1994). Table 2 shows hop supply elements during the period between 2010 and 2011 on a global level, where acreage and production are clearly illustrated.

Hop growers must respond to the ever-changing needs of the brewing community by providing appropriate varieties at a certain quality demanded by the market as well remain competitive in the global hop industry (Pavlovič et al. 2011).

Table 2: Global hop supply 2010 and 2011

Country	Hop Acreage 2010 (Hectares, Ha)				Hop Production 2010 (in MT = 1.000 kg)			Alpha acid Prod.	Hop Acreage 2011 (Hectares, Ha) estimations				Hop Production 2011 (in MT = 1.000 kg) estimations			Alpha acid Prod.
	Aroma	Alpha	Total	New	Aroma	Alpha	Total	MT	Aroma	Alpha	Total	New	Aroma	Alpha	Total	MT
Australia	32	416	448	0	51	1.048	1.099	144	46	378	424	0	59	1.037	1.096	139
Austria	185	32	217	16	300	68	368	30	193	36	229	9	305	71	376	30
Belgium	51	135	186	0	84	289	373	36	60	120	180	9	72	216	288	25
China	580	5.216	5.796	0	1.600	14.500	16.100	860	580	5.216	5.796	0	1.600	14.500	16.100	860
Czech Republic	4.943	74	5.017	193	7.631	141	7.772	314	4.454	64	4.518	200	5.400	100	5.500	190
France	398	45	443	137	691	99	790	34	361	63	424	68	653	90	743	34
Germany	9.649	8.460	18.109	277	16.333	17.901	34.234	3.600	9.500	8.100	17.600	200	16.000	17.000	33.000	3.500
New Zealand	230	150	380	0	440	350	790	95	230	150	380	0	440	350	790	95
Poland	408	1.360	1.768	0	500	1.400	1.900	150	408	1.360	1.768	0	500	1.400	1.900	150
Romania	64	172	236	9	62	145	207	16	61	173	234	7	50	160	210	17
Russia	346	74	420	43	26	40	66	4	84	54	138	20	92	70	162	9
Serbia	34	33	67	12	58	76	134	11	34	33	67	12	58	76	134	11
Slovakia	229	0	229	0	229	0	229	7	222	0	222	0	222	0	222	8
Slovenia	1.299	56	1.355	36	2.376	85	2.461	140	1.282	72	1.354	00	2.100	100	2.200	140
South Africa	0	492	492	0	0	913	913	128	0	492	492	0	0	913	913	128
Spain	0	477	477	0	0	1.037	1.037	128	0	507	507	0	0	900	900	128
Ukraine	660	276	936	52	510	240	750	42	439	206	645	10	470	230	700	47
UK-England	817	252	1.069	20	1.150	450	1.600	100	817	252	1.069	0	1.150	450	1.600	100
USA	4.375	8.270	12.645	0	5.513	24.194	29.707	3.500	4.193	7.954	12.147	0	5.451	23.067	28.518	3.150
IHGC	**24.300**	**25.990**	**50.290**	**795**	**37.554**	**62.976**	**100.530**	**9.339**	**22.964**	**25.230**	**48.194**	**557**	**34.622**	**60.730**	**95.352**	**8.761**

(Source: IHGC 2012)

EU AS THE MAIN PLAYER IN THE WORLD HOP MARKET

In the period 2001-2008, the hop-growing surface area in EU countries varied from 32,569 ha (21,554 ha of aroma hops and 11,015 ha of bitter hops) in 2001 to 29,705 ha (19,756 ha of aroma hops and 9,949 ha of bitter hops) in 2008. In 2008, the total EU hop production was about 57,000 t, more than 50% of the world hops production. The largest producer within the EU is Germany (39,676 t), followed by the Czech Republic (6,753 t), Poland (3,446 t), Slovenia (2,359 t), France (1,469 t), the UK (1,410 t), etc. Hops acreage is decreasing steadily in the EU, with a 16% reduction since 2001. Bitter varieties are grown in about one-third of the area. This percentage has been constant throughout the last eight years.

Number of hop farms (holdings) in EU

During 2000-2008, the number of holdings growing hops declined significantly in the main hop-producing countries (Table 3). The reduction ranges from 10.9% in Poland to 37.7% in Spain. In Germany, the decrease was 22.9%, with a loss of 446 farms. While the number of holdings has decreased, the average acreage per holding has increased in all the listed countries from +2.5% in the Czech Republic to +31.6% in Germany. These data series show a large variability in average acreage across member states. The largest holdings are in the Czech Republic (40.7 ha per holding in 2008), and the smallest are in Spain and Poland (around 2 ha per holding).

In the period 2004-2007, according to the data available for all member states, more than 480 farms abandoned hop production. Comparable data for the period 2001-2007 were not at hand. However, if we keep the number of farms abandoning hops growing in the new member states (which make a conservative estimate) constant, we estimate that more than 1,350 farms in Europe stopped producing hops in the period 2001-2007.

Growers mostly exit the hop sector as their farms and hop gardens are not able to guarantee a sufficient income. This phenomenon is affecting old farmers, whose farms are not

Table 3: Number of hop farms and average acreage per farm in major hop-producing countries (2002-2008)

	Indicators	2002	2003	2004	2005	2006	2007	2008	2000/08 (Change %)
Germany	Nr. of farms	1943	1710	1698	1611	1554	1510	1497	-22,9
	ha/farm	9,5	9,7	10,3	10,7	11,1	11,7	12,5	+31,6
Czech Rep.	Nr. of farms	185	165	162	145	145	139	131	-29,2
	ha/farm	40,0	36,0	36,0	39,0	37,0	39,0	41,0	+2,5
Poland	Nr. of farms	1191	1129	1121	1144	1113	1066	1061	-10,9
	ha/farm	1,9	1,9	2,0	2,0	2,0	2,0	2,1	+10,5
Slovenia	Nr. of farms	189	186	176	176	150	140	140	-25,9
	ha/farm	9,6	8,9	8,8	8,8	10,1	11,0	11,0	+14,6
UK-England	Nr. of farms	85	76	60	60	60	60	58	-31,8
	ha/farm	21,4	19,0	22,6	17,9	17,4	17,7	18,5	-13,6
France	Nr. of farms	111	100	96	96	96	90	89	-19,8
	ha/farm	7,4	8,2	8,2	8,4	8,3	8,8	9,3	+25,7
Spain	Nr. of farms	398	400	395	353	325	248	248	-37,7
	ha/farm	1,7	1,7	1,7	1,9	1,9	2,0	2,0	+17,7
Belgium	Nr. of farms	52	49	47	45	44	42	29	-44,2
	ha/farm	4,8	4,7	4,4	4,6	4,5	4,4	5,8	+20,7
Portugal	Nr. of farms	14	12	12	12	7	4	4	-71,4
	ha/farm	2,6	3,1	3,1	3,3	2,6	5,3	5,0	+89,2
Austria	Nr. of farms	72	73	70	70	67	65	63	-12,5
	ha/farm	3,1	3,0	3,0	3,0	3,0	3,1	3,3	+9,6
USA	Nr. of farms	60	60	52	52	56	62	74	
	ha/farm	196,3	188,6	216,0	227,3	212,7	201,7	267,0	

(Source: Munisteri et al. 2009)

continued by younger generations, and farmers who have small farms. Land abandonment is thought to occur rarely, but no relevant figure exists for hops. Farmers who stop growing hops normally sell their hop gardens to other hop growers, who continue to grow hops (Munisteri et al. 2009, Pavlovič 2010).

Average size of hop farms

The average hop acreage per farm increased in almost all the member states because several farmers stopped growing hops. The farmers mostly stopped because of ageing rather than for economic reasons, according to the interviewees. However, the economic component might be stronger than what the interviewees suggested. Related to measures of the EU Common Agricultural Policy (CAP) in the hop sector 2004-2008, some growers of the countries adopting full decoupling may wait to leave the hops sector until they face the next heavy investment (for instance, when renewing hop gardens) and exit at this point, keeping the decoupled support. No figures are available at the national level on the causes of the cessation of hops production, so the estimates are based on personal assumptions made by the interviewees. The hops gardens were mainly sold to other farmers who stayed in business.

Hop farmers are stepwise becoming entrepreneurs; thus, most try to attain a farm size that makes production more profitable. The main concern of farmers is to be able to spread the high fixed costs generated by hop growing over a sufficient number of hectares, so that the farmers can make profits per hectare. When this is not possible, hop growers are slowly stopping hop production, according to the interviewees. Spain, for instance, is an emblematic case in this sense.

Most Spanish and Polish hop holdings are extremely small (< 2 ha) so farmers do not find it convenient to invest in machinery and in new technology. In the long term, farmers will either abandon hop growing or will expand their business to become specialized. The size threshold that makes a farm profitable varies across countries. In Germany, a holding having 10 ha of hops starts being economically viable (once one takes subsidies into account). A similar size enabling the hop farm competitiveness is envisaged for Slovenia.

European hop farms (holdings) are becoming larger. The farm structure varies greatly across the EU countries. The main reason lies in the competitiveness at the international level. No effect of the CAP reform after 2004 on a farming structure was discovered. The difference in the average size of European farms depends on historical and agronomic reasons. In the Czech Republic, the current farms are the heritage of the enormous socialist collective farms; thus, Czech farms are much bigger than the European average. On the other hand, hop farms in Poland and Slovenia used to be much smaller and predominantly in the hands of independent private farmers during the socialist period. In Slovenia, the hop farms on average were significantly enlarged from 3.5 ha to 10 ha per farm after significant structural changes in year 1999 as the company "Hmezad kmetijstvo" had collapsed. Consequently, about 1000 ha of hop fields were purchased by 70 local hop farmers (Pavlovič 2010).

The average hop acreage per farm in Europe is increasing but is still much lower than in the USA. This may affect the competitiveness of European hops in the medium term. Therefore, the production structure of U.S. farms is more competitive than European farms. For an idea of the comparative advantage enjoyed by the United States in terms of production structure, the 12,510 ha devoted to hops in 2007 in the US (WA, OR, ID) were spread over 62 farms. This works out to 202 ha per farm, 18 times the average German farm and more than five times the average Czech farm (Munisteri et al. 2009, Pavlovič 2012).

Rate of specialization of hops farms

The rate of specialization of EU hop farms is generally increasing. The interview results showed that hop farms tend to become more specialized in Germany and Czech Republic. In Germany, the specialization rate (defined as the amount of revenues determined from hops of the overall farm revenues) for hop-producing farms increased from 42% in 2003 to 59% in 2006. A similar trend can be observed in the Czech Republic, with the specialization rate increasing from 16% in 2004 (the first year for which data were available) to 25% in 2006. As these data come from the FADN (Farm Accountancy Data Network) database, they are limited to these two countries.

Other EU countries had no hop sector FADN data available. However, a number of interviewees in other member states have confirmed this trend. Interviewees also linked the increased level of specialization to the high revenues that hops provide if cultivated on an adequate scale (Munisteri et al. 2009).

CONCLUSIONS

Hop and brewing industry must respond to the ever-changing needs of consumers by providing appropriate new types of beer. Since a brewing industry depends on hops to provide distinctive and proprietary characteristics to beer, a stable supply of high-quality hops is a high priority (Forster 2001, MacKinnon 2008, Anon 2010, Hopsteiner 2010, Barth 2011). The EU hop industry sector, similar to the global hop trade and the world brewing industry, is facing a trend toward a concentration in capital investment and decision making. An important issue related to competitiveness is the production structure in the hop industry sector (number of holdings, average farm size, and rate of specialization), which was discussed here.

The EU production structure is changing, which is mostly due to market-driven structural adjustment aimed at being more competitive. Growers are exiting the hop sector as their farms and hop gardens are not able to guarantee a sufficient income. No evidence regarding the influence of the CAP reform after 2004 on the production structure was discovered.

The average hop farm size is increasing in all EU member states. The growth in the average size is mainly due to the reduction in the number of growers, while the reduction in hop area is less pronounced. Small hop-producing countries with weak or no sector-linked national research and development support have seen a sharper decrease in growing area and in the number of farmers. In some countries, such as Spain, Belgium, Bulgaria, Portugal, and the UK, the reduction in the number of growers has endangered the very existence of the hops sector. The few farms left are becoming more specialized in hops in terms of equipment and other investments. However, the farms are still much smaller than in the U.S., and this could affect the competitiveness of European hops in the medium term.

With the exception of Germany, hop acreage in Europe is diminishing, following the global trend. This is mainly due to the launch of new bitter hop varieties by the USA and Germany that provide a higher yield per hectare so that less acreage is needed for the same amount of alpha acids, required by the global brewing industry. However, the acreage reduction was insufficient to prevent an oversupply of hops in years 2009, 2010 and 2011. Again, farmers' on-time business decisions linked to making forward contracts for their crop production play a crucial role in the farmers' hop supply competitiveness as clearly apparent throughout the period under the scrutiny here.

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Introduction to DEXi multi criteria decision models: What they are and how to use them in agriculture

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ABSTRACT

The planning process in agriculture often requires consideration of many conflicting criteria and participation of multiple stakeholders with conflicting interests. The multi criteria decision method DEXi is therefore a viable option for decision support in farm management. This study briefly reviews basic concepts of DEXi method and possible applications in agriculture on real life decision and assessment problems.

Key words: multi criteria analysis, assessment, DEXi

INTRODUCTION

Multi criteria decision analysis can be applied when the evaluation involves several variables that cannot be easily transformed into quantitative units, and the assessment process is likely to be influenced by multiple competing criteria. Such situation often emerges in agriculture and the multi criteria analysis for different kind of assessments systems has been applied in many cases (Pavlovič et al. 2011, Žnidaršič et al. 2008, Bohanec et al. 2008, Mazetto and Bonera 2003, Griffits et al. 2008, Rozman and Pažek 2005, Rozman et al. 2006, Tiwari et al. 2009, Tojnko et al. 2009).

The most common methods like analytical hierarchical process (AHP) and multi attribute utility theory are based on quantitative assessment. On the contrary, the method DEXi (Bohanec et al. 2000) is based on discrete values of attributes and utility functions in the form of "if…then" decision rules. In particular, some methods, such as DEXi (Bohanec and Rajkovič 1990, Bohanec et al. 2000), facilitate the design of qualitative (symbolic) decision models. In contrast to conventional quantitative (numeric) models, qualitative models use symbolic variables. These seem to be well-suited for dealing with 'soft' decision problems, that is, less-structured and less-formalized problems that involve a great deal of expert judgment and where qualitative scales can be more informative than quantitative scores. The DEXi method has already been successfully used in numerous real life decision and assessment problems such as for the estimation of hotel service quality (Rozman et al. 2009).

The aim of this paper is to present the possible applications of method DEXi in agriculture on real world farm management decision problems. We present the application of DEXi methodology on assessment of farm business alternatives, tourist farm service quality and hop hybrid assessment.

DEXi METHOD

The DEX (and its windows version DEXi) is a method for qualitative multi-attribute decision modelling and support. Many real life applications of multi-attribute methods were based on DEXi (Bohanec and Rajkovič 1990). The DEXi combines the "traditional" multi-attribute decision making with some elements of Expert Systems and Machine Learning. The main characteristic of the DEXi method is its capability to deal with qualitative variables. The objectives are hierarchically ordered into a tree structure. The DEXi expert system can be used for solution of various decision problems (Leskovar 1993, Bohanec et al. 1995, Bohanec and Rajkovič 1999, Bohanec et al. 2000,) and was developed by the University of Maribor, Faculty of Organizational Sciences in collaboration with the Institute Josef Stefan. The basic approach in the DEXi methodology is a multi-objective decomposition of the problem: the decision problem is decomposed into smaller and less complex decision problems (sub-problems). In this way, we get a decision model consisting of attributes, which represent individual sub-problems. The attributes are organized hierarchically and connected with the utility functions. The utility functions evaluate each individual attribute with respect to their immediate descendant's objective in the hierarchy. Instead of numerical variables, which typically constitute traditional quantitative models, DEXi uses qualitative variables; their values are usually represented by words rather than numbers, for example "low", "appropriate", "unacceptable", etc. Furthermore, to represent and evaluate utility functions, DEXi uses *if-then decision rules.* The decision rule can be for instance: "if the net present value is negative then the alternative is not acceptable" or "if the labour usage in the investment project

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is low then the alternative is excellent". The utility function, in fact, represents a knowledge base (the complete set of "what if" decision rules), which is ultimately used for evaluation of alternatives (Bohanec et al. 1995, Bohanec and Rajkovič 1999, Bohanec et al. 2000).

The utility function is defined through the entire hierarchy for each aggregate attribute. The utility functions in DEXi are described with a set of decision rules. The decision rule describes value of an aggregate attribute for each combination of input attributes and expresses the relative importance of individual attributes. In DEXi (Bohanec 2008), the value domains are discrete; therefore, the function f maps all the combinations of values X= X1 ×X2 ×…×Xn into the values of Y. The mapping is represented in a table, where each row gives the value of y for one combination of values x∈X.

Utility functions are components of multi-attribute models that define the aggregation aspect of option evaluation. For each aggregate attribute y, whose descendants in the tree of attributes are $x^1, x^2, \ldots, x_n$, the corresponding utility function f defines the mapping:

$$f = X_1 \times X_2 \ldots \times X_n \rightarrow Y$$

Where $X_1, \ldots, X_n$ and Y denote value domains of the attributes $x_1, \ldots, x_n$ and y.

Rows are also called decision rules, because each row can be interpreted as an "if–then" rule of the form:

If $x_1 = v_1$ and $x_2 = v_2$ and … and $x_n = v_n$ then $y = v$ where $v_1 \in x_1, \ldots, v_n \in x_n$ and $v \in Y$.

For a less detailed representation of utility functions the *weights* can be used. Given a decision rule, we use some suitable method to estimate the average importance of each input attribute for determining the value of dependent variable. We then obtain weights by expressing this importance as percentages relative to each other attributes. Two methods are used to assess weights with DEXi: one is based on regression and the other on measuring attribute informatively as in machine learning methods (Bohanec et al. 2000).

Using the *regression*, a decision rule is interpreted as a set of points in a multi-dimensional space and approximated with a hyperplane in that space. Let $x_{1\ldots}x_n$ represent the input attributes and *y*, the dependent variable, which is required to be ordered. For the purpose of this method, all qualitative values of attributes are represented by their ordinal numbers. Accordingly, we can interpret a decision rule as a collection of points and approximate them by a hyperplane. That means the coefficients a_0, $a_{1\ldots}a_n$ are approximated with the least-squares optimization. The regression equation is as follows:

$$Y = a_0 + a_1x_1 + \ldots + a_nx_n \tag{1}$$

Where:
$a_{1\ldots}a_n$ - regression coefficients
$x_{1\ldots}x_n$ - ordinal values of attributes

The weights are the calculated as shown in equation 2 (a_0 is omitted from the representation):

$$w_i = \frac{a_i}{\sum_{i=1}^{n} a_i} \tag{2}$$

Where:
wi - weight (relative importance of attribute i)

As an alternative method for the estimation of weights we can use a method used in machine learning algorithms to identify the most relevant attributes (Bohanec et al. 2000). The measure is based on the information theoretic measure of entropy, -pi log2 pi, where pi is the probability of the i-th event.

Another way of defining utility functions in the DEXi model is the so called weight-based strategy of defining decision rules (Bohanec 2008). Here, the experts explicitly define the values of only a small subset of rules but additionally specify the required weights of the attributes: the higher the weight, the more important the attribute. Using this information, DEXi constructs a linear function with which the software interpolates the values of all previously undefined rules in the table. In principle, the function is constructed so that its linear coefficients correspond to the required weights and its surface lies as close as possible to the initially specified subset of rules (Pavlovič et al. 2011). More formally, the problem is defined as shown in Figure 1 (Bohanec 2008):

Finally, the attribute values for each alternative are put into the DEXi input table and assessment is performed.

In following chapters we present three real life application of DEXi methodology in agriculture.

DEXi MODEL FOR STREUOBST STANDS ASSESSMENT

The model for "Streuobst" stands assessment was first presented by Tojnko et al. (2011). High-steam orchards (»Streuobst stands«, »Hey orchards«), traditionally grown on grassland, represent an important source of raw material for the processing industry and for traditional fruit processing on family-run farms. Near production aspects, the role of high steam orchards is also in preservation of the traditional landscape and indirectly in maintenance of the viability of rural areas. In this paper qualitative multi-attribute model for the assessment of »Streuobst stands« with respect to their multi functional characteristics, is presented. The assessment is based on four groups of attributes: Production criteria, Biological diversity, Landscape diversity and the Function of plantation.

The hierarchy of the model was established through the brain-storming of six experts involved in model development. The hierarchy is based on our previous research (see Tojnko et al. 2009). The final structure of attributes for the assessment of "Streuobst" stands and is shown in Figure 2.

Each stand that is to be assessed by the model is described by 10 basic (input) attributes. These attributes are grouped into four groups that describe 4 main functions of a "Streuobst" stand.

The aggregate attribute Production criteria consist of 2 basic attributes:

- Physiological condition of the trees: describes the trees fruit bearing potential with respect to its form and appearance
- Tree density: describes % of missing trees

1. A set of decision rules:

$$S = \{x_1 \rightarrow y_i, i = 1,2, \dots, r\}$$

Where $x_i \in X$ and $y_i \in Y$

2. With respect to required weights

$$w_1, w_2, \dots, w_n \; (w_1 \in R \; and \; \sum_{i=1}^{n} w_i > 0)$$

Construct the linear function:

$$h(x_1, x_2, \dots, x_n) = K\big(w_1 ord(x_1) + w_2 ord(x_2) + \dots + w_n ord(x_n)\big) + N$$

So so that it best fits the rules in **S**, minimizing:

$$\sum_{i=1}^{r} (h(x_i) - ord(y_i)^2$$

3. The function coefficients are then calculated:

$$K = \frac{\sum_{i=1}^{r} y_i W_i - (\frac{1}{r}) \sum_{i=1}^{r} y_i \sum_{i=1}^{r} W_i}{\sum_{i=1}^{r} W_i^2 - (\frac{1}{r})(\sum_{i=1}^{r} W_i)^2}$$

$$N = \frac{1}{r}(\sum_{i=1}^{r} y_i - K \sum_{i=1}^{r} w_i)$$

$$where W_i = \sum_{j=1}^{n} w_j \, ord(v_j) at \; x_i = (v_1, v_2, \dots, v_n)$$

Figure 1: Formal explanation of utility function using the weight based strategy

The aggregate attribute Landscape diversity consists of 3 basic attributes:
- Visual appearance: describes the incorporation of a stand into the landscape
- Ecological diversity: describes the presence of other natural elements in the stand (such as wetland, water streams or natural tree stands)
- Erosion protection: describes the stand contribution to erosion protection (for instance the contribution of stand on slopes is greater than on a flat land)

The aggregate attribute Biological diversity consists of 3 basic attributes:
-Artificial interventions in the stand: this attribute describes the intensity of artificial interventions in the stand (such as agro meliorations or terraces)
- Diversity: number of fruit species and varieties in the stand
- Cultivation: this attribute also describes but with respect to stand management such as soil management, fertilization, pruning (for instance smaller number of mowing contributes to better biological diversity)

The last aggregate attribute describes the function of a stand (production or country side appearance) and consists of 2 basic attributes:
- Type of plantation: independent stand or stand in the settlement or special important form (such as alley or individual important tree)
- Aim of plantation: this attribute describes the arbitrary assessment of stand main contribution (county side appearance or production)

Each attribute is assigned with a set of possible qualitative values as described in Figure 2.

The selection of stands was conducted with application of the public database of the Ministry of agriculture, forestry and food land usage (http://rkg.gov.si/GERK/viewer.jsp, also see figure 6) in following stages:

a) Using the database we identified 85 stands. Using the aerial photographs in the database we checked each location for its actual usage (to compensate for the changes in the land usage).
b) Each stand was visited and the attributes at the lowest level in the DEXi model

The results show relative poor assessment of analyzed “Streuobst” stands. These results are similar to our previous research (Tojnko et al. 2009) where the also the “poor” overall assessment prevailed as result of the poor cultivation: most of the stands are mainly not pruned which results in the poor Physiological conditions of the trees.

The DEXi methodology, based on qualitative attribute values and utility functions in the form of decision rules, was

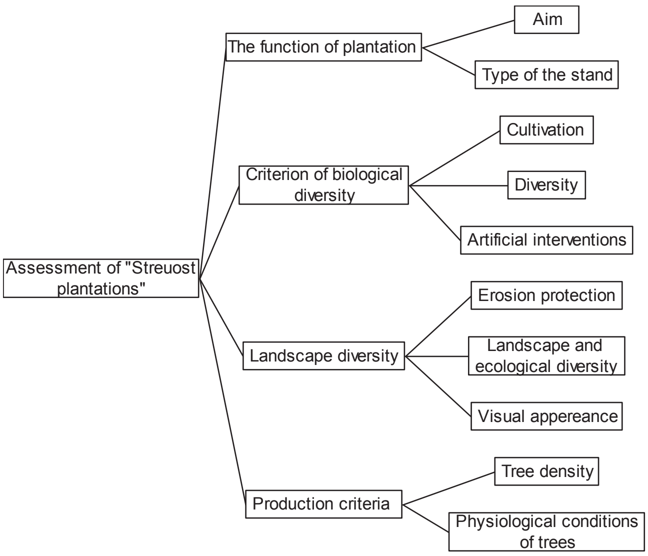

Figure 2: Attribute tree

applied to assess 85 stands The presented multi-criteria model enables precise estimation of contribution of “streuobst” stands to multifunctional agriculture according to the defined criteria. The value added of this approach in practice is detailed analysis of attribute values with the model features (radar charts), which can provide substantial information on possible improvements for each stand in order to ensure its ecological and landscape contribution
.

DEXi MODEL FOR TOURIST FARM QUALITY ASSESSMENT

The model was originally published by Rozman et al. (2009) in order to assess tourist farm service quality. The model was applied to seven tourist farms with data derived from questionnaires completed by tourist farm operators and guests. The results are shown as service quality assessments for individual farms. The potential of the model for assessing the farms is demonstrated with the aim of providing a comprehensive explanation and justification of the assessment technique. It also indicates potential improvements that farms can make through "what-if" analysis and visualization. According to the developed model, two questionnaires were constructed to derive priorities and values for individual criteria. The first questionnaire was issued to tourist farm operators and staff and the second questionnaire to customers—guests of the farm. Farm operators were asked two types of questions. The first set of questions was derived from the tree of attributes (Figure 3) so that each question corresponded exactly to one input attribute (terminal node). The second set of questions consisted of general questions about the operators’ satisfaction level with working in farm tourism. The guest questionnaires were set according to the recommendations of Taylor et al. (1992). They suggested multidimensional scaling of three different areas: attribute selection, number of attributes taken into account by the guests, and assessment of the relative importance of the attributes. Furthermore, the authors listed the set of attributes

Figure 3: The model hierarchy (Rozman et al. 2009)

that influence guests’ decisions and whether they select a specific vacation place according to their preferences.
Overall, the farms were assessed as indicated in the top data row of Figure 4 (next to *Tourist farm service quality*). The highest assessment (‘very good’) was obtained for Farms B, C, F, and G. This is followed by Farms A and D, which were assessed as ‘good.’ Farm E is a special intermediate case because, due to missing data, we could not obtain the overall value precisely as a single value; instead, we used the set ‘good; very good.’

An important feature of using DEXi is the ability to “drill-down” through the tree structure of the model, look at data and assessments at the lower level of the model, and see how

Table 1: The overall DEXi assessments of 85 stands

Assessment of "Streuost plantations"	Very poor	Poor	Average	Good	Excellent
Frequency	8	40	27	10	0

Attribute	A	B	C	D	E	F	G
Tourist farm service quality	good	very good	very good	good	good; very good	very good	very good
Guest	good	very good	very good	good	very good	very good	very good
Premises	very suitable	very suitable	very suitable	very suitable	very suitable	very suitable	suitable
Landscape	very suitable	very suitable	very suitable	very suitable	very suitable	very suitable	suitable
Environment	very suitable	very suitable	very suitable	very suitable	very suitable	very suitable	suitable
Architecture	very suitable	very suitable	very suitable	very suitable	very suitable	very suitable	suitable
Order and cleanliness	good	excellent	excellent	excellent	excellent	excellent	good
Access to the farm	good	good	good	good	good	good	acceptable
Parking	acceptable	good	good	good	good	good	acceptable
House	acceptable	good	good	good	good	good	good
Equipment	suitable	very suitable	very suitable	suitable	very suitable	suitable	suitable
Homeyness	yes	yes	yes	yes	yes	yes	yes
Cleanliness	good	excellent	excellent	excellent	excellent	excellent	excellent
Spaciousness	very suitable	very suitable	very suitable	very suitable	very suitable	very suitable	suitable
Services	acceptable	good	good	acceptable	good	good	good
Food	acceptable	good	good	acceptable	good	good	good
Taste	excellent	excellent	excellent	good	excellent	excellent	excellent
Look	excellent	excellent	excellent	good	excellent	excellent	excellent
Variegation	variegated	very variegated	very variegated	variegated	very variegated	very variegated	very variegated
Serving	acceptable	good	good	acceptable	good	good	good
Drinks	acceptable	acceptable	acceptable	good	good	good	acceptable
Diversity	diversified	diversified	diversified	diversified	diversified	diversified	diversified
Serving	acceptable	good	good	good	good	good	good
Tradition	typical	typical	typical	extra	extra	extra	typical
Attitude	friendly	friendly	friendly	*	friendly	friendly	friendly
Personnel to customer	friendly	friendly	friendly	*	friendly	friendly	friendly
Personnel to personnel	friendly	friendly	friendly	*	friendly	friendly	friendly
Personnel cleanliness	suitable	suitable	suitable	*	suitable	suitable	suitable
Additional services	poor	poor	poor	poor	good	acceptable	good
Sports	not available	not available	not available	not available	available	available	available
Animation	not conducted	not conducted	not conducted	not conducted	conducted sometimes	not conducted	conducted sometimes
Souvenirs	few	not available	not available	not available	few	few	few
Repeat visits	yes	yes	yes	yes	yes	yes	yes
Farm operator	very good	very good	very good	very good	*	very good	very good
Plans for the future	yes	yes	yes	yes	*	yes	yes
Satisfaction	good	good	good	good	*	good	good
Work comparison	more pleasant	more pleasant	more demanding	more pleasant	*	more demanding	more demanding
Income	acceptable	good	good	good	*	good	good
Labor distribution	very suitable	suitable	very suitable	very suitable	*	very suitable	very suitable
Interesting work?	very interesting	very interesting	very interesting	very interesting	*	very interesting	very interesting

Figure 4: The service quality assessment of 7 tourist farms (Rozman et al. 2009)

they contribute to the overall assessment (Figure 5). This is very important for better understanding and justification of the assessment process. Furthermore, such analysis can be easily and comprehensibly visualized using various charts. As an example, Figure 6 presents radar charts that show the evaluation of service quality for each farm for the aggregate attribute *Guest,* according to the defined decision rules. Individual points other than *Guest* show values of the four attributes that influence the *Guest* attribute. The ideal guest assessment is achieved when the line is at the edge of the pentagram (Farm E). In a non-ideal assessment, the line is shifted toward the center, clearly indicating an attribute and its value contributed to a less than ideal assessment. For example, it is easy to identify the reasons why Farm D was perceived as 'good' instead of 'very good': because of 'acceptable' *Services* and 'poor' *Additional services*.

THE DEXi-HOP MODEL

The model related to a hop industry (Pavlovič et al. 2011) was developed in order to assess new potential hop hybrids. Within the hop breeding research program carried out at the Slovenian Institute of Hop Research and Brewing, thousands of hop hybrids appeared to be perspective according to research objectives (Cerenak 2006). In this research the data from four different Slovenian hop hybrids A1/54, A2/104, A3/112, A4/122 were compared with a reference German variety Hallertauer Magnum, which had the desired characteristics plant resistance and brewing value. The assessment was carried out by a qualitative multi-attribute model based on the DEX methodology (Bohanec et al. 2000). We first developed the model and then applied it to assess the aforementioned perspective hybrids. The model hierarchy is shown in Figure 6.

Among over one thousand of hybrid hop plants analyzed and eliminated stepwise through a selection procedure, the four Slovenian hop hybrids such as A1/54, A2/104, A3/112, A4/122 and a reference variety Hallertauer Magnum were involved into a comparative model assessment. The hop hybrids had been selected through a hop breeding process among sets of seedlings analysed and assessed as highly forthcoming and promising new hop varieties. Numerical data of analyses and measurements of hop cones as well as beer sensory estimation were used to describe hybrids production and brewing quality parameters. They were analyzed and

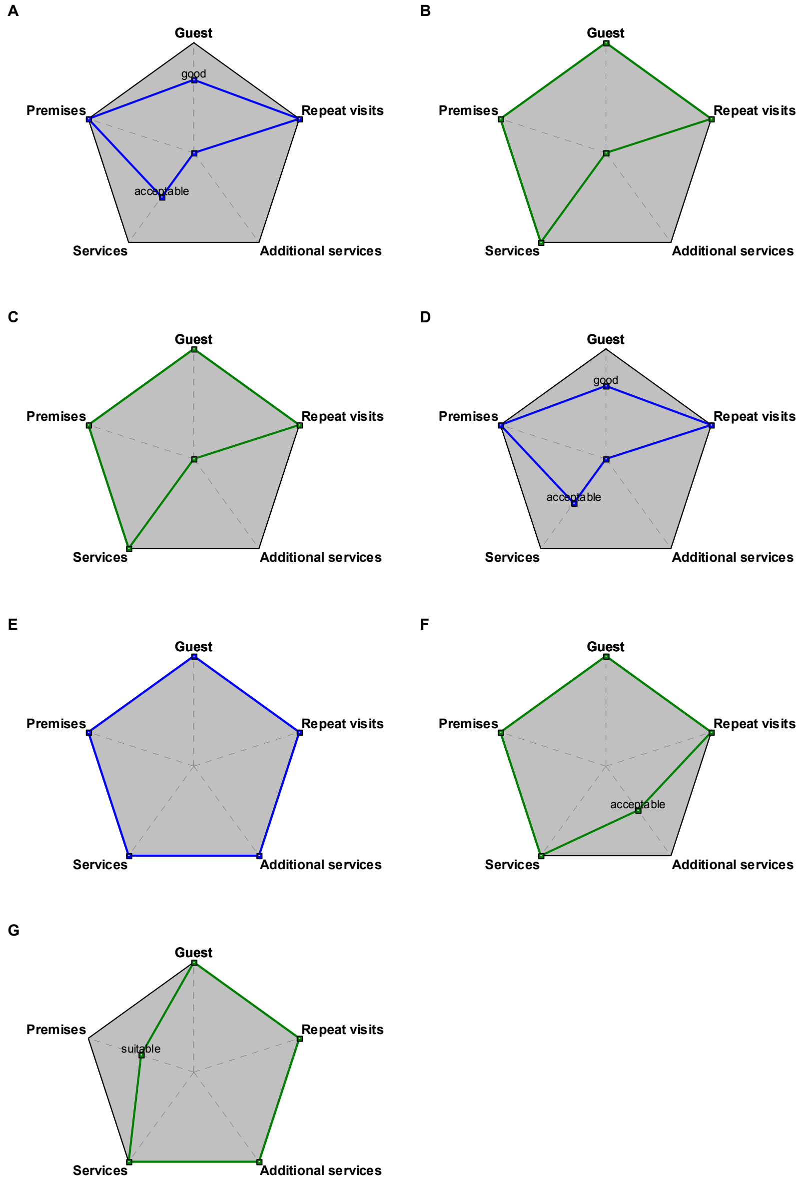

Figure 5: Graphical presentation of the assessment of the attribute Guest for individual farms

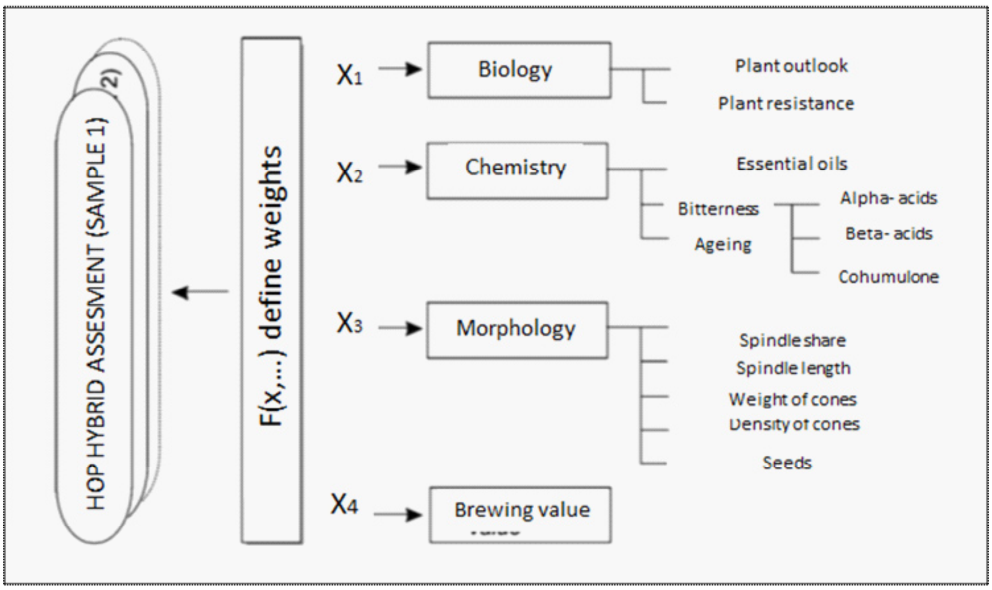

Figure 6: The hierarchical structure of the DEXi-HOP model

results were additionally discussed. The model enabled a final assessment of hybrids based on defined attributes and decision rules within defined utility functions.

Based on breeding experiences and the DEX-HOP 1.0 model results, the overall as well as individual (aggregated and derived) attributes assessments were carried out. A3/112 and A4/122 reached the overall level of reference and were thus assessed as appropriate for further breeding. On the contrary, A1/54 and A2/104 did not meet expectations in their attributes related to the reference variety. A2/104 was in overall assessed as WORSE, while A1/54 as NON PERSPECTIVE. Therefore, they were considered as hybrids with less breeding potentials.

CONCLUSIONS

In this paper, an attempt was made to present multi-criteria method DEX, based on qualitative attribute values and utility functions in the form of decision rules, and its possible application in the field of agriculture. The application of the method was presented on three real life decision/assessment problems.

Despite some deficiencies (such as the use of qualitative data only), the approach fulfills most of our expectations and reveals considerable advantages in comparison with other approaches. In particular, we emphasize the use of the qualitative multi-criteria DEXi model, which is suitable in a field where judgment prevails, thus making it difficult to give numeric answers. This kind of model is comprehensible to a wide range of users in the assessment process.

The multi-criteria DEXi model can therefore be regarded as a useful alternative tool decision support and different kinds of assessment in the field of agriculture. Further research is needed in the field of integrating quantitative data into the DEXi modeling framework, as well as comparing it other multi-criteria methods.

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A combination of the Multi-criteria approach and SWOT analysis for the identification of shortcomings in the production and marketing of local food

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ABSTRACT

A combination of multi-criteria decision analysis (MCDA) and SWOT analysis was developed by applying the DEX method for the identification of shortcomings of the production and marketing of local food products in Slovenia. Additionally, a plus-minus 1 analysis was introduced and the influences of different attributes on the final assessment of the local food products were examined. The main shortcomings in the production and marketing processes for local foods were found, and results were given in the form of attributes represented as **S**trengths, **W**eaknesses, **O**pportunities and **T**hreats. The joint results of DEX and SWOT analysis gave clear information as to which attributes or factors need to be improved for the success of local food production.

Key words: local food, multi-criteria decision model, DEX, SWOT analysis

INTRODUCTION

There is no precise definition as to what a local food system entails, but according to many literature sources worldwide, local food systems focus on supporting smaller local farms (and thus the local economy), protecting the environment by decreasing food-miles travelled and using fewer synthetic chemicals. Another valid way of thinking about local food is that its environmental impact depends not only on how far the food is transported, but also on how it is transported. Particularly from the consumer perspective, local food is predominantly about distance (Hingley et al. 2010). Furthermore, from an EU policy point of view, it is widely understood that European agriculture's best chance for competing on the world stage is to focus on quality, and to develop local food systems which can help to encourage the production of high-quality food using particular production methods. Indeed, Mintel (2010) indicates that buying locally sourced products is increasingly motivated by support for local farmers, food producers and retailers.

According to many authors (Weatherell et al. 2003, Tregear et al. 2007, Mintel 2010, Vechio 2010), local food marketing could be perceived as a development opportunity, although many obstacles are identified in relation to consumers, retailers' small local business and policy. Hingley (2010) even concludes that according to a study in UK, the lack of definition of local food is a major obstacle for the development of the local concept and its translation to consumers. In Slovenia, the number of studies on local food has increased in recent years (Bratec 2007, 2008, Majkovič and Borec 2010), but there are still no comprehensive frameworks or results which could give us the exact factors hampering the development of the local concept.

The objective of this paper is to determine and understand the main shortcomings in the process of producing local food, as these may be recognised as important factors hindering the development of the local food concept in Slovenia.

To identify these shortcomings, we need to apply a relatively easy, transparent and useful tool to assess the production and marketing of local food. According to some previous research, multi-criteria decision analysis (MCDA) seems to be applicable (Tiwari et al. 1999, Hyde and Maier 2006, Herman et al. 2007, Pažek et al. 2007, Rozman et al. 2009, Pavlovič et al. 2011). The most commonly used MCDA methods are multi-attribute utility theory (MAUT) and the analytical hierarchical process (AHP) (Saaty 1980, Alphonce 1997, Parra-Lopez et al. 2008, Galli et al. 2011), which both use a quantitative assessment of alternatives. In contrast, Bohanec et al. (2000) presented another MCDA method, the DEX system, which deals with qualitative decision models. To support decision making and to analyse environments in a systematic way, the most commonly used tool is SWOT analysis (Kotler 1988, Wheelen and Hunger 1995). According to Kajanus et al. (2012), SWOT analysis is an essential tool for strategic decision making and has been developed in various contexts (Hill and Westbrook 1997, Chang and Huang 2006, Feglar et al. 2006).

For our research proposes, we use a combination of one

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MCDA technique (the DEX methodology) and SWOT analysis. Kajanus et al. (2012) note that the rationale for using multiple-criteria decision support (MCDA) and SWOT framework jointly has to do with the systematic evaluation of SWOT factors with a view to making them commensurable in terms of their intensities (Kurttila et al. 2000). Helms and Nixon (2010) described SWOT analysis in research as a practical planning tool, and argued that it is a relevant assessment methodology in many ways. Shrestha et al. (2004) combined a quantitative MCDA method, specifically AHP, and SWOT analysis for the assessment of different silvopasture practices. In our research experience with the DEX method (Pažek et al. 2006, Pažek et al. 2010, Prišenk et al. 2012), we have found that the combination of DEX methodology and SWOT analysis is very compatible and efficient, as both of these approaches are based on qualitative assessments, whereas the combination with other MCDA methods is based on quantitative assessments.

MATERIAL AND METHODS

Methodology and data sources

For our research purposes, the DEX methodology was applied as an approach to qualitative multi-criteria decision modelling and support by Bohanec and Rajkovič (1990) and Tojnko et al. (2011). The DEX method is implemented by the software program DEX-i (Bohanec et al. 2008). For the DEX methodology, quantitative input data were transformed (with MS Office Excel) into qualitative values (for example, 'bad', 'good' and 'excellent'; 'low' or 'higher', etc...) and afterwards further applied for SWOT analysis. Input data for DEX were based on an open questionnaire prepared for compatible local food chains actors and individuals from local action groups (LAGs), mostly from mountainous and hilly regions of Slovenia. The selection of LAGs was based on characteristics such as remoteness, harsh environmental conditions and lack of infrastructure and public services, as well as on negative demographic trends and the unfavourable age structure of inhabitants. The interviews and field work were carried out between July and October 2011. Questionnaires were designed for the analysis of local food products which are typical for small local environments and are included in the development projects of different LAGs. Taking these restrictions into account, we examined 10 different local food products from seven LAGs in mountainous and hilly Slovenian regions. After the interviews were complete, the development of the model followed.

Model development

The first step in multi-criteria method development is the structuring of the decision hierarchy (Rozman and Pažek 2005). A hierarchical tree was created before interweaving began (all attributes based on interview answers). The hierarchical tree represents the process of solving the problem, where each problem is constructed from sub-problems on the first and second levels (the number of levels depends on complexity of the main problems) (Figure 1).

Attribute tree

Attribute

- **Final assessment of LFP**
  - **Production**
    - Size of cultivated area on farm
    - **Number of farms**
      - Production
      - Processing
      - Marketing
    - **Agricultural production**
      - Amount of agricultural production on farm
      - Percentage of sales
      - Purchase source
    - **Social-economic and environmental impacts**
      - Orientation of farm production
      - Farm types
    - **Technological aspect**
      - Technological equipment of farms
      - Technological equipment in processing companies
      - Complexity of processing
    - **Processing**
      - Processing on farms
      - Processing in companies
      - Final products on farms
      - Final products in companies
  - **Marketing**
    - **Product sales**
      - Designation
      - Success of product sales
    - Price
    - **Organization of marketing**
      - Farmers
      - Local public institutions
      - Alternative ways of marketing
    - **Consumers**
      - Local/regional consumers
      - Tourists
      - Local shops, supermarkets
      - Other target groups of consumers

Figure 1: Hierarchical tree of the developed DEX model

Each of these problems and sub-problems is represented as attributes which have defined value scales. For assessment of the production system of local food products, five aggregate attributes were identified: 'Number of farms', 'Agricultural production', 'Social-economic and environmental impacts', 'Technological aspect' and 'Processing'. Furthermore, one non-aggregate attribute was delineated, specifically 'Size of cultivated area on farm'. The 'Marketing' aggregate attribute consists of three aggregate attributes—'Product sales', 'Organisation of marketing' and 'Consumers'—and one non-aggregate attribute, 'Price', on the second level.

The third step in model development was the definition of value scales. With the previous data treatment in MS Office Excel, the numerical values were distributed into three-stage scales, which were given qualitative values after the definition of the utility functions. The last step in the model development was the definition of utility functions (UF1 and UF2) (i.e. decision rules) (Figure 2). The decision rules describe the value of an aggregate attribute for each combination of input attributes and express the relative importance of individual attributes (Rozman and Pažek 2005).

To define the decision rules in the DEX method, two approaches are employed. The first approach uses linear regression with weights; this was adopted in our research. The second approach is based on measuring attributes'

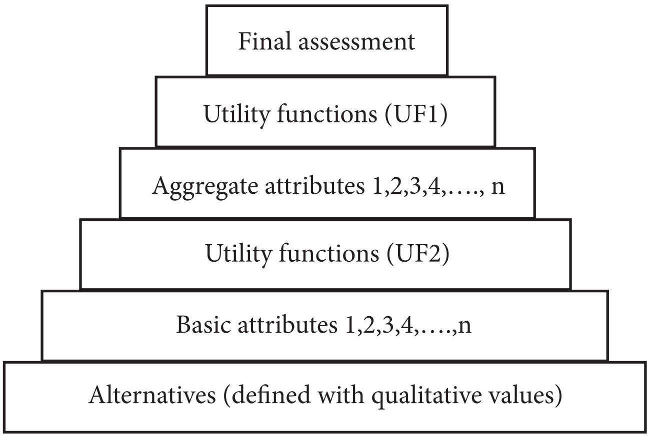

Figure 2: The structure of the DEX model

informativity, as in machine learning methods (Bohanec et al. 2000).

For research purposes, the definitions of the best and the worst decision rules were set out by experts. The scale represents the assessment between the worst ('bad') and best ('excellent') aggregate attributes. In Figure 3, an example of a second-level attribute, 'Technological aspect', is presented. The final assessment was defined as 'bad' if the processing was found to be sophisticated. If the assessment of the third-level attribute 'Technological equipment on the farms and/or companies', as well the attribute 'complexity of processing' had the same grade, e.g., 'excellent', then the final assessment of the aggregate attribute 'Technological aspect' was also 'excellent'. Some decision rules are presented in more complex form, such as '>=', which means 'equal or better' grade.

After the DEX model was finally developed, 'plus-minus 1' analysis was performed in order to identify shortcomings among the attributes previously chosen and used in the DEX model. To obtain a more clear and comprehensible picture of these shortcomings, a combination of MCD and SWOT analysis followed the plus-minus 1 analysis (Figure 4). The combination of these two methods helps us to represent shortcomings in production and marketing more clearly

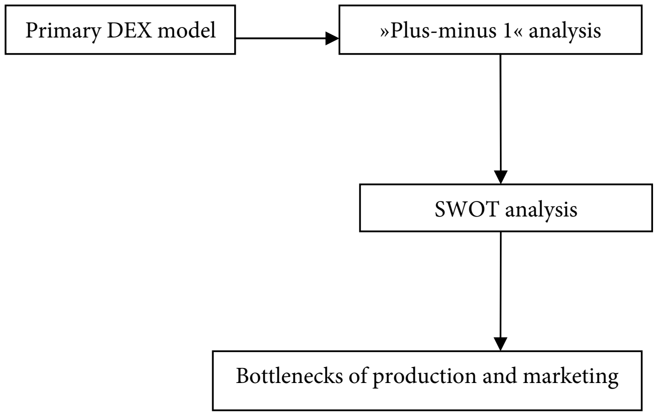

Figure 4: Combination of MCDA and SWOT analysis for the identification of shortcomings in production and marketing processes of local food products

Decision rules

	Technological equipment of farms	Technological equipment in processing companies	Complexity of processing	Technological aspect
	27%	27%	46%	
1	**Bad**	**Bad**	<=Not so complicated	**Bad**
2	**Bad**	<=Good	**Complicated**	**Bad**
3	<=Average	<=Average	**Complicated**	**Bad**
4	<=Good	**Bad**	**Complicated**	**Bad**
5	**Bad**	*	***Simple***	Good
6	<=Average	<=Good	***Simple***	Good
7	<=Good	<=Average	***Simple***	Good
8	*	**Bad**	***Simple***	Good
9	**Bad**	>=Average	>=Not so complicated	Good
10	<=Average	Average:Good	>=Not so complicated	Good
11	<=Good	Average	>=Not so complicated	Good
12	<=Good	>=Average	Not so complicated	Good
13	*	Average:Good	Not so complicated	Good
14	**Bad**	***Excellent***	*	Good
15	<=Good	***Excellent***	<=Not so complicated	Good
16	*	***Excellent***	**Complicated**	Good
17	Average	<=Good	>=Not so complicated	Good
18	Average:Good	<=Average	>=Not so complicated	Good
19	Average:Good	*	Not so complicated	Good
20	>=Average	**Bad**	>=Not so complicated	Good
21	>=Average	<=Good	Not so complicated	Good
22	Average	Good	*	Good
23	Average:Good	>=Good	<=Not so complicated	Good
24	>=Average	Good	<=Not so complicated	Good
25	>=Average	>=Good	**Complicated**	Good
26	Good	Average	*	Good
27	Good	>=Average	<=Not so complicated	Good
28	>=Good	Average:Good	<=Not so complicated	Good
29	>=Good	>=Average	**Complicated**	Good
30	***Excellent***	**Bad**	*	Good
31	***Excellent***	<=Good	<=Not so complicated	Good
32	***Excellent***	*	**Complicated**	Good
33	>=Average	***Excellent***	***Simple***	***Excellent***
34	>=Good	>=Good	***Simple***	***Excellent***
35	***Excellent***	>=Average	***Simple***	***Excellent***
36	***Excellent***	***Excellent***	>=Not so complicated	***Excellent***

Figure 3: Example of decision rules for the 'Technological aspect' aggregate attribute

and transparently, and could further represent a practical planning tool.

Plus-minus 1 analysis upgraded with SWOT analysis

The "Plus-minus 1" analysis describes changes in each basic attribute for one degree upwards and downwards, independent of other attributes (Bohanec et al. 2008). In Figure 5, the plus-minus 1 (PS-1) for a food product ten (X) is presented as an example.

The results of PS-1 represent input data for the further building of SWOT analysis. The attributes on the hierarchical tree were transformed into different factors in SWOT analysis. The attributes with higher and average (neutral) grades from PS-1 analysis are categorised as strengths and those with lower grades are categorised as weaknesses (Figure 5). Opportunities are represented by attributes defined in the +1 column in PS-1, whereas attributes in the -1 column represent threats.

RESULTS AND DISCUSSION

The results of developed model are presented for each food product as a joint or final qualitative assessment of produce and marketing and as assessments of separate aggregate attributes. For the assessment, five different grades ('excellent', 'successful', 'less successful', 'sufficient' and 'not sufficient') were used. Two of 10 food products (20%) were finally evaluated as 'excellent', 5 of 10 (50%) as 'sufficient' and 3 of 10 (33.3%) as 'less successful'. The greatest share of local food

Table 1: Grades for production and marketing of local food with final/joint assessments

Food product	Production grade	Marketing grade	Final assessment
I	Large	Successful	**Excellent**
II	Small	Partially successful	**Sufficient**
III	Small	Partially successful	**Sufficient**
IV	Small	Partially successful	**Sufficient**
V	Small	Not successful	**Not sufficient**
VI	Average	Not successful	**Sufficient**
VII	Large	Successful	**Excellent**
VIII	Small	Successful	**Less successful**
IX	Small	Partially successful	**Sufficient**
X	Average	Not successful	**Sufficient**

Plus-Minus-1 analysis

Attribute	-1	X	+1
Final assessment of LFP		**Sufficient**	
Size of cultivated area on farm	**Not sufficient**; **Sufficient**	3,1-6,5 ha	
Production		***over 350***	]
Processing		***over 350***	]
Marketing	[	**0-25**	
Amount of agricultural production on farm	[	*	]
Percentage of sales	[	**0-25%**	
Purchase source		***Own***	]
Orientation of farm production		6,1-18	
Farm types		Part time	
Technological equipment of farms		Average	
Technological equipment in processing companies		Good	
Complexity of processing		***Simple***	]
Processing on farms	**Not sufficient**	26-50 %	
Processing in companies	**Not sufficient**	26-50 %	
Final products on farms	[	**Low**	
Final products in companies	**Not sufficient**	***Yes***	]
Designation	[	**No designation**	
Success of product sales		***> 95%***	]
Price	[	**< 1%**	Less successful
Farmers		**No**	]
Local public institutions	Less successful	**No**	]
Alternative ways of marketing	Less successful	**No**	]
Local/regional consumers	[	***Yes***	
Tourists	Less successful	**No**	]
Local shops, supermarkets	[	***Yes***	
Other target groups of consumers	Less successful	**No**	]

Figure 5: Example of plus-minus 1 analysis for food product X

products received bad final grades. Looking more closely at the grades for the separate attributes, we may conclude, that the main reason for the bad final grades was the average or bad grades at the marketing level (Table 1).

The output of SWOT analysis is presented in Figure 6. The examined local food products are presented according to the factors in the SWOT analysis, and mainly show potential in the fields of promotion, marketing and consumer communication. The number of factors under strengths is much higher compared with the distribution of the other attributes. Strengths were found in different categories, specifically the farm characteristics category, the technological category, the food product characteristic category and the consumer category. We may conclude that the farms where local food products are produced are in good condition and with modern technological equipment for production or processing. The categories 'Consumers' and 'Food product characteristics' indicate that the products have a higher price, are sold at the local level to tourists and local inhabitants, and the local marketing environment is quite well developed.

Looking to the factors under the attribute weaknesses, it is evident that the main weaknesses related to the successful production and marketing of local food are connected to the number of farms which are oriented to the production, processing or sale of local food products. Indeed, studying the local food concept mostly in high-valued environments, e.g., mountains, the lack of sufficient quantities of quality local food becomes apparent. In general, many more farms and companies could be involved in the production and processing of local foods and still successfully sell their products. The last two factors are connected to the findings above: The numbers of final products offered on farms and local retail outlets are very small. Thus, the amount of each single product as well the quantity of different types of local products should be increased. Although these factors are outlined as weaknesses, they could also be discussed as attribute opportunities, as there still is a lot of room in the market for quality mountain products, especially in more extended markets, e.g., regional or national ones.

STRENGTHS:

- Amount of agricultural production on farm
- Purchasing sources
- Orientation of farm production
- Farm types
- Technological equipment on farms
- Technological equipment in companies
- Complex processing
- Designation
- Success of product sales
- Price
- Organisation of marketing: farmers
- Consumers: Local/regional consumers
- Consumers: tourists
- Consumers: other target groups of consumers

WEAKNESSES:

- Number of farms: production
- Number of farms: processing
- Number of farms: marketing
- Percentage of sales
- Processing in companies
- Final products on farms
- Final products in companies

OPPORTUNITIES:

- Organisation of marketing: local public institutions
- Organisation of marketing: alternative ways of marketing
- Consumers: local shops, supermarkets

THREATS:

- Size of cultivated area on farm
- Processing on farms

Figure 6: SWOT analysis of local food products

'Size of cultivated area' and 'Processing on farms' are important as threat factors, and could also be discussed as real weaknesses. For example, if the average size of cultivated area on a farm falls under 6.5 ha, farmers may have problems with production size. For the 'Processing on farms' factor, the interpretation could be similar. If the production of food products on an average small farm is low, the processing of the same food product on the farm could be anticipated to be low.

CONCLUSIONS

In this paper, a combination of multi-criteria and SWOT analysis was used for the evaluation of the production and marketing of local food products. A study of local food from the Slovenian mountain and hilly regions was performed in order to determine the main shortcomings in the production and marketing system that inhibit the development of the local food concept. The results of the research were generated from the DEX methodology and SWOT analysis based on qualitative attribute values, utility functions and final critical expert assessments. Because of its relative simplicity, the model could be employed from by policy decision makers and extension services to help farmers to improve different production stages, and consequently their economic status. We conclude that a hybrid method of MCDA and SWOT analysis can improve production and marketing, and will have a positive impact on strategic planning when it comes selling local food products.

For farmers, the results of the SWOT analysis can provide clear direction. With identification of the weakest links in the food chain, farmers can react and pay more attention to specific attributes or factors. SWOT analysis is easy to understand and has the advantage of high communicability to individuals. According to previous project experiences and the current research results, more shortcomings have been identified on the side of marketing system, although this is expected since local food products are generally marketed in the local environment and sophisticated marketing strategies are not well developed. To broaden the marked for local food, the quantity of single food products should be increased, as well as the variety of food products.

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Does accession to European Union substantially change the economic situation in Croatian agriculture: impact assessment for key production sectors on the basis of static deterministic farm revenue modelling

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ABSTRACT

The purpose of the paper is to assess the impact of introducing the Common Agricultural Policy on Croatian agriculture and on individual production sectors. The scenario analysis is made using a static deterministic model which simulates the changes brought about by the differences in prices and budgetary transfers. Compared to the base year, the total agricultural budget is estimated to increase by around 40 % in the first year after the accession and by almost 70 % in the fourth year, after the expiry of the transitional period. The aggregate prices in agriculture are expected to drop by around 4 % after the accession. According to the optimistic scenario, the revenues are expected to slightly increase (by around 1 %), and by a pessimistic scenario, revenues could drop substantially (by around 13 %). The revenues in crop production are expected to remain at the same level also after the accession. Revenues in livestock production are expected to drop according to all scenarios. The largest drop in revenues is expected in pig and milk production.

Key words: Croatian agriculture, European Union accession, Economic Accounts for Agriculture

INTRODUCTION

Due to the differences in production potentials, structure of agriculture, prices and volumes of production as well as different agricultural policy measures, the EU accession is a huge challenge for every country. By the date of accession, a country needs to be prepared for the Common Agricultural Policy (CAP), its complex administration and measures. After the accession, a new model of supports is introduced, which is usually different from the existing policy in terms of the amount of support and the content of measures (Volk 2004, Erjavec 2007). In this sense, the implementation of the EU model of agricultural policy will be a special challenge also for Croatia as the next new EU Member State.

As the CAP has been constantly changing, it is a moving target for all candidate countries. This will even more be the case for all future enlargements, although the reforms have so far shown certain stability of changes (Tracy 1997, Garzon 2006, Swinnen 2008). The agricultural policy goals have formally not changed since the beginning, and they are primarily related to securing the income to rural population, stabilising the market and increasing productivity and competitiveness of food production. The first important reform was the one in 1992, which took place under the pressure of international trade negotiations (today WTO); because of the decreasing levels of prices it introduced area and headage payments and gave a special significance to the rural development policy (Tracy 1997). The EU enlargement, new demands of the WTO members, as well as the definition of a new role of agriculture in the society led to new reforms, which started in 2003 and ended in 2008 (Swinnen 2008). The essence of these new reforms was further market deregulation, introducing the principle of direct payments decoupled from production, and strengthening the rural development policy.

The main concept of the policy remains the same, in particular the system of measures' implementation, and all the changes always carry the elements of the previous policy (Garzon 2006.). Thus, the main outlines of the future measures can to a certain extent always be predicted (Moyer and Josling 2002).

The reform of the policy and support to agricultural restructuring can strengthen the integration processes in agriculture (Erjavec 2004, 2007). The goal is to reduce the negative and to increase the positive effects of EU integration. In every country a large part of the measures is usually not compatible with the CAP; if they were retained by the very accession, it would give a wrong signal to the producers. It is therefore rational and useful for the policy to gradually adapt to the principles and requirements of the CAP. This is not

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possible without the reform of the policy and strengthening of the budgetary support to agriculture.

The process of reforms and adaptation after the accession can be supported by the assessment of the potential economic changes in agriculture. Using various types of models (static deterministic models, partial or general equilibrium models, programme models), agrarian economists made assessments of the changes in prices, budget, supply, demand, foreign trade, revenues, agricultural income, structure of holdings and other indicators relevant for agricultural policy. A bulk of such research has been made in the history of integration processes (Erjavec et al. 1998, Banse 2000, Muench 2000, Erjavec et al. 2006), which more or less successfully anticipated the post-accession changes. For Croatia no research has so far been available which would provide a simulation of the potential situation in agriculture after the accession in an integral, academically objective and neutral manner.

The objective of this paper is therefore to present the first relatively rough assessment of changes in Croatian agriculture brought about by the EU accession and introduction of the CAP. The paper presents the main results of the study commissioned by the Ministry of Agriculture, Fisheries and Rural Development of the Republic of Croatia (Erjavec et al. 2011). Given the relatively short deadlines, it was only possible to build a static deterministic model simulating the changes brought about by the differences in prices and budget. It is static because it does not include the changes in the volume of production, and deterministic because the elements of changes are defined outside the model on the basis of the analysis of prices in other countries which acceded to the EU and on the basis of already determined (by the limits of the future support under the CAP pillars as set out in the recently accomplished Croatia's negotiations with the EU) or planned budget of Croatia after the accession. The changes in revenues are analysed based on the fixed volume of production in various years before and after the accession. The concept of the model also enables a detailed analysis by agricultural sectors. A similar approach was also used in the agricultural studies that were made for the purpose of the unification of Germany, accession of Austria and Finland in 1995 as well as the accession of Slovenia and some other countries during the last EU enlargements.

MATERIAL AND METHODS

The level of prices of agricultural products in Croatia compared with the EU Member States was estimated on the basis of statistical data on average producer prices of selected products. The National Statistical Office data were used for Croatia (DZS RS 2011) with prices being converted from the national currency to EUR using the average annual exchange rate of the Croatian National Bank (DZS RH 2010d). Prices in the EU Member States were taken from the EUROSTAT database (EUROSTAT 2011). The analysis deals with the period 2000-2009 and includes 38 individual agricultural products, which are assembled into three basic groups: a) *arable crops* (wheat, barley, oat, maize, rapeseed, sunflower, soy bean, sugar beet, tobacco, potatoes); b) *fresh vegetables* (cauliflower, tomato, cabbage, lettuce, cucumber, water melon, paprika, carrot, red onion, peas, beans), *fruits* (apples, pears, peaches, sour cherries, plums, mandarins), *wine* (grapes, quality wine, table wine) *and olive oil*; and c) *animals and animal products* (young cattle, pigs, chickens, lambs, raw cow's milk, fresh eggs, honey).

Only the data on prices at the level of a Member State are available for the EU. The average price for the EU is calculated only for the products for which relevant data are available for at least 6 countries for the entire period 2000-2009 (approximately one-quarter of all Member States). The EU average price is in this case calculated as an arithmetic mean of the prices of all the Member States with complete data. As a detailed analysis of the level and changes of prices in Croatia and the EU revealed a great instability of prices, the average prices in the period 2007-2009 were taken as the representative level for most of the selected agricultural products.

The representative prices of selected agricultural products for Croatia serve as a *baseline scenario* of prices. This scenario is used as a basis for assessing the changes in prices after Croatia's accession to the EU. When assessing the possible changes in prices, the general presumption was that after the accession the level of prices in Croatia will be brought into line with the prices in the EU. This means that the prices of products in Croatia that are today relatively high compared to the prices in the EU can be expected to drop after the accession and vice versa. As the prices in new Member States are on average lower than prices in old Member States, the level of prices in new Member States (in particular the neighbouring ones) was taken as the basic reference for Croatia. For a great majority of products, prices vary considerably among individual countries; thus indicating that the prices in the EU are actually formed under the influence of a number of factors, from the quality of products to the volume of production and development of the market. These factors therefore served as an additional criterion also when assessing possible changes of prices in Croatia.

The assessment of the changes in prices (as well as revenues) was made using three scenarios, which were based on different general presumptions:

- *The realistic scenario* - **sR** (the most probable one) presumes that the prices in Croatia will largely be formed close to the prices in new Member States and that for the most important products the situation on the market will not change considerably;
- *The pessimistic scenario* - **sP** presumes that because of the pressure from open market, the prices of the majority of products in Croatia will be formed close to the average of the most competitive EU members (large producers and exporters); this represents theoretically lower level of possible changes;
- *The optimistic scenario* - **sO** presumes that Croatia will seize the new opportunities of the large common market (easier exports) and at the same time to preserve a considerable part of the domestic market; this level presents theoretically upper level of potential changes.

The extent of potential price changes was set for each product separately depending on its specificities. The final assessments for all three scenarios were a result of several rounds of coordination of assessments with the experts from the Croatian Ministry of Agriculture, Fisheries and Rural Development.

To assess the impacts of budgetary payments on revenues, the agricultural policy measures were classified according to their direct or indirect impact on farmers' revenues. In this context, five large groups were formed:

1. production coupled direct payments of the Pillar I (in the detailed analysis they are further grouped into output, area and headage payments and production coupled payments in transitional period);
2. production decoupled payments of the Pillar I (in the detailed analysis they are further grouped into payments under single payment scheme (SPS) and payments based on historical entitlements);
3. compensatory allowances of the Pillar II (income payments of the Axis 2 of Pillar II: payments for less-favoured areas (LFA) and agri-environmental payments);
4. payments of the Pillar II for increasing competitiveness (investment support of the Axis 1)
5. budget for other agricultural policy measures of the Pillar II (non-income payments of the Axis 2; measures under the Axis 3, LEADER, technical assistance).

The data on the budget were prepared for 2009 (the base year), the year of accession (A=2013), the first year after the accession (A+1=2014) and the fourth year after the accession (A+4=2017), i.e. the first year after the expiry of the period for which Croatia negotiated certain derogations from the CAP rules (preserving of the 'state aids' for selected products, which are fully financed from the national budget - Table 1).

For the assessment at the level of agriculture as a whole, the data as shown in the Table 1 are sufficient. However, to assess the impact of budgetary supports on the revenues by products, further disaggregation was required.

Table 1: Basic data on the budget by the groups of measures and by sources, for base year and years after the accession (in EUR million)

	2009			A			A+1			A+4		
	Total	CRO	EU	Total	CRO	EU	Total	CRO	EU	Total	CRO	EU
Total Pillar I	387.4	387.4	0.0	378.3	283.7	94.6	378.7	204.4	174.3	379.8	189.9	189.9
1. Production coupled	176.4	176.4	0.0	50.7	43.4	7.3	50.7	37.2	13.5	27.5	13.8	13.8
Payments by kg, ha, head	176.4	176.4	0.0	27.5	20.2	7.3	27.5	14.0	13.5	27.5	13.8	13.8
Transitional payments	0.0	0.0	0.0	23.2	23.2	0.0	23.2	23.2	0.0	0.0	0.0	0.0
2. Production decoupled	211.0	211.0	0.0	327.6	240.3	87.2	328.0	167.2	160.8	352.3	176.1	176.1
SPS	211.0	211.0	0.0	261.1	191.5	69.5	261.5	133.3	128.2	285.8	142.9	142.9
Historical	0.0	0.0	0.0	66.5	48.8	17.7	66.5	33.9	32.6	66.5	33.3	33.3
Total Pillar II	110.5	102.0	8.5	140.1	85.1	55.0	316.7	73.8	242.9	465.0	108.6	356.4
4. Axis 1	80.2	71.7	8.5	39.9	10.0	30.0	129.0	32.2	96.7	180.9	45.2	135.7
Axis 2	15.8	15.8	0.0	71.2	68.0	3.2	94.4	18.9	75.5	134.7	26.9	107.8
3.1.LFA	12.3	12.3	0.0	36.6	35.4	1.2	45.4	9.1	36.3	45.4	9.1	36.3
3.2. Agri-environment	3.5	3.5	0.0	33.5	31.5	2.0	43.7	8.7	35.0	65.4	13.1	52.3
5.1. Axis 2 other	0.0	0.0	0.0	1.1	1.1	0.0	5.3	1.1	4.2	23.9	4.8	19.1
5.2. Axis 3	0.0	0.0	0.0	27.6	6.9	20.7	81.0	20.2	60.7	130.7	32.7	98.0
Pillar II other	0.0	0.0	0.0	0.0	0.0	0.0	4.9	1.0	3.9	10.7	2.1	8.6
5.3.Leader	14.5	14.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.4.Technical assistance	0.0	0.0	0.0	1.4	0.3	1.1	7.6	1.5	6.1	8.0	1.6	6.4
Transfer to Pillar I	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*75.9*	*15.2*	*60.7*	*0.0*	*0.0*	*0.0*
Total	497.9	489.4	8.5	518.4	368.9	149.5	695.4	278.2	417.2	844.8	298.5	546.3

Only the payments of the Pillar I are disaggregated by individual products. Production coupled payments, as well as historical entitlements are allocated directly to products to which they refer. In the base year, production de-coupled payments are allocated on the basis of the data of the Agency for Payments in Agriculture, Fisheries and Rural Development (APAFRD) and the Croatian Agricultural Agency (CAA) on payments by products, whereas after the accession the total of these funds will be allocated according to a specific key.

For the period after the accession, all direct payments were defined on the basis of the programme of transformation of individual measures as set out in the Act on state support to agriculture and rural development (NN 92/2010). It is assumed that there will be no difference in single area payments (the same single payment per ha for all land uses except for pastures and meadows), and the following two-phase procedure is used for their allocation by commodity:

- first phase: calculation of area payment on the basis of area under individual commodity in the base year and the unit value of payment in the period after the accession;
- second phase: allocation of the difference in the value of payments (total funds in the period after the accession less the total amount calculated in the first phase).

Mathematically, this procedure can be written down as follows:

BPpi=HaAi*bpP+((HaSi-HaAi)/(ΣHaSi-ΣHaAi))*(ΣBPp-ΣHaAi*bpP) (1)

With the individual signs having the following meanings:
BPpi = funds for area payments for commodity i after the accession (in EUR)
ΣBPp = funds for area payments after the accession (in EUR)
HaSi = area under commodity i by the statistics in 2009 (in ha)
HaAi = area of commodity i included in payments according to APAFRD in 2009 (in ha)
bpP = single area payment after the accession (in EUR/ha)

The above described procedure of the allocation of the difference is based on the presumption that the producers of the commodities with the payments in the base year will apply with the same areas also after the accession. The areas which were not included in the system of payments in the base year will be included proportionally to the ratio between the total non-included areas in the base year and additional areas included in the system after the accession. By this procedure, production de-coupled area payments are distributed to all commodities from the list of Economic Accounts for Agriculture (EAA), regardless of whether they were included in the system of payments in the base year or not.

Based on the above described procedures, a part of the Pillar I payments are allocated to the commodities which are as a rule not market goods (meadows, fodder plants). These payments are eventually realised in livestock breeding. The same also applies to other products which the farm produces and uses as animal feed. In Croatia, a large part of cereals is used for this purpose (low rate of market production of cereals). Therefore, in order to obtain a more realistic picture for livestock breeding, direct payments for non-market crop production used as animal feed are in the last stage transferred to livestock breeding. The procedure is based on the expert assessments of the share of areas used for animal feed directly on a farm; and the structure of consumption of these products by types of livestock.

It has been assessed that a part of payments for cereals and all payments for fodder plants are realised through livestock breeding (animal feed on arable land and meadows). The structure of consumption by types of livestock was assessed on the basis of the number of livestock in the base year (DZS RH 2010a) expressed in livestock units, estimated technologies and estimated feed ratio.

The model used for the assessment of changes in revenues after Croatia's accession to the EU is a static deterministic model. This means that the model presumes a fixed technology, structure and volume of production and that all the changes in revenues are exclusively a consequence of changed prices and the level of direct payments. The model is based on the Economic Accounts for Agriculture (EAA) for Croatia (DZS RH 2010b and 2010c). 2009 is used as a base year. In the model, the revenue is defined as a value of production in producer prices increased by the value of direct payments.

Changes in prices according to various scenarios enter the model as an index of prices at the level of a product. In addition, the value of direct payments for each product is also taken as an entry data in the model. The revenue for various scenarios and periods is calculated using the following procedure:

Rijn=RBi*PIij+Bin ; iARjn=ΣRijn (2)

With the individual signs having the following meanings:
R = revenue; AR = agricultural revenue (aggregate) (in EUR)
RB = value of production in producer prices in the base year (in EUR)
PI = price index estimate
B = estimated budget for direct payments (in EUR)
i = type of product (wheat, maize, etc.)
j = type of scenario for prices (sR-realistic, sP-pessimistic, sO-optimistic)
n = period of assessment (B-base year, A-accession, A+1-first year after accession, A+4-a year after transitional period)

Scenarios for prices are not determined by time (they do

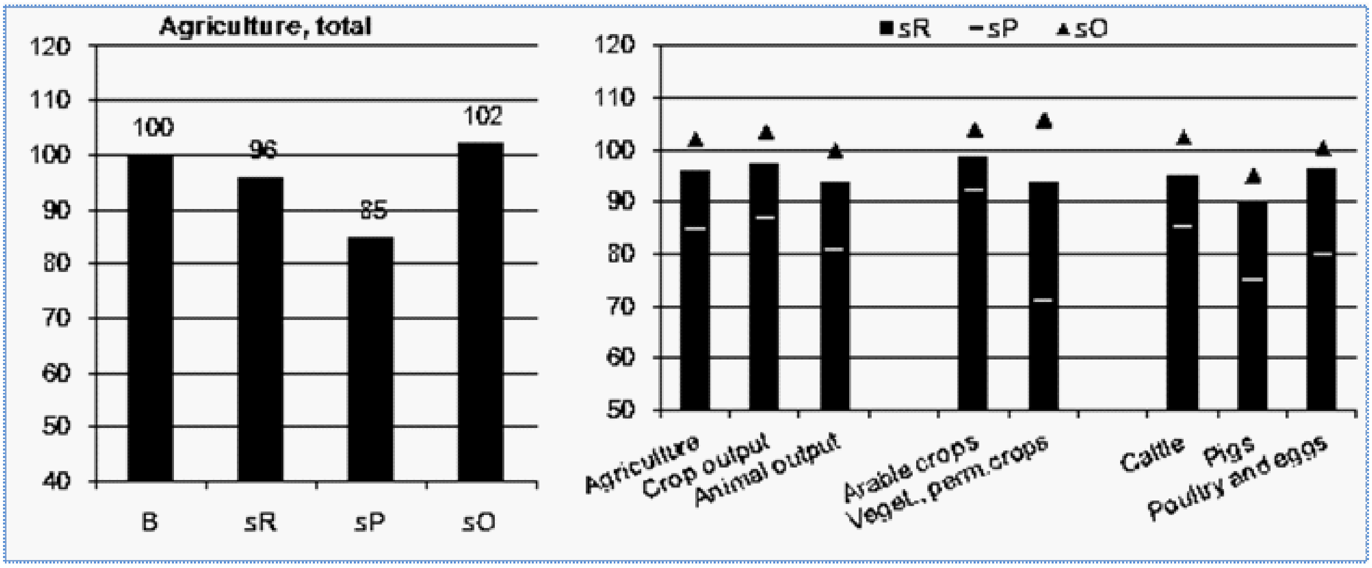


Figure 1: Aggregate price indices after the accession (base period = 100)

not change by periods). Only the level of direct payments changes by time. The final results matrix is therefore a combination of price scenarios and different levels of direct payments in selected years after Croatia's accession to the EU (Erjavec et al. 2011).

RESULTS AND DISCUSSION

Based on the assessments of changes by individual agricultural product, the aggregate price index shows that the prices of agricultural products in Croatia will most probably fall after its accession to the EU (Figure 1). According to the pessimistic scenario (sP), prices could drop by around 15 % and according to the optimistic scenario (sO), they could even rise by 2 %. It is the most realistic to expect (sR) a drop in prices at the aggregate level by around 4 %.

According to assessments, the drop is expected to be larger in livestock breeding than in crop production. The prices of all livestock products, in particular pigs, are relatively high before the accession (in comparison with prices in the EU countries). In crop production, smaller changes are expected in arable crops and greater changes in permanent crops and vegetables. The projections of prices in vegetable, fruit, wine and olive oil production are very uncertain. They could see either a large drop or a large rise in prices.

According to the projections, the total budget for agriculture is expected to strongly increase after the EU accession (Figure 2). Compared with the base year, the total budget for agriculture will be around 40 % higher in the first year after the accession (A+1) and by almost 70 % in a year after the expiry of the transitional period (A+4). The national sources of financing agricultural policy measures will be decreasing and the financing from the EU funds will be increasing.

As even before the accession Croatia has relatively high direct payments (higher than most Member States), no rise is expected in this group of measures. Compared to the base year – 2009, a slight drop by around 5 % is expected after the accession. However, the budget for rural development measures is expected to increase considerably.

Despite the expected huge rise in the total budget for agriculture, the direct effect of budgetary payments on the revenue of producers will be relatively small. Direct payments at the aggregate level will not increase. Only producers in specific areas (LFA) and producers with specific production technologies (agri-environmental measures) can expect a rise in revenues from higher budgetary payments.

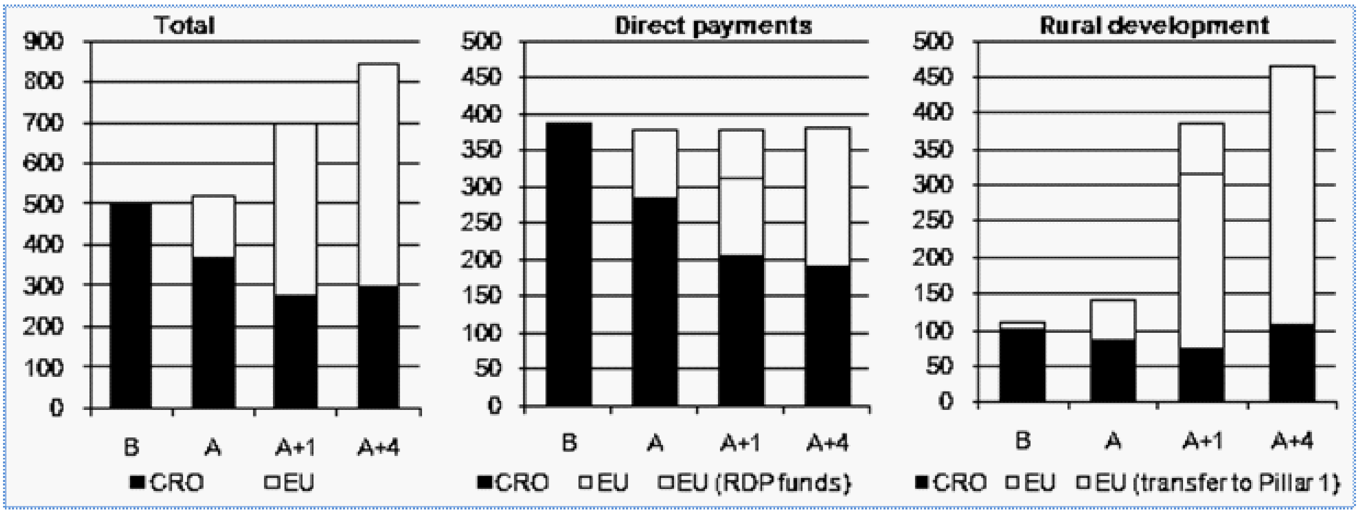


Figure 2: Total budget for agriculture by pillars and sources of finance; before and after the accession (in EUR million)

According to the initial plan, a large share of the total budget for agriculture will be earmarked for strengthening the competitiveness of agriculture (Axis 1). These payments have no direct effect on the current revenues, but by rising competitiveness, producers could increase the revenues in the long term. In theory, these are the most efficient measures in the long term, but only if they are really earmarked for increasing productivity and efficiency of production. A part of the measures of the Axis 2 and most of the measures of the Axis 3 have no direct effect on producers' revenues.

By adopting the CAP and entering the EU, the form of the direct payments will also change (Figure 3). There will be less and less measure linked directly to production (output payments, specific area or headage payments). After the transitional period, in which a part of production coupled payments for tobacco, sugar beet, milk and olive oil will be preserved, most production coupled payments will be abolished, except a part of the payments for suckler cows, sheep and goats. A considerable part of the production coupled payments will be transformed to historical entitlements (milk and tobacco output payments, a part of payments for cattle, sheep and goats). The volume of production decoupled payments in the form of single area payments (SPS) will increase.

Changes in the system of direct payments will also result in a redistribution of payments among the products. The amount of direct payments will decrease for the products for which production coupled payments will be abolished and which at the same time will not be transformed (or not fully transformed) to historical entitlements. This will result in

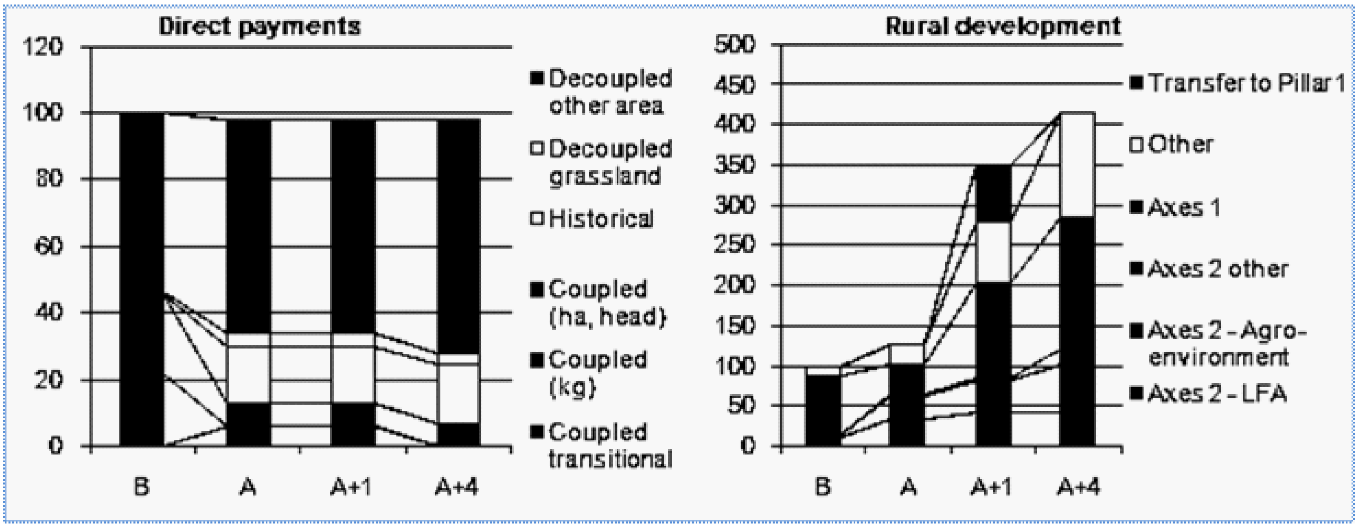


Figure 3: Budget for direct payments and rural development by types of payments; before and after accesion (index; base period =100)

lower payments for pigs, milk, cattle, sheep and goats, and after the expiry of the transitional period also for tobacco, sugar beet, and olive oil. During the transitional period, abolishing of production coupled payments for tobacco, sugar beet and olive oil, and in livestock sector for pigs and milk (payments for dairy cows), will be partly compensated for by the transitional payments (state aid), which will be financed exclusively from the national budget (Erjavec et al. 2011).

For some products, the redistribution will result in higher payments. After the accession, production decoupled area payments will be levelled for all agricultural land uses (except meadows and pastures), and there will be more areas included in the direct payments system. The rise will thus be recorded for the commodities which were in the base year not included in the direct payments system or were included to a smaller extent (smaller areas) or with smaller payments per unit. A rise can be above all expected in the fruit and vegetable sector. As a result of more areas under meadows and pastures included in the payment scheme, the proportion of payments for these areas in total payments will increase considerably.

The effect of changed level of direct payments on the revenues in individual agricultural sector will not only depend on the relative changes in the level of payments, but also on the share which direct payment contributed to revenues in the base period. A relative share of direct payments in the revenue differs across the sectors. It is the smallest in poultry production, representing only 2 % (practically only a part of the payments transferred through animal feed). Thus, the changes in the level of direct payments in this sector will have practically no effect on the level of revenues. Here, everything will depend on prices. The situation will be different in pig sector, crop production and in particular in cattle breeding. In these sectors, changes in direct payments more strongly affect the level of revenue, considering their relatively high level in the base period.

On the aggregate level of agriculture, direct payments represented around 14 % of the revenues in the base year. After Croatia's entry to the EU, the total budget for direct payments will remain approximately on the same level as in the base year (a drop by 2 %). Changes in total revenue will be thus almost exclusively a consequence of changes in prices. It

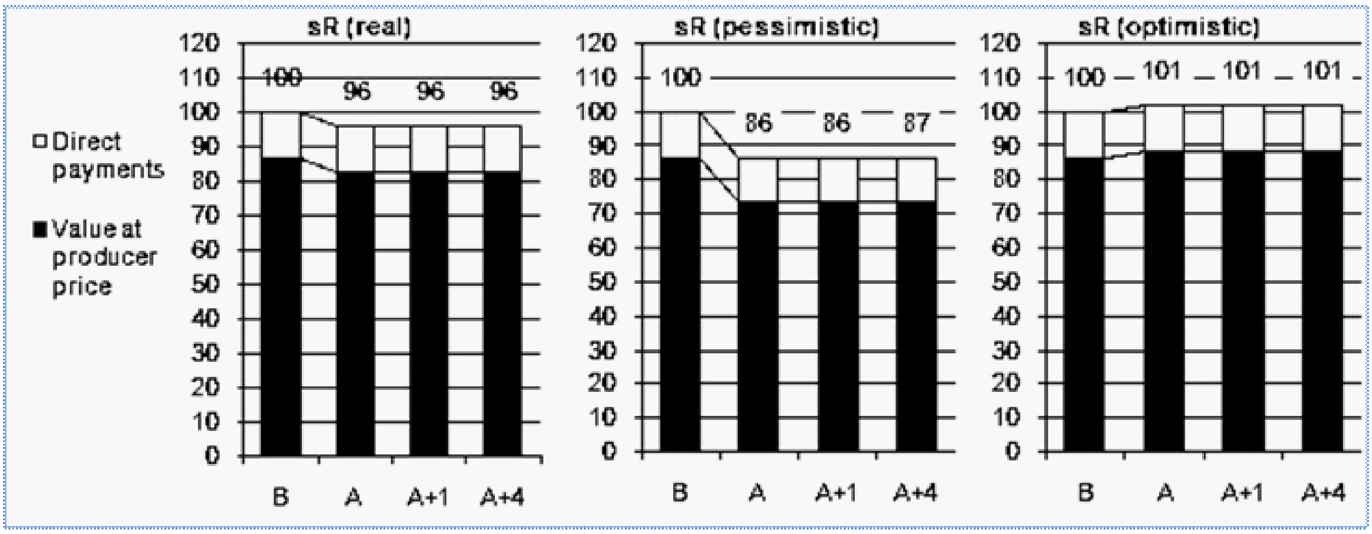
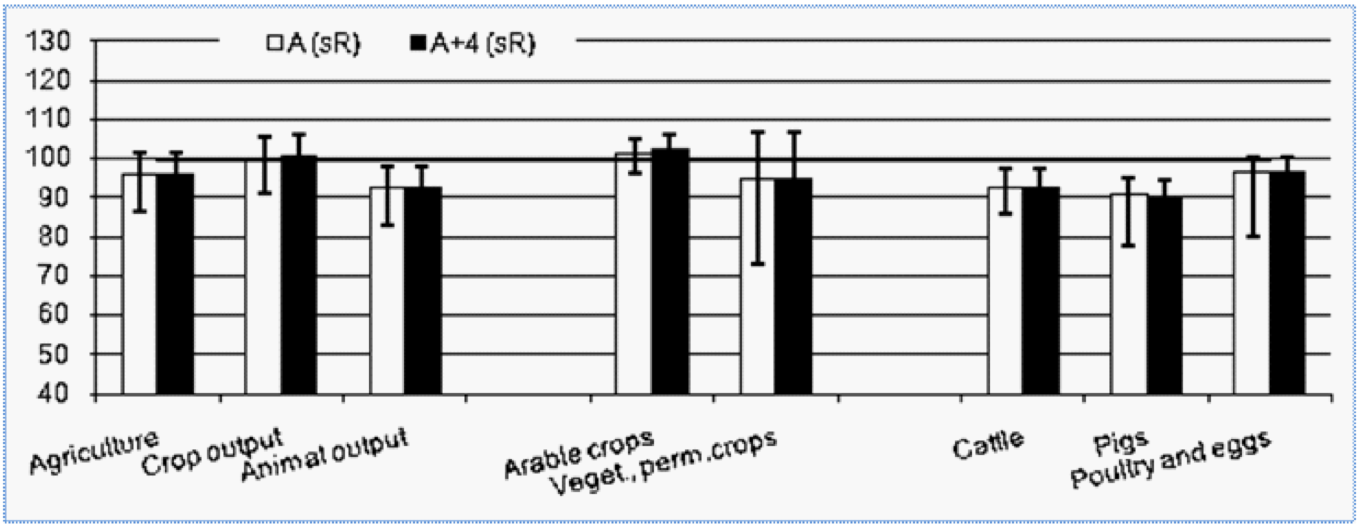


Figure 4: Estimated changes in revenues in agriculture after accession to the EU (index; base period =100)

is estimated that after the accession the agricultural output at producer prices will drop by around 4 % (realistic scenario), which will be fully reflected in the estimated changes in total revenues (figure 4). According to the optimistic scenario, a slight rise in revenues can be expected (by around 1 %), but a considerable drop (by around 13 %) according to the pessimistic scenario.

According to the realistic scenario, revenues in the crop production are expected to remain on the starting level even after the accession, as a result of a slight drop in prices and a rise in direct payments (figure 5). At the end of the transitional period (A+4), the revenues will further slightly increase as a result of higher direct payments. The optimistic scenario points to a possibility of a slight rise in revenues and the pessimistic one indicates a slight drop. For vegetables and permanent crops, it is realistic to expect a slight drop in revenues, although any predictions for this group of products are very uncertain.



Red vertical lines indicate the range of estimated changes from optimistic (upper limit) to pessimistic scenario (lower limit)

Figure 5: Estimated changes in agricultural revenues after EU accession by production groups (index; base year =100)*

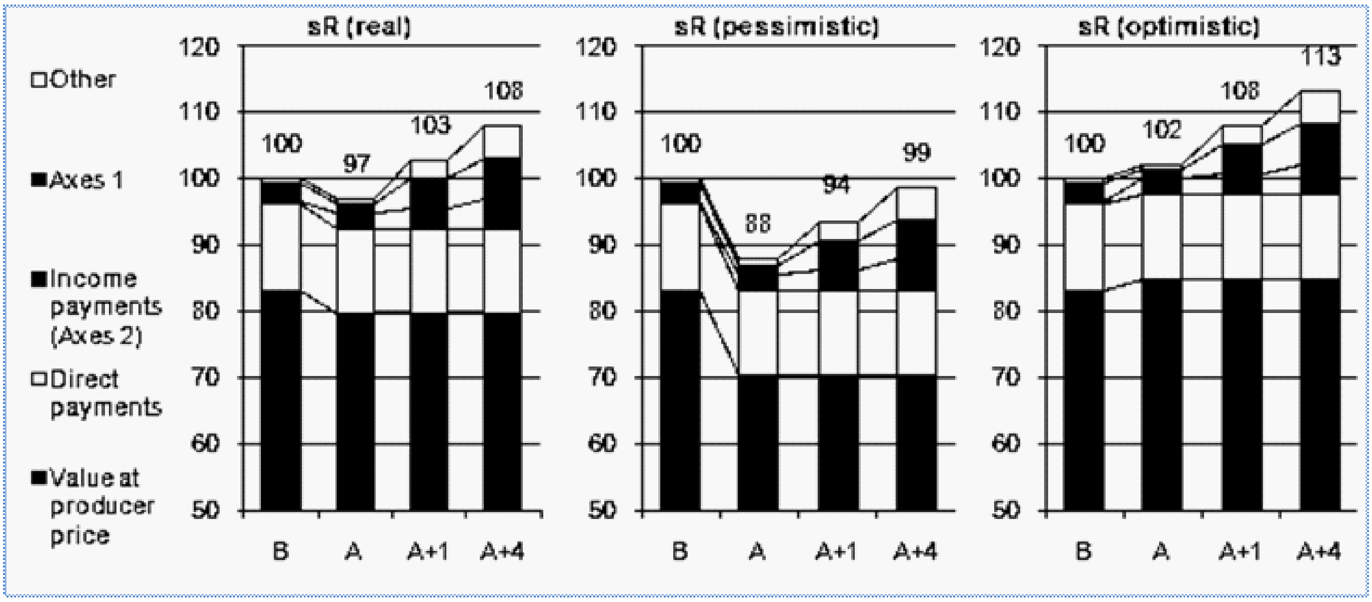


Figure 6: Estimated changes in agricultural revenues including the Pillar II payments after EU accession (in dex; base period =100)

As regards livestock sector, all scenarios point to a drop in revenues. Because of lower direct payments, revenues will go down more than prices. Revenues are expected to drop the most in pig (a substantial drop in prices) and milk production (a considerable drop in direct payments), slightly less in beef sector and only slightly in poultry sector (Erjavec et al. 2011).

In addition to prices and direct payments, also some other agricultural policy measures affect the income position of agriculture. A part of the payments of the Axis II of the rural development (LFA and agri-environmental payments) directly increase the revenues of a part of agricultural holdings.

The income payments of the Axis II were low in the base year, but they will substantially increase after the accession (Figure 6). After the accession, their contribution to total revenues will accordingly to the realistic scenario compensate for the drop in revenues stemming from prices and direct payments. In the second year after the accession, the total revenue will be slightly higher than in the base period, and at the end of the transitional period, it will be higher by around 9 %. Payments under the Axis 1 (competitiveness – various forms of investment support) do not count as income payments, but they still represent support to agriculture.

It should be mentioned that the results of the analysis of the effects of accession on the aggregate level are only one aspect of the analysis. The effects on the level of agricultural holdings can be entirely different. On this level, a lot will depend on the production structure, as well as on the preparedness and knowledge of producers to seize the opportunities of the CAP, but above all on their readiness and ability to adapt to the changes in the market.

CONCLUSIONS

The study provides the first assessment of possible changes of economic results in Croatian agriculture after the EU accession. It assesses the potential extent of changes in prices, budget and revenues across all the important agricultural sectors. The potential extent of changes is relatively wide, as it is difficult or practically impossible to precisely foresee the changes in prices, as well as in the redistribution of increasingly production-decoupled support in agriculture.

In addition to the future volatility of prices, the level of prices after the accession will be affected by the opening of a still relatively closed market, the perception and propensity of domestic consumers for domestic products, as well as the changes in the structure of the market (concentration in trade) and possible strengthening of the competitiveness of domestic agriculture. The more domestic agriculture will be competitive and technologically and organisationally developed, the easier it will be for it to put up with the expected pressures. These pressures may even be smaller than foreseen, if domestic consumers remain faithful to their local market channels and products. However, the experience of the former EU accessions shows that market relations usually toughen more than it is expected.

Another uncertainty in the assessment of economic results of Croatian agriculture is related to the future agricultural budget. Although the budget has been determined with the financial envelopes for both pillars in the EU negotiations, it is still related to certain ambiguities. Croatia could face some difficulties not only in the implementation of measures but also in terms of co-financing of it from the national budget. Besides, there will be changes in the EU agricultural policy after 2014, although they have not yet been fully set out. They will most likely bring about even more production-decoupling of support and given the circumstances, also certain reduction in total agricultural budget, if measured in real terms.

Despite all limitations regarding the reliability of the simulations, we believe that the results of the analysis in this study are fairly realistic. They point to the direction of changes, which needs to be taken very seriously when planning and implementing the future policy. In aggregate terms, the revenues will remain at around the current level after the accession or even more probably slightly below it. The drop in revenues will stem from the drop in prices, as well as from smaller budgetary support in some sectors which are today relatively well protected and do not achieve the level of competitiveness as will be required after the accession. This is in particular the case in pig, milk, wine and tobacco sector. There are also products where no substantial changes are expected in revenues, and some products for which the simulation even predicts an increase in revenues after the accession (e.g. for maize). Livestock sector will be in a less favourable position than crop production, which will largely be a consequence of the very concept of the policy in the EU (abolishing of production coupled payments).

A considerable part of the negative effects of the accession will stem from the difference in budgetary measures in Croatia compared with the EU. It should be mentioned that in the base year used for the purpose of this analysis, there was still a relatively wide inconsistency of the budgetary policy in Croatia compared with the CAP and that after 2009 some reforms were launched in Croatia which brought about further harmonisation of measures; nevertheless, some differences will remain in place by the accession. Along with the fact that agricultural budget was relatively large, the measures in Croatia in the base year were still more production coupled and they were allocated to the products for which the support in the EU is either lower (e.g. milk) or even non-existent (pigs). Although the budget for agriculture will increase after the accession, it will also bring about many changes in direct payments. Therefore, the results on the aggregate level and in particular in some sectors are expected to be negative.

Considering all the above facts, the following most important recommendations can be made based on the results of the study:

- The focus of agricultural policy should be moved from the Pillar I direct payments to the Pillar II measures, as under these measures specific goals and priorities of the national policy can be formed more easily.
-Strategic plans need to be devised with the aim of assuring the most efficient possible use of still very generous EU funds for Croatia for the rural development policy. Attention should be given to defining and stronger positioning of the measures of the current Axis II, where it is possible to achieve, in line with the current EU legislation, strong income effects of this policy.
- Competitiveness of agriculture needs to be strengthened, in particular competitiveness of the critical sectors, by investment supports, taking due consideration of policy of technological development, as well as establishing stronger links between the academic community and the business sector, in particular by way of applied research.
- By pursuing a transparent policy and proactive communication with the target groups, it should be properly indicated to which direction the expected changes will go, so that the farmers will be able to prepare for the changes. Special attention should be given to the implementation

of the measures and development of extension and other expert services which will help establish an efficient system of support for implementing the agricultural policy measures after the accession.

- Work should be pursued on the economic analyses of situation, monitoring of measures and assessing the effects of changes (impact assessment) in agricultural policy. To this end, the necessary infrastructure needs to be established for collecting, processing and exchanging of data and human and institutional resources need to be additionally strengthened.

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Premia for differentiated products at the retail level: can the market put a value on the mountain attribute?

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"So much is missed in the word mountain food – there is culture but it is not a mountain culture, it is a Highland culture"

"When you mentioned mountain food, I thought of goats and Heidi and Switzerland"

"I wouldn't want to buy Venison from anywhere, like the South of England"

Some comments about mountain food products from focus groups held in Edinburgh, Aberdeen and Fort William, August 2008 (Scotland, UK).

ABSTRACT

The purpose of this paper is, by comparing products with a mountain provenance with those from non-mountain areas, to explore whether the market puts a premium on the 'mountain attribute'. First, we present a theoretical framework on attributes and cues that helps answering the question what is "mountain" representing in a products or in other term, is it an attribute or a cue. Second, based on a shelves survey collected as part of the EuroMARC, we analyse for several products (apples, sausages, water and cheese) and countries (Austria, France, Norway, Scotland and Slovenia) using a hedonic price regression approach whether a premium is paid for mountain food products in comparison with identified similar non-mountain food products. The results indicate that the answer is mixed and depends on the product and country. Thus, premia was found only in the case of cheese and for Austria, Norway and Slovenia.

Key words: mountain quality food products, attributes and cues, hedonic regression

INTRODUCTION

The concept of mountain food product is a complex one because it evocates different images to consumers. This can be observed in the diversity of opinions reflected in the three comments, cited at the beginning of the paper, from focus groups held in Scotland in August 2008.

The purpose of this paper is to explore whether the market puts a value to the mountain attribute at the retailer level or in other terms whether consumers are willing to pay an additional amount (i.e. a premium) for buying a mountain quality food product. This is studied using prices from products representative from several European ranges -Highlands, Alps, Scandinavia, Massif Central.

The motivation for studying the current situation of mountain food products (or prices actually paid) instead of hypothetical ones expressing consumers intentions is due to the fact that there is always discrepancies between hypothetical and actual behaviour (MAFF 2000). Thus, whilst consumers may show high interest on mountain quality food products when responding a hypothetical survey this is not always reflected in their buying behaviour or in their willingness to pay the higher price that products of a higher quality may carry and therefore, in practice, one may not observe a premium for mountain quality food products.

As mentioned, the concept of mountain food is a complex one and this has been transmitted to consumers in several ways. Thus, the mountain origin of the products has been displayed to consumers in several ways and including a number of pieces of information, such as through the word 'mountain' itself, the mention of a geographic name of a famous mountain range or region, but mainly via images of

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mountains without compliance with procedures of origin. In some cases, nutritional information or positive claims such as 'farm products', 'traditional products', 'natural', 'extra', 'typical', 'without preservatives' are mentioned.

Within a more general framework, the interest on the marketing of mountain products is associated to find "market driven" ways for adding value to mountain food products as a prerequisite for the survival and the management of rural and cultural mountain diversity. This is motivated by the new orientation of the Common Agriculture Policy which looks to promote "market driven" type of production where European Union farmers will be expected to respond to market signals (Sylvander 1993, Ilbery 1998, Leat et al. 2000).

Mountain areas, which represent at least half of the area of six European States, with the greatest proportions in Austria (73 per cent), Greece and Slovenia (78 per cent), and Slovakia (62 per cent) and more than 90 per cent of both Norway and Switzerland- represent an important challenge for Europe to achieve sustainable development, including quality of life and the continued production of high-quality food, deriving mainly from environmental and cultural factors (Nordregio 2004).

The structure of the paper is as follows. First, we present a theoretical framework on attributes and cues that helps answering the question what is "mountain" representing in a products or in other term, is it an attribute or a cue. Second, based on information provided by a shelves survey collected as part of the EuroMARC project, we analyse for several products (apples, sausages, water and cheese) and countries (Austria, France, Norway, Scotland and Slovenia) using a hedonic price regression approach whether a premium is paid for mountain food products in comparison with identified similar non-mountain food products.

Theoretical framework - attributes and cues

In the 1960s, Kelvin Lancaster pioneered a new approach to consumer theory in which he broke away from the traditional idea that goods are the direct objects of utility, and that instead it is the properties or characteristics of the goods from which utility is derived (Lancaster 1966). Subsequent literature relating to the quality attributes of goods and services (e.g., Nelson 1970, Darby and Karni 1973, Andersen 1994) makes a distinction between 3 types of attributes (see also OECD 1997):

- *Search attributes* - which can be ascertained prior to a product's purchase (e.g., the colour of a cheese, or the thickness of fat cover on a piece of meat).
- *Experience attributes* - which cannot be determined prior to purchase but which can be ascertained during consumption (e.g., the creaminess and taste of a cheese, or the taste and tenderness of meat).
- *Credence attributes* - which cannot be determined prior to purchase or during consumption (e.g., the level of welfare experienced by a lamb during its life, or in some cases whether a product's ingredients were actually produced in a mountain area).

Caswell et al. (1998) consider the grouping of attributes into 'process' and 'product' attributes. Northen (2000), in developing the work of Caswell et al. (1998), distinguishes five types of product attribute, covering: food safety; nutrition; and sensory, functional and image attributes.

Process attributes relate to features of the production process. Whilst consumers may purchase products in order to consume physical product attributes, they may also be concerned about process attributes - such as artisanal production methods or organic production - and therefore purchase a particular product in order to purchase these as well. Beyond the farm gate, features of the processing and marketing channel, such as length of meat maturation, may also constitute a process attribute.

In some cases process attributes may influence the physical product, but in many instances this causal relationship - where it exists – may be weak. For example, it may be claimed that the extensive production environment of a beef animal in a mountain area may affect the final meat product, but it may be questionable as to whether this can be detected by consumers. In the case of organic production, the influence of this process attribute may well be detectable for some products and some consumers. Similarly, traditional production methods in a rural mountain setting may give rise to discernible taste, smell or appearance features.

These two classifications of attributes into 'search', 'experience' and 'credence', as well as 'process' and 'product' attributes can be combined as shown in Table 1, where the focus is on an organic meat product from a mountain area.
It should be recognised that some attributes may be of more than one type, e.g., the juiciness of a piece of meat might be apparent prior to purchase (a search attribute) but also confirmed during consumption (an experience attribute). Furthermore, there is clearly a linkage between some attributes, e.g., the fat content of a piece of meat or of a cheese may well influence its taste.

The communication of quality attributes: the deployment of quality cues

The question arises as to how quality attributes are communicated to consumers prior to purchase. Consumers' perceptions of quality prior to purchase are based on quality cues; stimuli which lead to the perception of certain quality attributes being present and *which determine when, where and how a person responds* (Kotler 1980).

Quality cues may be categorised into intrinsic and extrinsic cues (Olson and Jacoby 1972, Olson 1977, Bello Acebron and Calvo Dopico 2000). Thus:

- *Intrinsic quality* cues cannot be changed or manipulated without changing the physical characteristics of the product itself.

- *Extrinsic quality* cues are related to the product but are not physically part of it.

As noted by Oude Ophuis and Van Trijp (1995), extrinsic cues can be manipulated by marketing activity, without the need to change the product itself. Consequently, extrinsic cues need to be carefully developed and deployed if a product is to be sold to best effect.

In the case of meat, the intrinsic quality cues will include

Table 1: Categorisation of potential 'process' and 'product' quality attributes of organic meat production from a mountain area

Process Attributes	Food Safety	Nutrition	Product attributes Sensory	Functional	Image
Animal welfare (C)	Absence of Residues (C)	Fat content (S, E, C)	Appearance (S)	Product life (S and E)	Prestige Value (S, E, C)
Biotechnology (C)	Absence of artificial Hormones (C)	Energy content (C)	Taste (E)	Preparation Convenience (S and E)	
Organic production (C)	Absence of Additives (C)	Vitamins and minerals (C)	Texture (E)	Consumption Convenience (E)	Prestige value (S,E,C)
Traceability (C)	Absence of Toxins (C)		Tenderness (E)		
Feed and Feeding system (C)	Absence of Physical contaminants (E and C)		Juiciness (S and E)		
Mountain Production Environment (C)			Freshness and Taste (S and E)		Prestige value (S,E,C)
Treatment(s) in processing (C)			Smell (S and E)		

Note: S = Search attribute, E = Experience attribute, C = Credence attribute. The classification of the attributes into search, experience and credence is that of the authors. (Source: Developed from Northen (2000))

physical definitive features of the product such as lamb of a particular origin, as well as visual cues such as colour, leanness or fat cover, degree of marbling, juiciness and the type of cut. Smell may also be an intrinsic cue. For cheese, the intrinsic quality cues may again include its provenance, along with the colour, smell, texture, etc. Many of these cues may not be perceived by consumers either because they are ignored or because information is not provided (Bello Acebron and Calvo Dopico 2000).

Extrinsic quality cues may include the price of a product, its brand name, packaging, labelling and label information, point of sale information, other promotional activities, presentation in the sales outlet, the place of purchase (reputation/status of the outlet), and the influence of the salesperson (Steenkamp 1989).

The communication of attributes via cues is represented in Figure 1. It indicates that product attributes are capable of being communicated by intrinsic cues. The attributes concerned will be of the 'search' type.

It is important to note that, as Table 1 has indicated, a significant number of product attributes are of the 'experience' and 'credence' types. Andersen (1994) has argued that credence attributes cannot be communicated by intrinsic cues, and it may be that some particular experience attributes, such as tenderness and texture are not readily predicted from intrinsic cues. Thus extrinsic cues, along with intrinsic cues, are important in communicating product quality attributes.

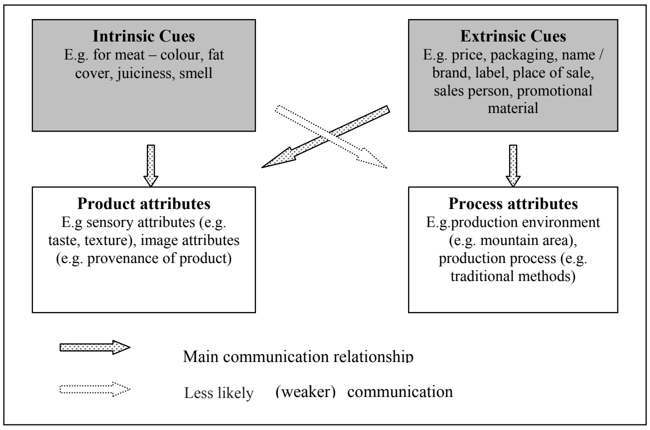

Figure 1: The relationship between cues and attributes (source: according to Northen, 2000)

Process attributes are very largely credence in nature, so that the effective communication of process attributes - including the production environment, animal welfare and traditional production systems - is largely dependent on extrinsic cues.

Mountain as an attribute and as cue

Within this framework of concepts, the mountain attribute may embody both product and process attributes, which can be regarded as a:

• Search attributes (where the provenance is clearly indicated by a verified source)

• Experience attributes (where the product's attributes give rise to a different experience to that of the non-mountain product, such as a different taste)

• Credence attributes (where the purchaser and consumer have to believe that the mountain provenance is real and that this conveys additional utility).

The cues which convey the mountain attribute may in some instances be intrinsic, such as the smell and colour of mountain heather honey, but in many instances the mountain attribute and its various aspects may need to communicated by extrinsic cues in the form of labelling, packaging, a relatively high price, information from the sales person, etc.

It should be noted that when the term 'mountain' is used in a label, the way that it is normally communicated to consumers, the label 'mountain' becomes a cue of a number of attributes associated with the specific mountain product, which can be product and process attributes.

In this paper we examine whether price, through the existence of a price premium, is being effectively used and accepted as a cue for the mountain attribute.

MATERIAL AND METHODS

Input data

The data used in this paper come from shelves surveys conducted in Austria, France, Norway, Romania, Scotland and Slovenia. The data from Romania was not used because it did not contain information about the prices of alternative non-mountain food products.

The main purpose of the shelves surveys was to study how Mountain Quality Food Products are currently marketed, covering issues such as whether the products are marketed as mountain products, whether labels are used in the shop or whether the products are presented together, and information amount prices of mountain food products and of similar non-mountain food products, etc.

As regards the way the shelves surveys were planned and conducted, it is important to note that they were not constructed following any sampling procedure, i.e., based on any known population. Strictly speaking, the sampling population was all the retailers that market mountain quality food products, however, the characteristics of this population are unknown. In this respect, the type of sampling used was random sampling with replacement, since each country was committed to collect 90 shelves.

Table 2 presents a summary of all the information collected by the shelves surveys. In total information corresponding to 564 shelves was collected, which resulted in 1,765 products (i.e., a product in the analysis consists of each element comprising a shelf; therefore, if the same product is sold in two different shops, it counts as a two products). In addition, this information was collected from a total of 351 different outlets (i.e., shops).

As regards of shelves, 59.6 per cent of them where collected in mountain areas and 40.4 per cent of the outlets were also from mountain areas. As regards the distribution by country, the two extremes were Norway, with a higher proportion of non-mountain shelves (43.8 per cent mountain /56.2 per cent non-mountain) and on the other extreme was Austria, where a substantial part of the shelves where from mountain areas (92 per cent mountain /8 per cent non-mountain).

Even if controlling by repeated products the diversity of these was high. In order to make the analysis possible, the products from the survey were classified into 18 food product categories: mineral water, soft drink, cheese, other dairy, apples, pears, beef, fish, pig meat, sheep meat, poultry products, venison, moose, ham, sausage, other meat products, bread, honey and other food products. These products were further classified into 6 groups: beverages, dairy, fruits, meats, meat products and other products. The most popular product in the sample was cheese, with information was collected in 5 of the countries (except in Romania). It was followed by mineral water and sausages, which were collected by 4 countries.

As regards the sampled outlets, these were classified into the following categories: cash and carry, discount shop, factory outlet, farmers shop, farmers market, foreign supermarket, hypermarket, mini-market, national supermarket, regional supermarket, specialty shop, vending machine and web shop. Most of the shelves collected came from national supermarkets (146 shelves or 26.8 per cent), specialty shops (97 shelves or 17.8 per cent), mini-markets (94 shelves or 17.3 per cent), and farmers markets (44 shelves or 8.1 per cent).

As mentioned, the shelves surveys collected information about prices for mountain and similar non-mountain food products, which are the basis for the empirical work done in this paper. Table 3 present the information about the all the mountain food products for which an equivalent non-mountain food product price was present in the database. As shown, overall 22.7 per cent of the products had an equivalent non-mountain food product price recorded in the database. However, this percentage varied dramatically from one product to another and from one country to another. It should be noted that whilst this may reflect problems in the data collection, it can also be due to the fact that some of the products do not have equivalent non-mountain ones.

Methodology

As pointed out by Combris et al. (1997) the hedonic price method is a useful approach to study the price-quality relationship of a product. The method consists of a regression analysis of the price on the characteristics of the product. It has been used for both durable (e.g., automobiles) and non-durables (e.g., wine, cereals)[1].

[1] See Combris et al. (1997) for references about hedonic regressions analysis applied to the different type of products.

Table 2: All the countries: Results of the shelves survey - results per country (counts)

	Austria	France	Norway	Romania	Scotland	Slovenia	Total
Number of shelves	100	91	105	90	88	90	564
By type of shelf							
Beverages	27	34	10	90	0	0	161
Dairy	73	12	34	0	43	65	227
Fruits	0	44	0	0	0	0	44
Meats	0	0	25	0	31	0	56
Meat products	0	1	15	0	14	25	55
Other products	0	0	21	0	0	0	21
By type of outlet							
Cash and carry	11	0	0	1	0	0	12
Discount shop	4	10	23	0	0	0	37
Factory outlet	0	0	0	0	3	11	14
Farmers shop	0	1	0	0	19	13	33
Farmers market	13	7	3	0	1	20	44
Foreign supermarket	0	0	0	0	0	11	11
Hypermarket	0	28	0	0	0	0	28
Mini-market	0	9	6	89	10	0	114
National supermarket	22	29	61	0	18	16	146
Regional supermarket	18	1	0	0	0	2	21
Speciality shop	26	6	11	0	37	17	97
Vending machine	0	0	1	0	0	0	1
Webshop	6	0	0	0	0	0	6
According to mountain area							
In mountain areas	92	47	46	44	53	54	336
Out of mountain areas	8	44	59	46	35	36	228
Number of products	410	230	283	246	232	364	1765
Beverages	94	95	34	246	0	0	469
Mineral water	91	95	32	246	0	0	464
Soft drink	3	0	2	0	0	0	5
Dairy	316	23	95	0	84	271	789
Cheese	293	23	59	0	76	155	606
Other dairy	23	0	36	0	8	116	183
Fruits	0	74	0	0	0	0	74
Apples	0	66	0	0	0	0	66
Pears	0	8	0	0	0	0	8
Meats	0	0	68	0	109	0	177
Beef	0	0	4	0	34	0	38
Fish	0	0	0	0	11	0	11
Pigmeat	0	0	10	0	13	0	23
Sheepmeat	0	0	44	0	15	0	59
Poultry products	0	0	1	0	8	0	9
Venison	0	0	3	0	28	0	31
Moose	0	0	6	0	0	0	6
Meat products	0	36	39	0	39	93	207
Ham	0	14	0	0	0	2	16
Sausage	0	22	39	0	15	35	111
Other meat products	0	0	0	0	24	56	80
Other products	0	2	47	0	0	0	49
Bread	0	0	17	0	0	0	17
Honey	0	1	2	0	0	0	3
Herbs and spices	0	0	20	0	0	0	20
Other food products	0	1	8	0	0	0	9
Total number of different outlets	68	77	35	90	37	44	351
In mountain areas	64	33	11	44	19	28	199
Out of mountain areas	4	44	24	46	18	16	152

The implicit price of a characteristic is defined as the derivative of the price with respect to the product attribute. Rosen (1974) has shown under which market conditions the implicit price can be interpreted as the value consumers place on an additional unit of the characteristic. If the estimated implicit price is not significantly different from zero, then the characteristic is not valued by consumers, or the characteristic is not considered important or relevant in connection with the product.

Thus, the starting point is the estimation of the following equation:

Table 3: All the countries: Distribution of cases for which the price of an equivalent "non-mountain" product was recorded in the database

	Austria	France	Norway	Romania	Scotland	Slovenia	Total
Number of products	162	114	63	0	14	49	402
Total	410	230	283	246	232	364	1765
Beverages	45	55	0	0	0	0	100
Total	94	95	34	246	0	0	469
Mineral water	43	55	0	0	0	0	98
Total	91	95	32	246	0	0	464
Soft drink	2	0	0	0	0	0	2
Total	3	0	2	0	0	0	5
Dairy	117	5	31	0	14	40	207
Total	316	23	95	0	84	271	789
Cheese	107	5	12	0	14	20	158
Total	293	23	59	0	76	155	606
Other dairy	10	0	19	0	0	20	49
Total	23	0	36	0	8	116	183
Fruits	0	30	0	0	0	0	30
Total	0	74	0	0	0	0	74
Apples	0	24	0	0	0	0	24
Total	0	66	0	0	0	0	66
Pears	0	6	0	0	0	0	6
Total	0	8	0	0	0	0	8
Meats	0	0	3	0	0	0	3
Total	0	0	68	0	109	0	177
Beef	0	0	1	0	0	0	1
Total	0	0	4	0	34	0	38
Fish	0	0	0	0	0	0	0
Total	0	0	0	0	11	0	11
Pigmeat	0	0	0	0	0	0	0
Total	0	0	10	0	13	0	23
Sheepmeat	0	0	2	0	0	0	2
Total	0	0	44	0	15	0	59
Poultry products	0	0	0	0	0	0	0
Total	0	0	1	0	8	0	9
Venison	0	0	0	0	0	0	0
Total	0	0	3	0	28	0	31
Moose	0	0	0	0	0	0	0
Total	0	0	6	0	0	0	6
Meat products	0	23	9	0	0	9	41
Total	0	36	39	0	39	93	207
Ham	0	11	0	0	0	1	12
Total	0	14	0	0	0	2	16
Sausage	0	12	9	0	0	1	22
Total	0	22	39	0	15	35	111
Other meat products	0	0	0	0	0	7	7
Total	0	0	0	0	24	56	80
Other products	0	1	20	0	0	0	21
Total	0	2	47	0	0	0	49
Bread	0	0	16	0	0	0	16
Total	0	0	17	0	0	0	17
Honey	0	1	0	0	0	0	1
Total	0	1	2	0	0	0	3
Herbs and spices	0	0	0	0	0	0	0
Total	0	0	20	0	0	0	20
Other food products	0	0	4	0	0	0	4
Total	0	1	8	0	0	0	9

$$Y_i = \alpha_0 + \alpha_1 Z_{1i} + \alpha_2 Z_{2i} + ... + \alpha_n Z_{ni} + u \quad (1)$$

Where Y_i are the product prices, the Z_i are the attributes and the α_i are the parameters of the regression.

The attributes considered in the analysis were introduced by means of dummy variables (i.e. dichotomous variables that take the value of 1 when a characteristic is present and 0 otherwise). The procedure used to introduce the dummies into the regression was the one in Oczkowski (1994), which avoids choosing a base category for the comparisons. For instance, one could consider in the case of the mineral water regressions, the category base 'still water from non-mountain origin sold in non-mountain areas by non-specialised stores' and all the parameters of the dummy variables in the regression would indicate deviations with respect to the base category. Thus, the parameter associated to a variable "mountain origin" would indicate whether 'still water from mountain origin sold in non-mountain areas by non-specialised stores' would receive a different price than the base category. Instead one may consider that all the parameters from the dummies indicate deviations with respect to the mean price but this requires reformulating the typical approach used when dealing with dummy variables.

The procedure used in this paper to introduce the dummy variables into the regression -presented here for completeness sake- can be explained by means of a simple two dummy variable model, $Y = \alpha_0 + \alpha_1 D_1 + \alpha_2 D_2 + u$ where D_1 is the first dummy variable that takes the value of 1 if say, the store is in a mountain area and 0 otherwise; D_2 is the second dummy variable that takes the value of 1 if the store is in a non-mountain area and 0 otherwise. By construction the two dummies add up to 1 (i.e. the store can be either in a mountain area or outside of it) and therefore, only one should be considered in the regression. However, it is possible to impose a constraint in the regression such that the parameters associated to the dummies become deviations with respect to the mean of the dependent variable (which is measured by the intercept, i.e., $\alpha_0 = \bar{Y}$). Thus, using the constraint that $\alpha_1 D_1 + \alpha_2 D_2 = 1$, it is possible to estimate all the parameters from the model by running the following two regressions (2') and (2"):

$$Y = \alpha_0 + \alpha_1 \left[D_1 - \left(\frac{P_1}{P_2} \right) D_2 \right] + u \quad (2')$$

$$Y = \alpha_0 + \alpha_2 \left[D_2 - \left(\frac{P_2}{P_1} \right) D_1 \right] + u \quad (2'')$$

The dummy variables in the analysis comprised four groups: first, attributes associated to whether the product was a mountain product, which included three dummy variables: (1) the mountain product did not have an equivalent product in the database, (2) the mountain product has an equivalent non-mountain products in the database and (3) non-mountain food products. Second, attributes associated to the location of the stores, which consisted of two dummies: (1) the shop was in a mountain area and (2) the shop was not in the mountain area. Third, attributes associated to the type of store, which comprised three dummies: (1) small non-specialised shop (i.e., discount shop, mini-market, vending machine and web shop.), (2) specialised (shop factory outlet, farmers shop, farmers market, specialty shop and regional supermarket), (3) supermarkets and similar stores (i.e., cash and carry, foreign supermarket, hypermarket, national supermarket). Fourth, attributes associated with the product types (e.g., type of apples), which depended on the product and can be found on the regression notes.

RESULTS AND DISCUSSION

The results are presented in Table 4 and Table 5. Although the regressions could have been run for all the products in the database as far as the product price was recorded, the main idea of the paper was to compare the price of similar mountain and non-mountain products. Therefore, only those cases where a sizable number of non-mountain food products was present (at least 4 cases). In addition, the analysis was performed differentiating by products and countries.

The statistical significance of the parameters associated to the variables x1 and x2 in the table indicate that the prices of the mountain food products (in the group without and with equivalent product) are different from the mean (above or below depending on the sign of the parameters). This was the case for sausage in France and cheese in Austria, France and Norway. In the case of Scotland and Slovenia the prices were not different than the mean value.

The parameters corresponding to x2 and x3 allow testing the hypothesis whether mountain food products carry a premium with respect to the non-mountain products. A premium was found only on the case of cheese and only for Austria, France (though favouring non-mountain products), Norway and Slovenia. In Austria the parameter of x2 was not statistically different than zero but the non-mountain products was -1.125 €/Kg (i.e., 1.125 was the size of the premium). In the case of Norway, the premium was found to be more substantial and equal to 23.1 €/Kg and in Slovenia, it was 2.5 €/Kg.

As regards whether the location of the store had effect on prices (related to variables x4 and x5) it was only found positive in the case of Austria and Slovenia. In the case of Austria mountain areas carry a higher price in the case of water (in the case of cheese, the same is observed but it is not statistically significant). In the case of cheeses in Slovenia, the situation is just the opposite and it is store in non-mountain areas the ones that carry a premium.

Variables x7 to x9 indicate that in some case specialised shops carry prices above average (this is for all the products not just mountain products). This is found for the case of cheese and water in Austria and only water in France.

As for the remaining variables (product type) several characteristics brought differences in prices but not in a systematic way.

Overall the mixed results obtained from the empirical analysis may indicate that probably in not all the cases the mountain attribute can operate as a creator of value (i.e. a source of differentiation in the eyes of consumers or buyers) and this may differ by product and country. Table 6 is an attempt to organise the possible cases that may arise.

Table 6 considers three degrees of differentiation: a

Table 4: Hedonic regressions for apples, sausages and water for selected countries

Variables	Apples 2/			Sausages 2/						Water 2/					
	France			France			Norway			Austria			France		
	Coefficient	t-statistic	Signif.	Coefficient	t-statistic	Signif.	Coefficient	t-statistic	Signif.	Coefficient	t-statistic	Signif.	Coefficient	t-statistic	Signif.
Dependent variable: Price in €/Kg				Dependent variable: Price in €/Kg						Dependent variable: Price in €/Litre					
Intercept 1/	1.848	28.543	0.000	15.887	16.672	0.000	32.526	6.314	0.000	0.489	15.308	0.000	0.330	26.680	0.000
x1	0.105	1.077	0.285	-4.118	-2.231	0.034	4.216	0.907	0.371	0.145	2.725	0.007	-0.016	-0.666	0.507
x2	-0.080	-0.622	0.536	1.427	1.132	0.268	-8.607	-0.652	0.519	-0.108	-2.372	0.019	-0.022	-1.267	0.207
x3	-0.116	-0.865	0.389	1.318	1.046	0.305	-8.860	-0.671	0.507	-0.024	-0.524	0.601	0.033	1.963	0.052
x4	0.082	0.718	0.475	--	--	--	-1.150	-0.265	0.793	0.022	2.025	0.045	-0.011	-0.826	0.410
x5	-0.073	-0.718	0.475	--	--	--	2.972	0.265	0.793	-0.223	-2.025	0.045	0.011	0.826	0.410
x6	-0.419	-1.977	0.052	-4.849	-0.863	0.396	-0.915	-0.125	0.901	-0.163	-2.271	0.025	-0.018	-0.703	0.483
x7	0.128	1.804	0.075	5.481	0.976	0.338	-18.536	-0.504	0.618	0.192	4.569	0.000	1.092	7.237	0.000
x8	0.027	0.504	0.615	-0.021	-0.076	0.940	3.696	0.556	0.582	-0.169	-2.770	0.007	-0.004	-0.566	-0.566
x9	0.086	1.113	0.269	--	--	--	-9.848	-1.031	0.310	-0.065	-0.609	0.544	-0.005	-1.363	-1.363
x10	-0.437	-1.817	0.073	--	--	--	29.073	1.853	0.073	-0.049	-1.140	0.257	--	--	--
x11	0.076	0.251	0.803	--	--	--	-5.727	-0.501	0.620	0.438	2.053	0.042	--	--	--
x12	-0.018	-0.211	0.834	--	--	--	16.401	0.387	0.701	0.052	0.949	0.345	--	--	--
x13	--	--	--	--	--	--	-0.289	-0.034	0.973	--	--	--	--	--	--
R^2	0.17			0.23			0.21			0.28			0.30		
Obs.	89			32			43			125			146		

Notes:
1/ The intercept is the mean of the dependent variable, the other coefficients are intepreted as deviations from that mean.
2/ '--' indicates that the variable was not included in the regression.

Variables
x1 = Dummy mountain product (without no equivalent non-mountain product in the database)
x2 = Dummy mountain product (with equivalent non-mountain product in the database)
x3 = Dummy non-mountain product
x4 = Dummy shop in the mountain area
x5 = Dummy shop not in the mountain area
x6 = Dummy shop type 1 - Small non specialised
x7 = Dummy shop type 2 - With some or more specialisation
x8 = Dummy shop type 3 - Large establishments (e.g., supermarkets)

For apples
x9 = Dummy apple variety - Golden
x10 = Dummy apple variety - Royal Gala
x11 = Dummy apple variety - Fuji
x12 = Dummy apple variety - Other

For sausages
x9 = Dummy sausage type - Sheep
x10 = Dummy sausage type - Reindeer
x11 = Dummy sausage type - Moose
x12 = Dummy sausage type - Beef
x13 = Dummy sausage type - Not specified

For water
x9 = Dummy water type - Still
x10 = Dummy water type - Sparkling
x11 = Dummy water type - Flavoured (not in France)
x12 = Dummy water type - Not specified (not in France)

Table 5: Hedonic regressions for cheese for selected countries

Variables	Cheese 2/													
	Austria			France			Norway			Scotland			Slovenia	
	Coefficient	t-statistic	Signif.	Coefficient	t-statistic	Signif.	Coefficient	t-statistic	Signif.	Coefficient	t-statistic	Signif.	Coefficient	t-statistic
Dependent variable: Price in €/Kg (or £/Kg in Scotland)														
Intercept 1/	13.086	44.615	0.000	10.642	22.781	0.000	32.536	8.845	0.000	15.199	33.103	0.000	9.607	35.178
x1	0.763	2.698	0.007	0.633	1.720	0.099	8.398	2.418	0.019	0.255	0.636	0.527	0.283	1.541
x2	-0.410	-0.900	0.369	-2.085	-2.035	0.054	-9.676	-1.045	0.301	0.663	0.548	0.585	0.253	0.264
x3	-1.125	-2.470	0.014	-0.195	-0.190	0.851	-23.075	-2.492	0.016	-1.791	-1.480	0.143	-2.521	-2.636
x4	0.087	1.027	0.305	--	--	--	-10.874	-1.742	0.088	-0.254	-0.307	0.760	-1.657	-6.272
x5	-0.896	-1.027	0.305	--	--	--	4.401	1.742	0.088	0.133	0.307	0.760	1.974	6.272
x6	-3.184	-4.777	0.000	-0.223	-0.185	0.855	--	--	--	-0.484	-0.267	0.791	--	--
x7	0.696	5.212	0.000	0.441	0.827	0.417	3.424	0.571	0.571	0.209	1.182	0.241	-0.144	-0.842
x8	-0.973	-1.847	0.066	-0.494	-1.220	0.235	-0.445	-0.187	0.853	-4.792	-5.654	0.000	0.710	0.842
x9	0.458	0.755	0.451	--	--	--	-4.177	-0.724	0.472	1.377	1.621	0.109	0.452	0.846
x10	-0.090	-0.227	0.820	--	--	--	--	--	--	--	--	--	0.904	1.061
x11	-0.106	-0.394	0.694	--	--	--	-15.393	-1.428	0.160	-1.255	-2.548	0.013	2.075	5.286
x12	-0.843	-0.618	0.537	--	--	--	-0.692	-0.063	0.950	-1.265	-0.403	0.688	-4.024	-8.150
x13	--	--	--	--	--	--	-11.389	-0.514	0.610	2.589	2.269	0.026	--	--
x14	--	--	--	--	--	--	8.948	1.597	0.117	--	--	--	--	--
x15	0.718	0.655	0.513	--	--	--	--	--	--	-4.758	-1.840	0.070	2.324	2.166
R^2	0.13			0.21			0.20			0.43			0.47	
Obs.	385			28			59			90			160	

Notes:
1/ The intercept is the mean of the dependent variable, the other coefficients are intepreted as deviations from that mean.
2/ '--' indicates that the variable was not included in the regression.

Variables

x1 = Dummy mountain product (without no equivalent non-mountain product in the databas
x2 = Dummy mountain product (with equivalent non-mountain product in the database)
x3 = Dummy non-mountain product
x4 = Dummy shop in the mountain area
x5 = Dummy shop not in the mountain area
x6 = Dummy shop type 1 - Small non specialised
x7 = Dummy shop type 2 - With some or more specialisation
x8 = Dummy shop type 3 - Large establishments (e.g., supermarkets)
x9 = Dummy cheese type - Soft
x10 = Dummy cheese type - Semi hard
x11 = Dummy cheese type - Hard
x12 = Dummy cheese type - Cream
x13 = Dummy cheese type - Blue
x14 = Dummy cheese type - Brown
x15 = Dummy cheese type - Not specified

Table 6: Hedonic regressions for cheese for selected countries

Degree of Differentiation	Product provenance	Role of the 'mountain' attribute
Homogeneous product (no differentiation)	The product is produced in **both** mountain and non-mountain areas.	The attribute 'mountain' does not produce any discernible differentiation.
Partially differentiated product	The product is produced in **both** mountain and non-mountain areas.	The attribute 'mountain' may differentiate the product, relative to the non-mountain substitute product, due to a special raw material, production environment, or production process. The 'mountain' attribute may create value, relative to the non-mountain product, and can be combined with other value creating attributes (e.g., Cairngorm Mountain Farmhouse Cheese). The 'mountain' attribute can be the basis of a quality label.
Totally differentiated product	The product is **only** produced in mountain areas.	With no direct substitute, the 'mountain' attribute may be enhanced with other value creating attributes (e.g., Cairngorm Mountain Heather Yoghurt) for differentiation from other mountain products. However, 'mountain' can still be the basis for a 'quality' label.

first degree is that one for which the term 'mountain' does not provide any sort of differentiation in the eyes of consumers or buyers. This is because the products (both from mountain and non-mountain provenance) can be consider homogeneous. The second case occurs when the attribute 'mountain' indicates some special raw material or production process that differentiates the mountain product from the non-mountain version. The third case consists of those products that are totally differentiated, i.e., there is not a non-mountain version of the product. In this case, the term 'mountain' cannot be used a differentiation label (although it can be a quality label). In this last case, other attributes are required to differentiate amongst similar versions of mountain products.

CONCLUSIONS

The purpose of the paper has been to analyse the prices for mountain and non-mountain food products collected as part of shelves survey carried around six countries (although only information from five were used due to the fact that the data from Romania do not contain information about non-mountain food product prices).

The paper starts presenting a theoretical framework on attributes and cues that helps answering the question what is "mountain" representing in a products or in other term, is it an attribute or a cue. The analysis indicates that the cues which convey the mountain attribute may in some instances be intrinsic, such as the smell and colour of mountain heather honey, but in many instances the mountain attribute and its various aspects may need to communicated by extrinsic cues in the form of labelling, packaging, a relatively high price, information from the sales person, etc. However, a different way of seeing it happens when the term 'mountain' is used in a label, the way that it is normally communicated to consumers, the label 'mountain' becomes a cue of a number of attributes associated with the specific mountain product, which can be product and process attributes.

As regards the empirical analysis its main purpose was to test whether mountain carry a premium associated to higher quality with respect to non-mountain products. The analysis was carried out using hedonic price regressions for the following products and countries: apples in France, sausages in France and Norway, water in Austria and France and cheese for Austria, France, Norway, Scotland and Slovenia.

The results indicated that in the case of sausage in France and cheese in Austria, France and Norway mountain products prices are above average. In the case of Scotland and Slovenia the prices were not different than the mean value.

As regards whether mountain food products carry a premium with respect to the non-mountain products, a premium was only found on the case of cheese and only for Austria, France (though favouring non-mountain products), Norway and Slovenia. In Austria the parameter of x2 was not statistically different than zero but the non-mountain products was -1.125 €/Kg (i.e., 1,125 was the size of the premium). In the case of Norway, the premium was found to be more substantial and equal to 23.1 €/Kg and in Slovenia, it was 2.5 €/Kg.

Whilst the diversity of products creates challenges for the comparison, overall the results indicate that not all mountain products receive a premium, but in some cases the non-mountain products are more expensive. Thus, the existence of a premium appears to be very situation specific – depending on the product type, the mountain area (and possibly its association with food), the other value creating attributes embodied in the product, and the existence of substitutes.

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Binominal models application of investments in agri-food production

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ABSTRACT

The paper presents the integrated technologic-economic deterministic simulation system for decision-making support in agri-food production. Under current agricultural situation and conditions the standard management evaluation methods do not account the uncertainty. An emphasis was made on the use of standard financial analysis (i.e. Cost Benefit Analysis, CBA) and its indicator, net present value (NPVt) upgraded with the real options approach for fruit processing as a supplementary activity on a part time farm. The application of real options (RO) was presented using the binomial model. Three different apple processing alternatives were assessed; juice, vinegar and dried apples. Real options have an important value in decision management where standard methods of investment analysis are upgraded and take into consideration stochastic elements as well.

Key words: fruit processing, simulation, investments, binominal models

INTRODUCTION

Farmers constantly face decisions about whether to invest in 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 business or investment opportunity is to use traditional discounted cash flow methods (Pažek 2006, Pažek et al. 2006). Investment assessment is the very important part of the capital operations and important perception for the success of investment projects. Although the Net Present Value (NPVt) methodology is widely used by project decision making process, a disadvantage of the NPVt is that the method does not include the flexibility or uncertainty. Several researchers argue that Net Present Value (NPVt) is not adequate under uncertain conditions and typically considers projects to be irreversible (Dixit and Pindyck 1994, Collins and Hanf 1998, Amram and Kulatilaka 1999, Tegene et al. 1999). To evaluate suitable investment possibilities (Leuhram 1998) an investor-farmer needs to take into account the value of keeping options open, including the impact of sources of uncertainty and risk attitudes. The risk and uncertainty associated with management decisions are included in the formulation of real options problems (Dixit and Pindyck 1994, Turk and Rozman 2002) and real option models (Brennan and Schwartz 1985). However, real options approach (ROA) rise from the doubt of NPVt method and can make up for it in assessment investment agricultural projects.

There are some limitations of NPVt by evaluating agricultural investment project. Wang and Tang (2010) presented some of them; NPVt is not flexible and only uses information available at the time of the decision. NPVt method only emphasizes that a prospective project must be positive value. The traditional discount cash will not recommend embedding an option to expansion which is expected to be negative – the expansion is an option and not an obligation. 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. Real options approach can make up for the deficiencies of NPVt, which greatly enhance the accuracy of investment decisions.

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 (Black and Scholes 1973). Real options use a flexible approach to uncertainty by identifying its sources, developing future business alternatives, and constructing decision rules. Further, ROA approach focus on irreversibility of investment in agricultural venture capital project. In reality, the majority of investment projects are irreversible. This is one of the major theoretical flaws of NPVt method. Real options approach reputes that, in most cases, although the investment is irreversible, investment could be postponed. NPVt method ignores the strategic value of the projects, such as the opportunity to expand into a new market, to develop natural resources or technology. ROA approach takes into consideration the flexibility of agricultural venture capital project too (Wang and Tang 2010).

Theoretical advances in real options methodology have been formulated and assimilated in several empirical

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applications (Dalila-Fontes 2008, Nishihara and Fukushima 2008, Pandža et al. 2003). The practice of real options approach has played a positive role in richening the theory of real options. Therefore real options, just as the same as financial options, are not only the right to investment, but also gradually become a kind of investment philosophy. Real options theory is increasingly used in industry projects too. Real options methodology was used to evaluate organic agriculture scheme by Tzouramani and Mattas (2009). The technology adoption of a free-stall dairy housing under irreversibility and uncertainty and its implications in the design of environmental policies was examined by Purvis et al. (1995). Further, the stochastic dynamic model of investment decision of an individual farmer under risk in the presence of irreversibility and technical change was assessed (Ekboir 1997). Musshoff and Odening (2005) explore the potential of the real options approach for analyzing farmers' choice to switch from conventional to organic farming. The model for effect-assessment of prices variability by the decision to invest in conservation with application to terrace construction was developed by Winter – Nelson and Amegbeto (1998). Price and Wetzstein (1999) developed a model for determining optimal entry and exit thresholds for investment in irrigation systems when there is given irreversibility and uncertain returns with price and yield as stochastic variables. The model for investment decision to convert farmland to urban as an irreversible investment under uncertainty when use of this land is restricted by government policies so as to protect the environment were developed by Tegene et al. (1999). The appliance of real options evaluation is showed on model of plum and plum brandy as an extension with option valuation method - Black-Scholes model by Hadelan et al. (2008). The impact of price uncertainty and expectations of declining fixed costs on the optimal timing site specific crop management was presented by Khana et al. (2000). The application of real options in agriculture further presented Morgan et al. (2007), Musshoff and Hirschhauet (2008), Kuminoff and Wossink (2010), Nadolnyak et al. (2011), Pažek and Rozman (2011) and Musshoff (2012).

In the presented research the use of the decision making process and its tools for evaluating investments in fruit processing business alternatives using elements of the real options methodology is presented. The study focuses on the impact of Net Present Value (NPVt) as a parameter for investment decisions in the framework of Cost Benefit Analysis (CBA) and the real options model (binominal model).

MATERIAL AND METHODS

Model development

The methodological framework for the financial and real option approach assessment of fruit processing alternatives lies within the inter-relation of the agricultural product processing simulation model KARSIM 1.0 (Pažek 2006). The first technique presented is one of the common methodological approaches to farm management, while the real option approach is based on the binominal models.

KARSIM 1.0 integrated technologic-economic deterministic simulation model

Simulation modeling can be efficiently applied in both cost estimation and cost benefit analysis (Csaki 1985, Rozman et al. 2002). Furthermore, simulation represents one of the fundamental tools for making management decisions (Kljajić et al. 2000). The computer simulation model KARSIM 1.0 was developed for the financial and technological analysis of food processing (organic and conventional). The system as a whole represents a complex calculation system and each sub-model results in a specific enterprise budget. Through a special interface, the system enables simulation of different alternatives at a farm level. Furthermore, based on enterprise budgets, cash flow projections can be conducted together with investment costs for each apple processing business alternative, and the net present values for each simulated alternative can be computed. All iterations (calculations for individual alternative) are saved into a database, which is finally used as one of the data sources for real option analysis. The simulation system is built in an Excel spreadsheet environment in order to ensure better functionality of a user friendly calculation system.

As presented, the KARSIM 1.0 model is based upon deterministic technologic-economic simulation where the technical relations in the system are expressed with a set of equations or with functional relationships. The amounts of inputs used are calculated as a function of given production intensity, while apple production costs are calculated as products between the model's estimated inputs usage and their prices. Furthermore, based on enterprise budgets, cash flow projections can be conducted together with the investment costs for each business alternative, and the NPVt for each simulated alternative can be computed.

The standard Net Present Value (NPVt) analysis versus the real options approach

The decision as to which farm management decision method to undertake on an individual farm is rarely made on the basis of NPVt calculation alone. Traditional investment appraisal should be completed with real option methodology into the planning process where some further KARSIM 1.0 results represent input variables for binomial model analysis. The preferred approach to evaluating investments is NPVt analysis. For an investment of t periods the formula is:

$$NPV_t = -I + \sum_{i=1}^{n} \frac{TR - TC}{(1+r)^t} \qquad (1)$$

Where:
NPVt - standard Net Present Value (€)
I - investment costs (€)
TR - total revenue (€)
TC - total costs (€)
r - discount rate (%)
t - time - number of years (Turk and Rozman 2002).

According to the standard CBA approach, it was presumed that the maximization of the Net Present Value (NPVt) of the project investment used market prices for expenditures and commodities and describes the financial feasibility. The

Net Present Value (NPVt) parameter is 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). By isolating the cash costs from enterprise budgets, the annual cash flows are estimated, representing a basic input parameter for the computation of NPVt. In NPVt equation, the aggregate benefits TR and the aggregate costs TC are annually summed and discounted to the present with the selected discount rate r. With isolation of cash costs from enterprise budgets the annual cash flows are estimated, representing a basic input parameter for computation of NPVt. In equation, where NPVt is presented, the aggregate benefits and the aggregate costs 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) and vice versa if the sum is negative. If the NPVt of the investment after discounting is positive then this investment is better than the alternative earnings. However, in the continuation the concept of options will be introduced how the real options can be appended to the basic NPVt model.

The binominal model

To illustrate the real options methodology, example of developed real options model apple processing output is presented, i.e. the binomial models for apple processing business alternatives were developed. The binomial option-pricing model is currently the most widely used real options valuation method. The binomial model (i.e., lattice) describes price movements over time, where the asset value can move to one of two possible prices with associated probabilities (Wang and Tang 2010). The binomial model is based on a replicating portfolio that combines risk-free borrowing (lending) with the underlying asset to create the same cash flows as the option. Figure 3 represents the binomial process through a decision tree. Since an option represents the right but not the obligation to make an investment, the payoff scheme for the option is asymmetric. The analysis performed in this work makes use of the multiplicative binomial model of Cox and Rubinstein (1979), the standard tool for option pricing in discrete time.

According to Figure 1, a node of value C = NPVt can lead to two nodes with their values being given by C = NPVt with probability 1+d = d1= Cg (up factor, u) and 1-d = d2 = Cd (down factor, d), respectively. The up and down factors are calculating using the underlying volatility (σ):

Cg = 1 + upside change = e^{σ} (2)

Cd = 1 + downside change = 1 / Cg (3)

Next period underlying asset price (Vs) is calculated as:

V_s up = V_0 * u (4)

V_s down = V_0 * d (5)

Probability of up and down change of the asset price (p) is followed:

Up change = $p = \frac{e^{rt} - d}{u - d}$ (6)

Where:

e^{-rt} - the exponential term (2,71828).

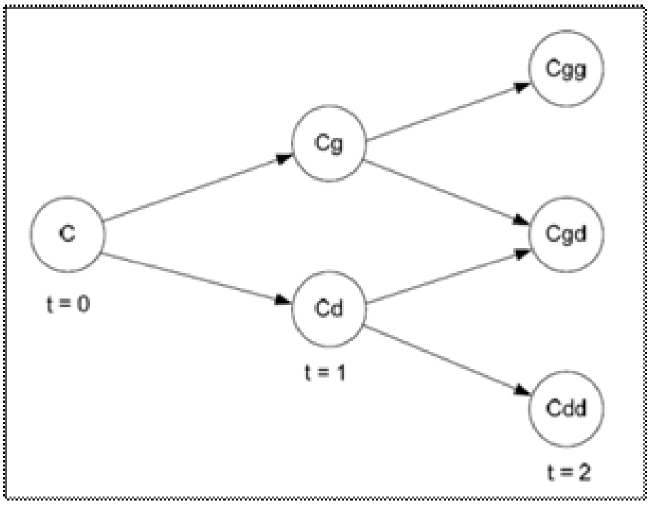

Figure 1: Binominal lattice structure (C = NPVt with probability d1 =Cg and d2 = Cd)

Down change = 1 – p (7)

Binomial option is done by asset and option value tree (i.e. lattice) project, using all maintained elements. The option valuation begins solving the tree's node value at the latest year and work back to the beginning year through backward induction (Rozman et al. 2006, Winter-Nelson and Amegbeto 1998).

The option on the node resulted by the n price increase (un) and can be calculated by the formula (Hadelan et al. 2009):

$OV(u^n) = \max(Vs(u^n) - X; 0)$ (8)

Value of the option in the node dn can be formulated as:

$OV(d^n) = \max(Vs(d^n) - X; 0)$ (9)

The calculation of the option value in previous steps is:

$$OV(u^{n-1}) = \frac{p * OV(u^n) + (1-p) * OV(u^{n-1}d)}{1+r} \quad (10)$$

Where:

X – investment's value (€)

OV - option value of project (€)

r - annual risk free continuously compounded rate (%)

σ - annualized variance (risk) of the investment's project.

The strategic real options of the investment project are calculated using the Black-Scholes methodology and is provided as:

$NPV_{SRO} = NPV_t + OV$ (11)

Where:

NPV_{SRO}-strategic real option (€).

Thus, the lattice provides a representation of all possible demand values throughout the whole project life (Dalila-Fontes 2008).

However, the goal of integrated model development is to provide answers which business alternative is the best solution for the given farm.

RESULTS AND DISCUSSION

The identified business alternatives are evaluated using a specially developed simulation models in Excel spreadsheet environment. Basic production data and calculated economical parameters for individual business alternatives in apple processing are presented in Table 1.

Based on a discounted cash flow methodology, the traditional net present value (NPV_t) criterion is used extensively in assessing an investment opportunity for three analysed apple products (Table 2). The results are calculated under the assumption of successful product selling at the expected prices. As shown in Table 2, economic analysis of apples production indicates relatively high profitability. Further, CBA analysis shows positive net present values for two processed apple alternatives (juice and vinegar). The highest NPV_t was observed for apple juice (NPV_t = 4.239,48 €). The relatively high estimated NPV_t for juice can be explained by high prices, achieved in the market. The negative NPV_t was calculated for dried apples and is expected to be so.

Table 1: The simulation model results for the planned fruit processing projects on a sample farm

Business alternative	Products quantity (l, kg)	Total costs (€)	Total revenue (€)	Coefficient of economics
Apple juice	5.025	4.745,33	8.094,66	1,71
Apple vinegar	5.980	4.354,04	6.580,23	2,99
Dried apples	1.507,5	13.865,51	15.163,18	1,09

Table 2: CBA analysis of the planned fruit processing projects on a sample farm (after 5 years, r = 8%)

Product	Investment costs (€)	Annual cash flow (€)	NPV_t (€)	Investment return period=Pd (years)	NPV_t by Pd (€)
Apple juice	9.133,43	3.349,33	4.239,48	4	447,43
Apple vinegar	6.666,41	2.226,19	2.222,13	5	2.222,13
Dried apples	6.066,95	1.297,66	-886,76	6	22,53

However, as expected, the investment into dried apples production is financial unfeasible (NPVt = -886,76 €) and investment return period is under presumed model input parameter (see Table 2) not possible to be assessed. From financial aspect this project should be rejected by the farmer.

Further, the results of traditional Net Present Value for all business alternatives present the base for calculation of strategic real option of apple processing. The risk-free rate and variance of the investment's project were defined deterministic. To illustrate the real options methodology, we present some examples of our real options model output.

Investment project option values are calculated using the binomial lattice. However, the results of real options approach show more favorable picture from farmers' perspective by binominal model. The results showed that financially the most interesting and suitable investment is again apple juice production where the option value results in a value of 221,48 € followed by apple vinegar production (129,74 €). All binomial model results are calculated under the assumption presented in Tables 1 and 2.

The detailed presentation of the binomial lattice calculations are in Tables 4-8, where binomial models

Table 3: Option value assessments for apple processing using binominal model

Parameter	Apple juice	Apple vinegar	Dried apples
OV* (€)	221,48	124,74	0,00
NPV_{SRO}	4.460,96	2.347,86	-885,76

Table 4: Asset valuation lattice for apple juice production by binominal model (for first 5 years of production)

Time (years)	0	1	2	3	4	5
OV (€)	3.349,33	4.521,12	6.102,88	8.238,03	11.120,17	15.010,66
		2.481,25	3.349,33	4.521,13	6.102,88	8.238,03
			1.838,15	2.481,25	3.349,33	4.521,13
				1.361,74	1.838,15	2.481,25
					1.008,80	1.361,74
						747,34

comprise two underlying lattice generation – asset and option value lattice

Table 4 indicates that that the possible project value after 5 years of production can be ranged from 747,34 € to 15.010,66 €, depending on favorable or unfavorable business circumstances.

Option value assessments for dried apples by binominal model for first 5 years of production result with value 0,00. In all cases, the most preferable alternative is apple juice production. The presented results showed that binominal models (Table 3, values of NPVSRO) in presented case further confirm the preliminary CBA results (Table 2), where dried apple production is from financial point of view for the farmer unacceptable.

Table 5: Option value assessments for apple juice production by binominal model (for first 5 years of production)

Time (years)	0	1	2	3	4	5
OV (€)	221,48	426,68	821,99	1.583,56	3.050,73	5.877,23
		0,00	0,00	0,00	0,00	0,00
			0,00	0,00	0,00	0,00
				0,00	0,00	0,00
					0,00	0,00
						0,00

Table 6: Asset valuation lattice for apple vinegar production by binominal model (for first 5 years of production)

Time (years)	0	1	2	3	4	5
OV (€)	2.226,19	3.005,04	4.056,38	5.475,54	7.391,21	9.977,09
		1.649,20	2.226,19	3.005,04	4.056,38	5.475,54
			1.221,76	1.649,20	2.226,19	3.005,04
				905,10	1.221,76	1.649,20
					670,52	905,10
						496,73

Table 7: Option value assessments for apple vinegar production by binominal model (for first 5 years of production)

Time (years)	0	1	2	3	4	5
OV (€)	124,74	240,31	462,95	891,87	1.718,19	3.310,09
		0,00	0,00	0,00	0,00	0,00
			0,00	0,00	0,00	0,00
				0,00	0,00	0,00
					0,00	0,00
						0,00

Table 8: Asset valuation lattice for dried apples by binominal model (for first 5 years of production)

Time (years)	0	1	2	3	4	5
OV (€)	1.297,66	1.751,66	2.364,49	3.191,73	4.308,38	5.815,71
		961,33	1.297,66	1.751,66	2.364,49	3.191,73
			712,17	961,33	1.297,66	1.751,66
				527,59	712,17	961,33
					390,85	527,59
						289,55

But it should be mentioned that it does not mean that financial weak project (i.e. production of dried apples) should be rejected immediately. And contrary, financial strong project (i.e. apple juice and vinegar production) should not be accepted and invested immediately. It should be taken into account the flexibility and possible options. In the further decision process, under other presumed input production parameters, a weak option values means that the farmer should hold the option of analyzed project investment, prepare some possible project scenarios and not to abandon the project instead.

CONCLUSIONS

The application of discount cash flow approach in agriculture is not always the appropriate way to decide if an investment project is feasible or not. In the paper, an attempt was made to employ a real options approach to evaluate the apple processing business alternatives on a farm. The general implication from this empirical analysis is that uncertainty and risk attitudes play an important role in farmers' decision to adopt a new business. Empirical results reveal that the production of dried apples is not advisable for the analyzed farm. The model results are useful in practice and helpful in setting up hedges in the correct proportions to minimize risk. However, real option approach offers a new point of view to investment evaluation of Agri-food project. The option methodology takes into account uncertain parameters, forecasting and the most important, the value of opportunity. We can conclude that real options are comprehensive and integrated solution to apply options theory to value real investments project to improve the decision making process.

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