

We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

4,800

Open access books available

122,000

International authors and editors

135M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com



A Case Study on the Application of the Analytic Hierarchy Process (AHP) to Assess Agri-Environmental Measures of the Rural Development Programme (RDP 2007–2013) in Slovenia

Monica Huehner, Črtomir Rozman and
Karmen Pažek

Additional information is available at the end of the chapter

<http://dx.doi.org/10.5772/63924>

Abstract

The reform of the Common Agricultural Policy (CAP) in 2003 focused mainly on the economic and environmental challenges. The Rural Development Programme 2007–2013, hereafter RDP, being implemented in Slovenia is therefore aiming at promoting proposed activities that help to improve the rural areas. Agri-environmental measures (AEMs) encourage farmers to make an environmental commitment for a period of at least 5 years aiming at preserving the environment and maintaining the countryside. Because of practising environmental friendly production methods, the farmers might be encountered with more costs and reduction of yield. Therefore, payments are made as compensation. Concentrating only on one of the four pillars of the RDP, “Improvement of environment and the countryside”, this paper attempts to assess the Slovenian agri-environmental measures with the help of the multicriteria decision analysis, that is, analytic hierarchy process (AHP) and its supporting software Expert Choice™. In the presented case study, three main criteria and their attributes were determined. With the help of experts (questionnaires), data were collected, which made the assessment possible. The results show that organic fruit, vine and horticultural production are seen as the most important AEM. This is specific for the Republic of Slovenia because of its large amount of area designated as least favoured areas (LFA) that are not suitable for arable farming.

Keywords: agri-environmental measures, rural development programme, multicriteria decision method, analytic hierarchy process, Expert Choice™

1. Introduction

For a long time, agriculture was marked by intensive production practices, which meant that the massive use of mineral fertilisers and pesticides was indispensable to achieve high yields. This led to the deterioration of the environmental conditions [1]. The pollution of soils and ground water was the result, biodiversity dwindled [2]. The Slovene agriculture is not an exception. The resources in Slovenia are already limited because of unfavourable natural conditions. More than 75% of the Slovene territory lies in the less favoured areas (LFA), where agricultural practice is limited by natural factors. More than half of the Slovene territory is covered by forests. Also, 90% of the entire Slovene territory is classified as rural, with 57.2% of its inhabitants living there [3]. Of the 57.2% inhabitants in the rural areas, only 6% are engaged in agriculture [4]. Agriculture has a potential of making a great contribution to the economic development in the rural areas. The emphasis in today's agricultural policies, therefore, has to be on sustainable agricultural production, which can be practised and maintained when the following three main features are fulfilled [3,5]:

- Social acceptability
- Environmental reliability
- Economic feasibility

Sustainable agricultural production is strongly linked to the environmental aspect. Many countries or regions in the world have therefore adopted environmental programmes to slowly suit the changing agricultural production methods and to counter climatic change. While a couple of years ago environmental protection was a fashion, today, it has become a strong and indispensable philosophy being followed in all aspects of life. The research on the role of environmental attitudes towards the participation in the next generation of agriculture conservation programmes was already going on in the USA in 1999 [6]. Ho et al. [7] point the importance of the Environmental Technology Centre of the Murdoch University in Australia with training and research programmes on renewable energy in the context of environmentally sound technologies. Zbinden and Lee [8] state that since 1997, Costa Rica's Payments for Environmental Services Programme has provided payments to more than 4400 farmers and forest owners for reforestation, forest conservation and sustainable forest management activities. The idea of a Danube River Basin environmental programme was born in Sofia in 1991, and the programme was started in 1992 as described by Nachtnebel [9]. Nachtnebel [9] points out that the Danube River Basin environmental programme provides for joint actions of the 10 Danubian countries to assist integrated environmental management in the basin. Environmental programmes are not only limited to the agriculture but are also found in the industrial sector. Abaza [10] argued that the structural adjustment programmes of the World Bank in the 1990s, packages of economic reforms specifically designed to enhance the recovery of economies in crises, were urged to address environmental issues. Abaza elaborates further that efficient management of natural resources is essential for sustainable development and poverty alleviation. To promote and support sustainable agriculture in its member states, the European Union introduced a Common Agricultural Policy (CAP) [11]. Within the scope of

CAP and to be able to successfully integrate the environmental aspect, agri-environmental measures (hereafter AEM) were compiled as part of the second pillar of the Slovenian rural development programme (RDP) aiming at improving the environment and the rural areas. AEM are now compulsory for all EU member states. Each EU member state has its own RDP especially compiled to suit their circumstances and special conditions. Petersen [12] from the European Environment Agency gathered information on the countries preparing to access the European Union using questionnaires and information from the responsible national ministries. He used this data for his exposition with the main focus on agri-environmental programmes of the candidate countries. AEM enable payments to farmers who voluntarily take up environmental commitment for at least five years. In these 5 years, they commit themselves to use environmental friendly production methods (RDP 2007–2013). The emphasis is on the right balance between competitive agricultural production and the respect of nature and the environment. Furthermore, awareness of sustainable production with focus on regenerative use of the available natural resources has to be roused [13]. AEM also ensures agricultural production that suits the needs of consumers and protects their health. Through these measures, the standard of living in the countryside is expected to be improved.

An ex ante evaluation carried out by the Biotechnical Faculty of the University of Ljubljana together with the Danish Orbicon in September 2006 using the Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis was to help reveal loopholes and faults in the draft for the RDP. In the evaluation, the need for a hierarchical structure of the objectives was mentioned several times in order to clearly determine the main objective and the subobjectives [14].

Cunder analysed the role of rural development policy in environmental and land management in Slovenia based on a desk research [15–17] using the legislative documents like the Common Agricultural Policy Reform from the EU and the document on the analysis of the accession of Slovenia and its agriculture into the EU in 2004. No modelling was done in all these cases. At this point, in the decision-making process, the analyst should consider a multicriteria (objective) decision analysis approach (hereinafter MCDA), which combines different mathematically based methods—the most commonly known approaches are the utility theory and the analytical hierarchical process [18–20]. Multicriteria analysis (MCA), also known as multicriteria decision analysis (MCDA), is an umbrella term for a number of decision-making techniques. As the name implies, MCDA makes it possible to tackle “problems” with many different conflicting criteria. According to the Department for Communities and Local Government in London [21], their role is to deal with the difficulties that human decision-makers have been shown to have in handling large amounts of complex information in a consistent way. In agriculture, decisions to be made are complex, mostly consisting not only of a single criterion but multiple criteria as in the implementation of the AEM. Thus, many criteria determine or influence the optimum decision. For such complex decision-making procedures, the traditional mathematical programming, especially linear programming, is therefore not adequate for modelling them [22]. Also, just determining strengths, weaknesses, opportunities and threats does not analyse the problem being assessed thoroughly enough. The relations and interactions of the criteria are not determined.

Besides for making decisions, some scientists [23–25] have used MCDA methods also as assessment tools. Ferrarini et al. [26] used MCA to assess and compare municipal performance in environmental quality and sustainability in the province of Reggio Emilia in Italy. Gómez-Limón et al. [27] also made use of MCA to analyse input usage in agriculture and the way it affects the environment. Hellstrand [28] found MCA useful to survey the sustainability effects of increasing concentrate intensity in Swedish milk production. Solomon and Hughey [29] proposed a MCA decision support tool for international environmental policy issues on the example of emissions control in the international aviation sector. Crete Tsoutsos et al. [30] showed how sustainable energy planning can be done by MCA. The analysis of air pollution [31] and soil pollution [32] in an urban area in Serbia was done by Nikolić et al. using MCA. For improving strategic environmental assessment of water programmes in Brazil, MCA was also taken by Garfi et al. [58]. In Malaysia, Al-Hadu et al. [33] showed how useful MCA is for environmental management. Payraudeau and Gregoire [34] modelled pesticides transfer to surface water with MCA.

One of the most common methods of MCA is analytical hierarchical process (AHP). AHP has found its use in a few branches of the agricultural field for more than two decades, though not extensively. It has since been very attractive and useful for water management engineers. Pillai and Rasu [35] used this method for ranking irrigation management alternatives in an Indian region in order to increase the effectiveness of the irrigation system, which was underutilised. Tiwari et al. [36] used AHP to develop a framework for environmental-economic decision making that includes the environmental and economic sustainability criteria, and local people's preferences in the context of a lowland irrigated agriculture system in Thailand. The method was also relevant for Ni and Li [37], who used it for the assessment of soil erosion in terms of land use structure changes. Tran et al. [38] used AHP to prioritize future renewals of irrigation and drainage assets in the La Khe irrigation scheme in North Vietnam; Srdjevic and Medeiros [39] also demonstrated the use of AHP for the assessment of water management plans. Braunschweig and Becker [40] showed how AHP could be used in international agriculture to choose research priorities. Pažek et al. [18] used AHP for evaluation of business alternatives on organic farms. Liu et al. [5] made an assessment of how sustainable a high-yield agro ecosystem in Huantai County, China, was. In Iran, Rezaei-Moghaddam and Karami [41] used AHP for the evaluation of sustainable agricultural development models. Ziolkowska [42] used AHP in combination with cost-effectiveness analysis for the evaluation of the AEM and analysis of the economic aspects to support the decision-making process of the Polish government. In the same year, Ziolkowska [43] also combined AHP and linear programming to estimate the importance of AEM with respect to the environmental objectives and calculate an objective orientated budget allocation for AEM. Ziolkowska also used the AHP to investigate/evaluate the importance of AEM from the regional perspective in Poland. Mortazavi et al. [44] showed how AHP can successfully be used for prioritizing agricultural research projects. Vindis et al. [45] also used AHP to perform a further evaluation of energy crops for biogas production.

The aim of this paper is therefore a further attempt to show how multicriteria decision models can be successfully applied in the assessment of agricultural problems, the main focus being

on the assessment of AEM in Slovenia. The paper is organised as follows: first, we present the methodology and describe the AHP model, and this is followed by the main results. The main findings conclude this article.

2. Materials and methodology

The assessment in this paper is based on one of the most used multicriteria decision methods (hereafter MCDM), the AHP. As recommended by Saaty [46], Meixner and Haas [47], the paper is organised as follows:

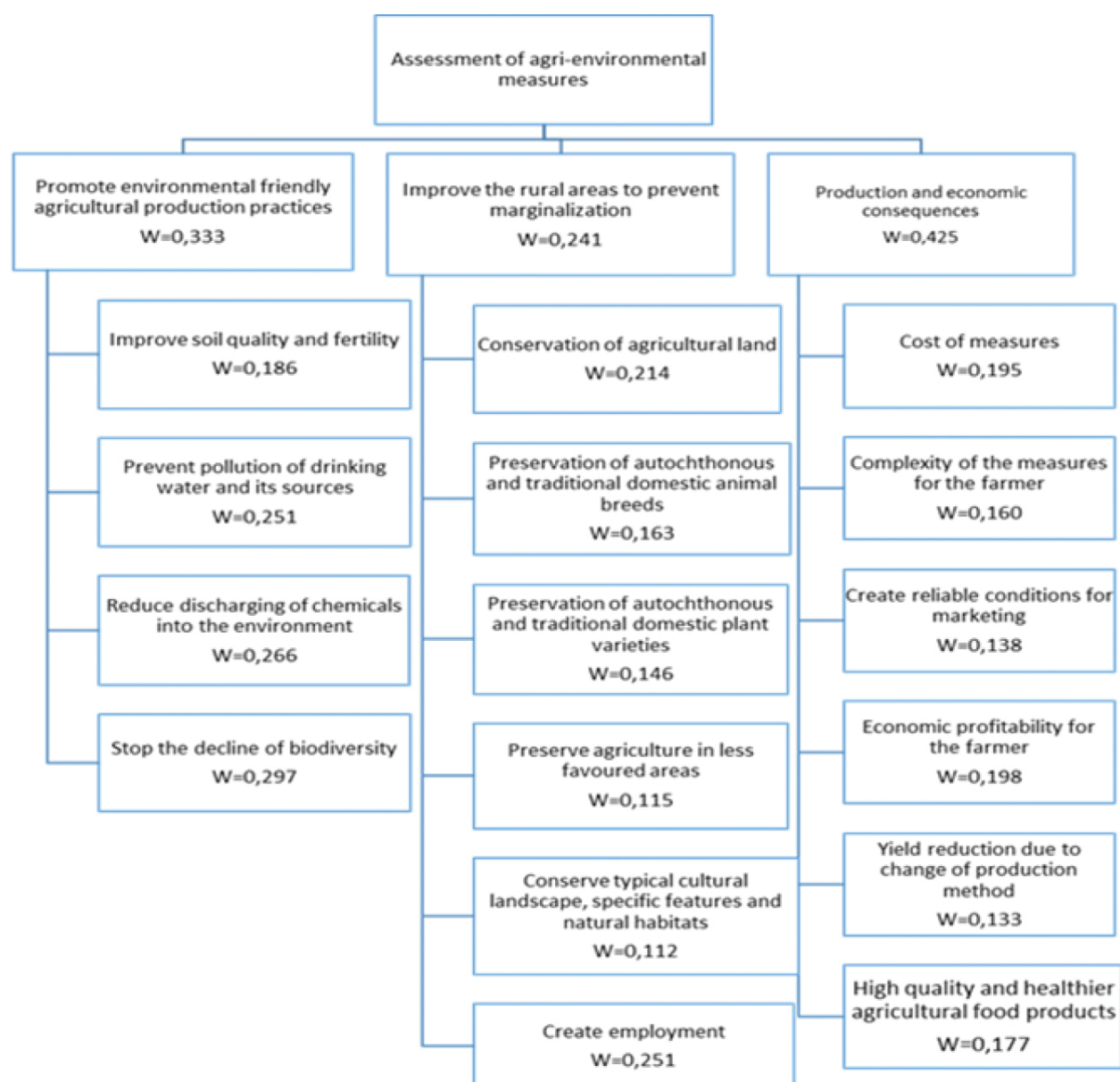


Figure 1. Aggregated weights based on group judgements.

Step 1: The main goal, subgoals (attributes), criteria, people involved and/or affected and their objectives and the means of reaching the goal were identified and formulated.

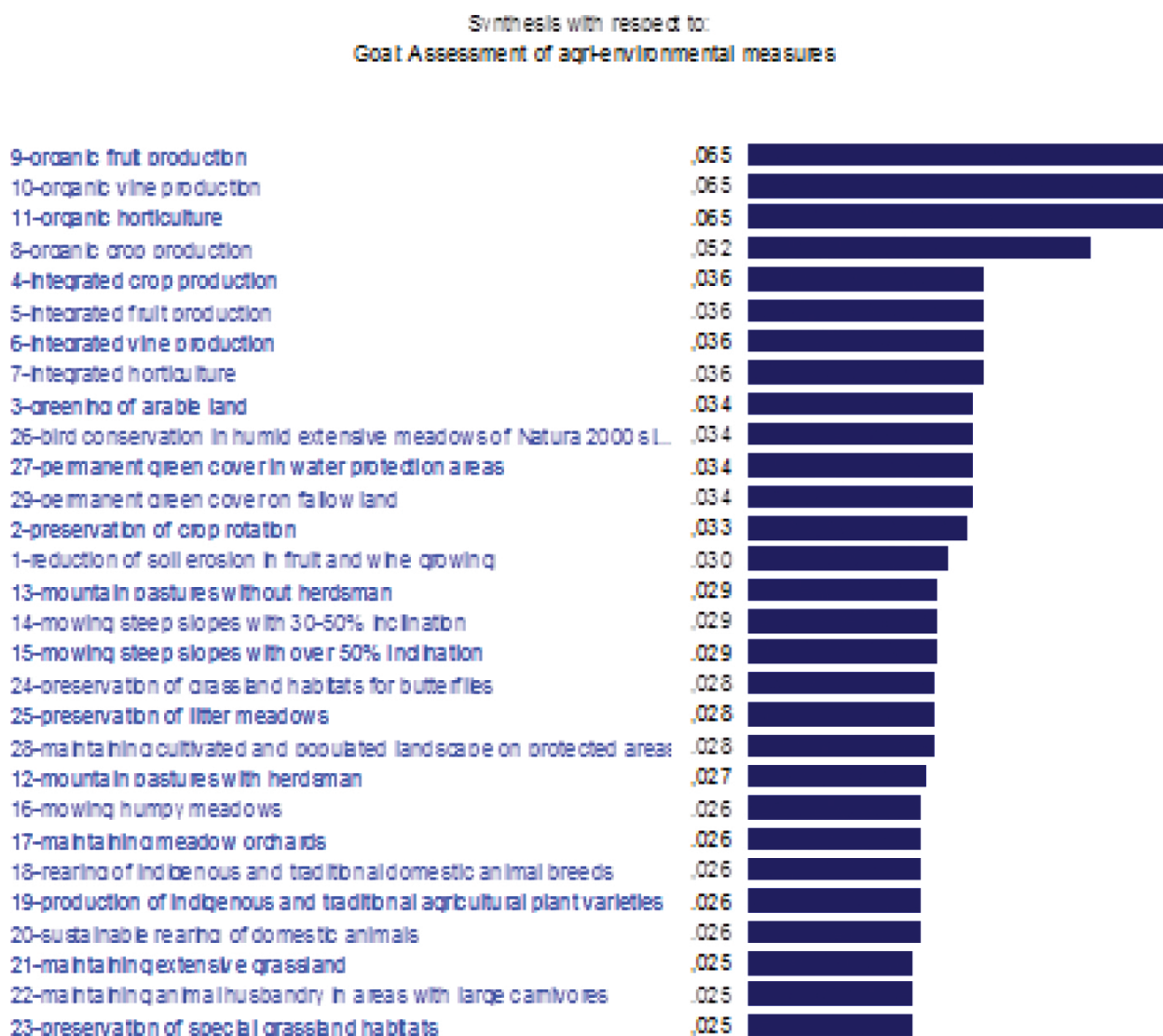


Figure 2. Synthesis with respect to goal (group judgements).

Step 2: The models in AHP were built by decomposing the complex main goal into smaller less complex sub-goals, factors that affect the subgoals and ending with the outcome of the strategies [46,48]. This led to a hierarchical structure (Figure 1) with criteria, attributes and alternatives [48,49]. The concrete measures to fulfil the defined objectives to finally reach the main goal, 29 of them in this case compiled by the state, are at the bottom of the hierarchy.

Step 3: To determine the interrelations in the hierarchy, pairwise comparisons of the parameters at each level of the hierarchy were done with respect to the element immediately above them. Through pairwise comparison of the elements at each level of the hierarchy and within the hierarchical levels, weights were determined (Figure 2), which help to show the correla-

tions within the structure [49]. AHP allows comparisons using real measurements (quantitative judgement) or a scale created by Saaty which expresses the degree of preference, importance or likelihood (qualitative judgement) [18,46].

Step 4: Aggregation of the priorities to have a ranking of the alternatives was carried out. This was done by determining the ratings of the alternatives with respect to each criterion and then adding up these ratings for all criteria.

Step 5: Control of consistency was done by determining the consistency index, CI that is calculated as follows:

$$CI = \frac{\lambda_{\max} - n}{n - 1}$$

where λ_{\max} is the eigenvalue of the matrix and n the size of the matrix. A consistency index of up to 10% is tolerable. A slight deviation of the consistency index from 10% is not a problem. A large deviation means that the judgements are not optimal and have to be improved.

The attributes/criteria and alternatives included in the hierarchy (**Figure 1**) were extracted from the agri-environmental measures of the RDP of the Republic of Slovenia. Each EU member state has its own RDP especially compiled to suit its circumstances and special conditions.

The hierarchical structure consists of four levels with the main goal, "Assessment of agri-environmental measures" as the first level. The second level has three subgoals (•) and the third level a different number of subgoals (-) for each subgoal, as shown in **Figure 1**:

- Promote environmental friendly agricultural practices: sustainable and careful use of agricultural resources is the main focus in this subgoal.
 - Soil quality and fertility will be improved by reducing soil erosion, loss of humus and loss of nutrients through leaching [50].
 - Agri-environmental measures aim at reducing the contamination of groundwater and drinking water sources through chemicals discharged into the environment during agricultural production.
 - According to Latacz-Lohmann and Hodge [51], there has been an exaggerated and uncontrolled use of chemical fertilizers and pesticides in the past. As a result, considerable decline of biodiversity was observed among other negative consequences. The agri-environmental measures aim at reducing this destructive practice.
- Improve the rural areas to prevent marginalisation: Because of lack of income in the rural areas there has been a significant amount of rural exodus, people moving to areas of industrial concentration and into bigger towns [52]. With this subobjective, there is hope that the rural exodus might be reduced or even reversed to a certain degree.
 - Conservation of agricultural land implies minimal soil disturbance, permanent soil cover and crop rotation.

- Unique traditional and indigenous domestic animal breeds are mostly well known for their toughness and resistance against aggressive animal diseases. So the main aim here is to retain this valuable genetic material. Genetic diversity will help reduce loss in times of drought and epidemics.
- Climatic change has evoked unreliable weather conditions. The growing seasons are threatened by these unpredictable weather conditions. Traditional and indigenous plant varieties contribute to a greater diversity of crop plants that can be utilised for agricultural food production. They are a valuable genetic source towards food security since many can grow under harsh conditions. Their constituents are usually highly nutritious or medically effective. Preservation of a high agro-biodiversity is one of the important goals towards sustainable agricultural production.
- Less favoured areas already have the problem that agricultural land is limited and the conditions for agricultural production are not favourable. The little space that is available has to be used gently/carefully to avoid deterioration. Traditional and indigenous domestic animal breeds and plant varieties could play a role to make these areas usable for agricultural purposes [53].
- The landscape has to preferably be kept in its natural state so that many animals, big and small, have their ideal habitat. This means for example that grasslands have to be maintained to avoid bush encroachment.
- Job creation is vital to make the rural areas an attractive place to live. This might help to attract many people out of the industrial/urban areas back to the rural areas.
- Production and economic consequences: With farmers investing in the rural areas, new jobs will be created. If the rural areas are made attractive enough with the appropriate infrastructure, even young farmers will find it worth settling in the rural areas [54].
 - Costs of measures play a major role as to whether they are successfully implemented until the end of the given period.
 - Successful implementation of the agri-environmental measures also depends on how complex they are for the farmers. Too complex measures will be wrongly put into practice, which leads to the wrong outcome as the intended.
 - To be able to get the produce from the rural areas on the markets, reliable channels for marketing have to be created.
 - If there is economic profitability for the farmers through implementation of the measures, the farmers might not give up farming. They might also not leave rural areas and migrate to urban areas [55].
 - The farmers will probably encounter yield reduction if they changed the method of production to suit the demand for more biologically produced foodstuff. Their products are healthier and of a higher quality. They produce less but will be able to sell their products at higher prices.

The fourth and last level at the bottom of the hierarchy has 29 measures that are very specific for Slovenia.

After determining the hierarchy, questionnaires were sent to five experts involved in the preparation and evaluation of agriculture environmental subsidies payment system, on who made pairwise comparisons at each level of the hierarchy. These pairwise comparisons were used to assess the agri-environmental measures. For assessment, the individual judgements obtained from questionnaires were turned into comparison matrices for each expert. Since this decision procedure is considered as a group decision, the decision values from the individual experts have to be aggregated to one matrix. This can be done by aggregating the values of the individual pairwise comparisons at each level of the hierarchy or by first calculating the priority weights for each individual expert at each level of the hierarchy and then aggregating these priority weights. In both cases, the aggregation is done by building the geometric mean as recommended by Saaty and Vargas [49] and Meixner and Haas [47]. The geometric mean (G) is obtained by calculating the n -th root of the product of the individual expert values:

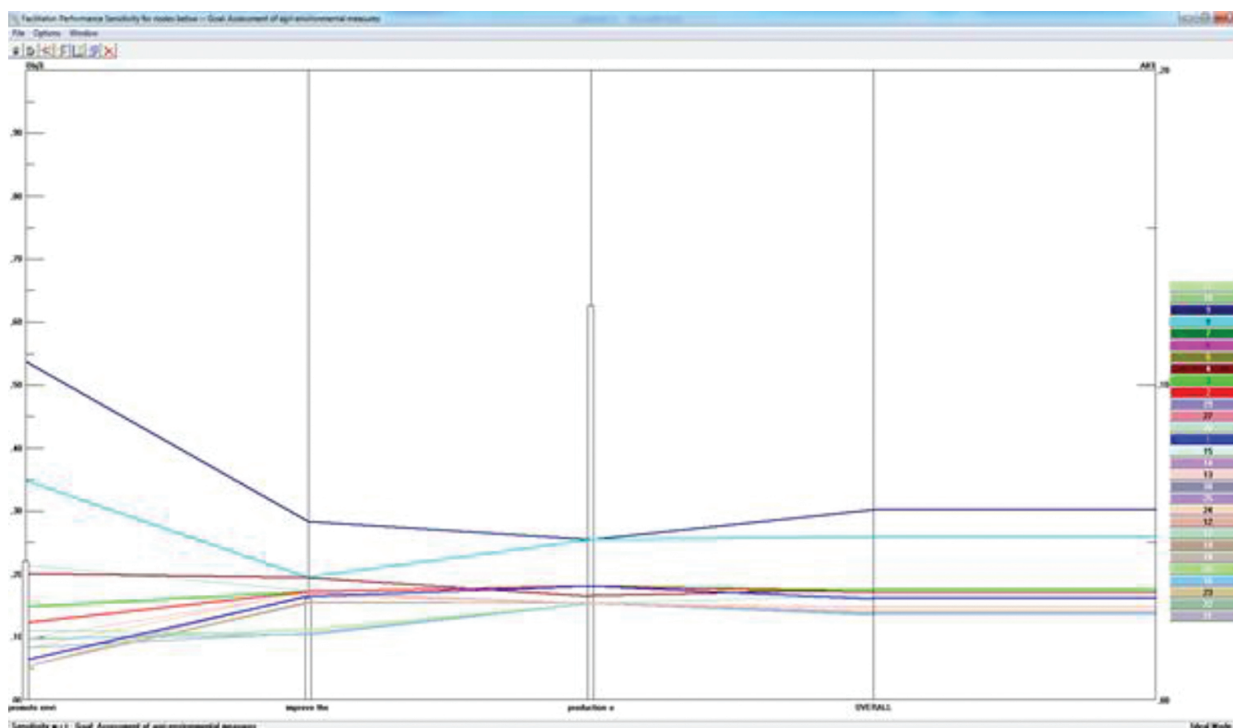
$$G = \sqrt[n]{x_1 x_2 \dots x_n}$$

where x represents each expert and n is the total number of experts. The results in this paper were obtained by aggregating the values of the individual pairwise comparisons at each level of the hierarchy. The values of the aggregated matrices were fed into the software programme Expert Choice™, which was programmed to implement AHP. Expert Choice™ calculated the criteria, subcriteria and alternative weights with respect to importance and the consistency index.

3. Results and discussion

The alternative priority weights with respect to the goal were calculated. The bigger the weight is, the more the measure is considered as important. Ranking the calculated priority weights with respect to the goal gave an insight into which AEM is considered important. Some rankings have more than one AEM, which indicates that the AEM for the particular ranking are considered to have the same importance. Weights of criteria show that production and economic consequences (0.425) are considered to make the most substantial influence on the assessment of AEM, followed by promotion of environmental friendly agricultural practices (0.333); improvement of rural areas to prevent their marginalization (0.241) is on third place. All three criteria are an integral part of the efforts towards improving the rural areas and the environment because they address different aspects of these efforts. The aggregated weights for the criteria and subcriteria of the group model are shown in **Figure 1**.

Further, the control of consistency was done by controlling the consistency index (CI) calculated by expert choice. The CI of 0 shows that the assessment results are consistent. The overall results (priorities) for each AE measure are shown in **Figure 2**.



Where:

- 9-organic fruit production
- 10-organic vine production
- 11-organic horticulture
- 8-organic crop production
- 4-integrated crop production
- 5-integrated fruit production
- 6-integrated vine production
- 7-integrated horticulture
- 3-greening of arable land
- 26-bird conservation in humid extensive meadows of Natura 2000 si...
- 27-permanent green cover in water protection areas
- 29-permanent green cover on fallow land
- 2-preservation of crop rotation
- 1-reduction of soil erosion in fruit and wine growing
- 13-mountain pastures without herdsman
- 14-mowing steep slopes with 30-50% inclination
- 15-mowing steep slopes with over 50% inclination
- 24-preservation of grassland habitats for butterflies
- 25-preservation of litter meadows
- 28-maintaining cultivated and populated landscape on protected areas
- 12-mountain pastures with herdsman
- 16-mowing humpy meadows
- 17-maintaining meadow orchards
- 18-rearing of indigenous and traditional domestic animal breeds
- 19-production of indigenous and traditional agricultural plant varieties
- 20-sustainable rearing of domestic animals
- 21-maintaining extensive grassland
- 22-maintaining animal husbandry in areas with large carnivores
- 23-preservation of special grassland habitats

Figure 3. Sensitivity analysis with an increased weight of production criteria.

The ranking shows that organic and integrated agricultural production practices make the best contribution to promote sustainable agriculture and protect the environment (Figure 3).

Permanent green cover on fallow land and greening of arable land are measures that contribute to reducing soil erosion and improving soil quality and fertility. Permanent green cover in water protection areas is vital to prevent the pollution of drinking water and its sources. Also considered as important is bird conservation in humid extensive meadows of Natura 2000 sites, which contributes to stopping the decline of biodiversity. Preserving and maintaining extensive meadows of Natura 2000 sites will not only secure natural habitats for birds, but also for other indigenous wild animals and plants. Almost equally important to promote environmental friendly agricultural production practices are stopping the decline of biodiversity, reduction in discharging chemicals into the environment and preventing pollution of drinking water and its sources. Improvement of the rural areas is best achieved by creating employment. Conservation of agricultural land is also an important factor to prevent the marginalisation of the countryside.

Stopping the decline of agricultural biodiversity through rearing of indigenous and traditional domestic animal breeds and production of indigenous and traditional agricultural plant varieties is also considered as important. These are key measures towards sustainable agricultural production and food security.

The importance of AEM for the individual criteria and attributes can be shown by synthesizing their priority weights at each node of the hierarchy levels. These values are seen in **Figure 3**. The sensitivity analysis, a test of the reaction of the agri-environmental measures to a change of the priority weight of the objectives, shows no significant changes in the overall ranking of importance of the measures.

By varying the priority weight of each objective, making it most important as shown in **Figure 3**, a slight change in the importance of the agri-environmental measures is only visible for each objective. **Figure 2** shows the highest overall performance in organic production. Integrated crop production, greening of arable land, and preservation of crop rotation are the next important measures.

The criteria weights are 33.3% for promoting environmental friendly agricultural practices, 24.1% for improving the rural areas to prevent marginalisation and 42.5% for production and economic consequences. The organic fruit and vine production and organic horticulture are the most important measures with 6.5% each, followed by organic crop production with 5.2%, integrated crop, fruit, vine production and integrated horticulture with 3.6% each. Bird conservation in humid extensive meadows of Natura 2000 sites, permanent green cover in water protection areas, and on fallow land and greening of arable land got 3.4% each. The preservation of crop rotation was allocated a weight of 3.3% and reduction of soil erosion in fruit and wine growing 3.0%. By changing the priority weight of the criteria: promote environmental friendly agricultural practices to 49.0%, organic fruit and vine production, organic horticulture kept their leading position as most important measures but their weights increased to 7.5% each, followed by organic crop production which also got a bigger weight of 5.6%; integrated crop, fruit, vine production and integrated horticulture each got 3.7%, a weight bigger than in primary assessment. Bird conservation in humid extensive meadows of Natura 2000 sites and permanent green cover in water protection areas and on fallow land each has a weight of 3.6%. Greening of arable land went down to 3.3%, whereas the preser-

vation of crop rotation reduced to 3.1% and reduction of soil erosion in fruit and wine growing to 2.6%.

By changing the weight and priority of the objective: improve the rural areas to prevent marginalisation to 49.0%, the ranking of the measures still stayed the same. Organic fruit and vine production, organic horticulture kept their leading position as most important measures, followed by organic crop production with 4.8%; integrated crop, fruit, vine production and integrated horticulture kept their weights of 3.7%. Bird conservation in humid extensive meadows of Natura 2000 sites, permanent green cover in water protection areas and on fallow land, greening of arable land and preservation of crop rotation each got a weight of 3.4%, reduction of soil erosion in fruit and wine growing 3.1%.

By changing the weight and priority of the objective: production and economic consequences to 49.0%, there was no significant change in the weights of the measures compared to Figure 6. Organic fruit and vine production, organic horticulture kept their leading position as most important measures with weights of 6.4% each, followed by organic crop production with 5.2%; integrated crop, fruit, vine production and integrated horticulture kept their weights of 3.6% each. Bird conservation in humid extensive meadows of Natura 2000 sites, permanent green cover in water protection areas and on fallow land show weights of 3.4% each, greening of arable land 3.5%, the preservation of crop rotation each 3.4% and reduction of soil erosion in fruit and wine growing 3.1%.

However, the organic fruit production is seen as the most important agri-environmental measure is specific for Slovenia because of its geographical features. Vrišer [56] states that in the census of the agricultural sector made in 2000, the proportion of Slovenia's total surface area of plains and low hills amounts to 36.4%, on which 54.5% of the utilised agricultural area is found, whereas on the karst regions that occupy about 25.3% of the total surface area, there is only 17.5% of utilised agricultural area, and in the high mountains (10.8%), only 3.5%. Vrišer also noted that 2.6% of the agricultural area was used for fruit production. In 2006, Sušnik et al. [57] still noted that fruit is grown on 2–3% of all agricultural land in Slovenia. This shows no increase in the fruit-growing area.

Despite limitations (particularly in the field of data acquisition), we found that the approach full field our expectations in the field of AEM assessment. The methodology results in precise AEM ranking with respect to defined criteria priorities. Furthermore, the group approach and priorities aggregation enable inclusion of the large number of experts relevant for the analysis.

4. Conclusion

The attempt in this paper was to show how AHP can successfully be employed in agriculture by assessing the role of agri-environmental measures to improve agriculture and the countryside. The goal, criteria and their attributes were compiled by the government of Slovenia. Arranging them in a hierarchy helped to analyse their interactions within the hierarchy and with respect to the main goal. The correct implementation of the necessary steps in AHP results

in very comprehensive data, which can be used to verify the goal. Very decisive for the data to be representative is its collection either by questionnaires, brain storming or discussions. Since the AHP process mostly involves a group of experts, stake holders or other persons affected, the collected data have to be compressed by building the geometric mean. In this example, it was successfully done. Though it is time consuming, it is the best way to take the different opinions involved in the assessment procedure into consideration. Compressing the data is necessary to be able to feed the information into the computer software programme Expert Choice™.

Instead of just using SWOT, a form of MCDA could have therefore been successfully used to evaluate the AEM. AHP could have combined different interests, expertise and opinions of all the government institutions involved. The employment of Expert Choice™ could have delivered reliable information. The results obtained in the assessment clearly show that organic and integrated production methods are seen to contribute most to achieving the set environmental goals and enhancing sustainable agricultural production. At the same time, measures that contribute to stopping the decline of biodiversity and preventing contamination of drinking water and its sources are also seen as an integral part of agricultural activities. However, the results generated by AHP do not end debates on further action regarding environmental friendly agricultural practices and policy. They are a good basis for further discussion.

Author details

Monica Huehner, Črtomir Rozman and Karmen Pažek*

*Address all correspondence to: karmen.pazek@um.si

Faculty of Agriculture and Life Science, University of Maribor, Maribor, Slovenia

References

- [1] Food and Agricultural Organisation: http://www.fao.org/farmingsystems/description_en.htm
- [2] Tamis W L M & Van den Brink W J: Conventional, integrated and organic winter wheat production in The Netherlands in the period 1993–1997. *Agriculture, Ecosystems and Environment*. 1999: 76: 47–59
- [3] Perpar A: Characteristics of rural areas in Slovenia: advantages, weaknesses and possibilities for improvement of present situation from viewpoint of sustainable rural development. *Journal of Central European Agriculture*. 2007: 8(2): 229–236

- [4] Erjavec E: EU accession effects and challenges for agriculture and agricultural policy in Slovenia. *Yearbook of the Austrian Society of Agricultural Economics*. 2005: 13: 1–18
- [5] Liu W, Wu W, Wang X, Wang M & Bao Y: A sustainability assessment of a high yield agro ecosystem in Huantai County, China. *International Journal of Sustainable Development & World Ecology*. 2007: 14: 565–573
- [6] Luzar E J & Diagne A: Participation in the next generation of agriculture conservation programs: the role of environmental attitudes. *Journal of Socio-Economics*. 1999: 28: 335–349
- [7] Ho G, Dallas S, Anda M & Kuruvilla M: Renewable energy in the context of environmentally sound technologies – training and research programmes at the Environmental Technology Centre, Murdoch University. *Renewable Energy*. 2001: 22: 105–112
- [8] Zbinden S & Lee D R: Paying for environmental services: an analysis of participation in Costa Rica's PSA program. *World Development*. 2005: 33(2): 255–272
- [9] Nachtnebel H P: The Danube river basin environmental programme: plans and actions for a basin wide approach. *Water Policy*. 2000: 2: 113–129
- [10] Abaza H: UNEP/World Bank workshop on environmental impacts of structural adjustment programmes. *Ecological Economics*. 1995: 14(1): 1–5
- [11] European Commission, EC: Directorate General for Agriculture and Rural development, Unit G-4 – Evaluation of Measures Applied to Agriculture. *Studies*. 2005: March 2005
- [12] Petersen J E: International conference on EU-CAP and enlargement-an opportunity for nature and environment? 2003. Potsdam, Germany
- [13] Van Ittersum M K, Ewert F, Heckelei T, Wery J, Alkan Olsson J, Andersen E, Bezlepkina I, Brouwer F, Donatelli M, Flichman G, Olsson L, Rizzoli A E, Van der Wal T, Wien J E & Wolf J: Integrated assessment of agricultural systems – a component-based framework for the European Union (SEAMLESS). *Agricultural Systems*. 2008: 96: 150–165
- [14] University of Ljubljana, Faculty of Biotechnics and Orbicon (DK). 2006. Annex 16, Ex ante evaluation of the Rural Development Programme of the Republic of Slovenia 2007–2013.
- [15] Cunder T: Reform of the Rural Development Policy in Slovenia – challenges and dilemmas. 2003: 13. *Tagung der Oesterreichischen Gesellschaft für Agrarökonomie*
- [16] Cunder T: The role of rural development policy in environmental and land management in Slovenia. 2006: 1st International Conference on Agriculture and Rural Development in Topusko, Croatia
- [17] Cunder T: The role of rural development policy in environmental and agricultural management in Slovenia. *Journal of Central European Agriculture*. 2008: 8(2): 237–242

- [18] Pažek K, Rozman Č, Borec A, Turk J, Majkovič D, Bavec M & Bavec F: The use of multi criteria models for decision support on organic farms. *Biological Agriculture and Horticulture*. 2006: 24: 73–89
- [19] Rossi G, Cancelliere A & Giuliano G: Case study: multicriteria assessment of drought mitigation measures. *Journal of Water Resources Planning and Management*. 2005: 131(6): 449–457
- [20] Rozman Č & Pažek K: Application of computer supported multi-criteria decision models in agriculture. *Agriculturae Conspectus Scientificus*. 2005: 70(4): 127–134
- [21] DCLG: Multi-criteria analysis: a manual. Department for Communities and Local Government: London. 2009: 168pp
- [22] Romero C & Rehman T: Multiple criteria analysis for agricultural decisions. Elsevier: Amsterdam. 2003.
- [23] Madlener R, Henggeler C A & Dias L C: Multi-criteria versus data envelopment analysis for assessing the performance of biogas plants. 19th Mini EURO Conference on Operational Research Models and Methods in the Energy Sector (ORMMES'06). 2006. Coimbra, Portugal
- [24] Nixon R & Oliveira P: Benefit-risk of multiple sclerosis treatments: lessons learnt in multi-criteria decision analysis. 2011. BBS Spring Conference Comparative Quantitative Assessments: Benefit-Risk & Effectiveness, New York, USA.
- [25] Thokala P: Multiple criteria decision analysis for health technology assessment. Report. 2011. School of Health and Related Research, University of Sheffield, Sheffield, England.
- [26] Ferrarini A, Bodini A & Becchi M: Environmental quality and sustainability in the province of Reggio Emilia (Italy): using multi-criteria analysis to assess and compare municipal performance. *Journal of Environmental Management*. 2001: 63: 117–131
- [27] Gómez-Limón J A, Riesgo L & Arriaza M: Multi-criteria analysis of input use in agriculture. *Journal of Agricultural Economics*. 2004: 55(3): 541–564
- [28] Hellstrand S: A multi-criteria analysis of sustainability effects of increasing concentrate intensity in Swedish milk production 1989–1999. *Environment, Development and Sustainability*. 2006: 8: 351–373
- [29] Solomon D S & Hughey K F D: A proposed multi criteria analysis decision support tool for international environmental policy issues: a pilot application to emissions control in the international aviation sector. *Environmental Science and Policy*. 2007: 10: 645–653
- [30] Tsoutsos T, Drandaki M, Frantzeskaki N, Iosifidis E & Kiosses I: Sustainable energy planning by using multi-criteria analysis application in the island of Crete. *Energy Policy*. 2009: 37: 1587–1600

- [31] Nikolić D, Milošević N, Mihajlović I, Živković Ž, Tasić V, Kovačević R & Petrović N: Multi-criteria analysis of air pollution with SO₂ and PM₁₀ in urban area around the copper smelter in Bor, Serbia. *Water, Air and Soil Pollution*. 2010: 206: 369–383
- [32] Nikolić D, Milošević N, Živković Ž, Mihajlović I, Kovačević R & Petrović N: Multi-criteria analysis of soil pollution by heavy metals in the vicinity of the copper smelting plant in Bor (Serbia). *Journal of the Serbian Chemical Society*. 2011: 76(4): 625–641
- [33] Al-Hadu I A R, Sidek L M, Nor M, Desa M & Basri N E A: Multi criteria analysis in environmental management: selecting the best storm water erosion and sediment control measure in Malaysian construction sites. *International Journal of Energy and Environment*. 2011: 2(5): 853–862
- [34] Payraudeau S & Gregoire C: Modelling pesticides transfer to surface water at the catchment scale: a multi-criteria analysis. *Agronomy for Sustainable Development*. 2012: 32: 479–500
- [35] Pillai C R S & Raju K S: Ranking irrigation management alternatives by multicriterion analysis. *Water Resources Development*. 1996: 12(3): 329–345
- [36] Tiwari D N, Loof R & Paudyal G N: Environmental-economic decision-making in lowland irrigated agriculture using multi-criteria analysis techniques. *Agricultural Systems*. 1999: 60: 99–112
- [37] Ni Y R & Li Y K: Approach to soil erosion assessment in terms of land-use structure changes. *Journal of Soil and Water Conservation*. 2003: 58 (3): 158–169
- [38] Tran T X M, Malano H M & Thompson R G: Application of the analytic hierarchy process to prioritise irrigation asset renewals. A case of the La Khe irrigation scheme in Vietnam. *Engineering, Construction and Architectural Management*. 2003: 10(6): 382–390
- [39] Srdjevic B & Medeiros D P Y: Fuzzy AHP assessment of water management plans. *Water Resource Management*. 2008: 22: 877–894
- [40] Braunschweig T. & Becker B: Choosing research priorities by using the analytic hierarchy process: an application to international agriculture. *R&D Management*. 2004: 34(1): 77–86
- [41] Rezaei-Moghaddam K & Karami E: A multiple criteria evaluation of sustainable agricultural development models using AHP. *Environment, Development and Sustainability*. 2008: 10: 407–426
- [42] Ziolkowska J: Evaluation of agri-environmental measures: analytic hierarchy process and cost-effectiveness analysis for political decision making support. *International Journal of Rural Management*. 2008a: 4(1&2): 1–24

- [43] Ziolkowska J: Designing agri-environmental measures for maximal environmental benefit: linear programming for Poland. *Economic and Rural Development*. 2008b: 4(2): 35–44
- [44] Mortazavi M, Ghanbari L, Rajabbeigi M & Mokhtari H: Prioritizing agricultural research projects with emphasis on analytic hierarchy process (AHP). 2009. EFITA Conference, Wageningen, The Netherlands.
- [45] Vindiš P, Muršec B, Rozman Č, Čuš F: A multi-criteria assessment of energy crops for biogas production. *Journal of Mechanical Engineering*. 2010: 56(1): 63–70
- [46] Saaty T L: *The analytic hierarchy process*. RWS Publications: 1990
- [47] Meixner O & Haas R: *Computergestützte Entscheidungsfindung*. 2002. Wirtschaftsverlag Ueberreuter
- [48] Rozman Č, Potočnik M, Pažek K, Borec A, Majkovič D & Bohanec M: A multicriteria assessment of tourist farm service quality. *Tourism Management*. 2009: 30: 629–637
- [49] Saaty T L & Vargas L G: *Models, methods, concepts & applications of the analytic hierarchy process*. Kluwer Academic Publishers, Boston: 2001
- [50] Parr J F, Papendick R I, Hornick S B & Meyer R E: Soil quality: attributes and relationship to alternative and sustainable agriculture. *American Journal of Alternative Agriculture*. 1992: 7: 5–11
- [51] Latacz-Lohmann U & Hodge I: European agri-environmental policy for the 21st century. *The Australian Journal of Agricultural and Resource Economics*. 2003: 47(1): 123–139
- [52] European Commission, EC: Directorate-General for Employment, Social Affairs and Equal Opportunities. Unit E2. Poverty and Social Exclusion in Rural Areas. Report. 2008: September 2008
- [53] Northoff E: Loss of domestic animal breeds alarming. 2004. <http://www.fao.org/newsroom/en/news/2004/39892/index.html> (20.3.2015)
- [54] Baum S: Socio-economic, demographic, and agricultural patterns of rural areas in the new Member States. 2008: Research Project Structural Change in Agriculture in Rural Livelihood “SCARLED” SSPE-CT-2006-044201, IAMO, Germany.
- [55] Möllers J, Fritzsich J & Buchenrieder G: Farm and non-farm incomes of rural households in Slovenia. Canonical correlation analysis. *South East European Journal of Economics and Business*. 2008: 3(2): 39–48
- [56] Vrišer I: Agricultural Production in the Republic of Slovenia according to the census of the agricultural sector 2000. *Geografski Zbornik*. 2002: XLII: 1–60
- [57] Sušnik A, Matajč I & Kodri I: Agrometeorological support of fruit production: application in SW Slovenia. *Meteorological Applications (Supplement)*. 2006: 13(S1): 81–86

- [58] Garfi M, Ferrer-Martí L, Bonoli A & Tondelli S: Multi-criteria analysis for improving strategic environmental assessment of water programmes. A case study in semi-arid region of Brazil. *Journal of Environmental Management*. 2001: 92: 665–675

IntechOpen

IntechOpen