# An assessment of improving the sustainable agro-touristic offer in an emerging country using the integrative approach based on fuzzy logic

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Adis Puška
Government of the Brcko District of BiH


Miroslav Nedeljkovic
Institute of Agricultural Economics


Marko Jelocnik
Institute of Agricultural Economics Belgrade


Jonel Subic
Institute of Agricultural Economics, Belgrade, Serbia

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EDITED BY
Qingsong He,
Huazhong University of Science and Technology, China

REVIEWED BY
Simona R. Gradinaru,
University of Bucharest, Romania
Harsuko Riniwati,
University of Brawijaya, Indonesia

*CORRESPONDENCE
Dumitru Nancu,
dumitru.nancu@gmail.com
Jean Vasile Andrei,
andrei_jeanvasile@yahoo.com

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# An assessment of improving the sustainable agro-touristic offer in an emerging country using the integrative approach based on fuzzy logic

Adis Puška[1], Miroslav Nedeljković[1], Marko Jeločnik[2], Jonel Subić[2], Dumitru Nancu[3]* and Jean Vasile Andrei[4]*

[1]Faculty of Agriculture, Bijeljina University, Bijeljina, Bosnia and Herzegovina, [2]Institute of Agricultural Economics, Belgrade, Serbia, [3]Doctoral School Economics II, The Bucharest University of Economic Studies, Bucharest, Romania, [4]Faculty of Economic Sciences, Petroleum-Gas University of Ploiesti, Ploiesti, Romania

The process of improving tourism requires prior determination of the existing offer, as well as assessment of the advantages and weaknesses of the given offer. Upon the analysis, it is possible to improve the tourist offer. This study examined ways in which agro-tourism can be improved, related to the foundation of sustainability. Methodologically, this article involves the use of expert assessment, additionally supported with fuzzy logic based on the fuzzy PIPRECIA and fuzzy MARCOS methods. Using the fuzzy PIPRECIA method, the criteria and sub-criteria were weighted, while the observed agro-tourism facilities in Bosnia and Herzegovina (BiH) were ranked according to the applied fuzzy MARCOS method. The results of the application of the fuzzy PIPRECIA method showed that for experts the most important are economic criteria, then environmental, and the latter important are social criteria. The most important sub-criterion is the quality of services. Out of the six facilities in question, the most appropriate results are achieved at the "Šadrvan" rural household, while the worst outcome is exhibited at the agro-tourism facility, (rural household) "Kovačević." Sensitivity analysis confirmed these results. The aim of this article was to evaluate the agritourism offer in BiH, taking into consideration these six agritourism facilities. Based on that, it is necessary to determine on what advantages to build agritourism in BiH, and what should be corrected in order to be more competitive. Based on the obtained results, the facilities management should determine which sustainability criteria would need to be improved, as well as on which criteria it is desirable to build a competitive advantage, aiming to advance the tourist offer.

KEYWORDS

**agro-tourism, fuzzy logic, fuzzy PIPRECIA, fuzzy MARCOS method, sensitivity analysis**

## Introduction

The most of European countries see their chance in the fight against poverty in emphasis of the sustainability of rural areas (Ciolac et al., 2019). The stability of the development of rural areas is realized by applying the principles of sustainability. The emphasis of sustainability is on the application of the values and principles that aim to direct human activities in a liable and coordinated way, considering the ecological and social aftereffects, as like the economic purpose of business (Tseng et al., 2019). The application of the sustainability concept in tourism implies the presence of economic, environmental, and social dimension (Prevolšek et al., 2020) as the primary criteria of sustainability.

As a concept, business sustainability has its application in various economic activities and is very noticeable in tourism. Sustainable tourism, which is applied in many rural areas, could represent the good alternative to exotic touristic destinations abroad (Sanagustin Fons et al., 2011).

During the last couple decades, tourism globally changes its role from "just" one segment of the local economy to one of the key factors of local economic development (development driven by the tourism). Current trends show the building of strong and widely recognized tourist brands (creation of destinations' image as highly desirable touristic ambient) that will be fully competitive within the targeted market segment (Rabrenović, 2018). Sustainability linked to tourism is usually framed by its large share in created GDP, role of significant employer and provider of silent exporter, influence to balanced regional development, and attraction of FDI (Jeločnik et al., 2013).

On the other hand, agriculture is characterized by instability and unpredictability (Rozman et al., 2009) because the success of agriculture is influenced by many factors that cannot be predicted, such as weather conditions. In addition to the traditional activities in rural territories, farmers are diversifying their activities and introducing the possibility of tourists' visits to the farms (Villanueva Álvaro et al., 2017). Doing this, farmers affect the development of agro-tourism, which represents a way to strengthen the competitiveness of rural areas (Puška et al., 2020a). Therefore, the presence of tourism in rural areas has effect on the development of given areas, and in order to achieve their development, it is necessary for tourism to be based on the consistent application of the sustainability concept (Weaver, 2014). Agro-tourism represents an alternative, which is interesting to tourists who want to get involved in the implementation of the sustainability of tourist areas (Villanueva Álvaro et al., 2017), as the basis of the tourist offer. During the global pandemic affected by the COVID-19 (since the end of 2019 and throughout 2020), tourists had limited access to tourist destinations abroad, so they are largely focusing on national touristic destinations and facilities, while tourism in rural areas is experiencing a boom.

Agritourism is realized in rural areas and as such belongs to the form of rural tourism, but it is not the only one performed in rural areas. There are two conceptions in the literature that agritourism is actually rural tourism and that there is a difference between these two concepts (Puška et al., 2020a). However, agritourism includes farms, nurseries, and orchards in the tourist offer, and on that occasion the agricultural potentials of these areas are used. It can be said that there are similarities between rural tourism and agritourism, but there are also differences, thus agritourism should not be equated with rural tourism. The World Tourism Organization claims that over the ¾ of the global touristic demand is focused to natural areas. Although it is not precisely specified what share belongs to rural territories (Vukovic et al., 2016), it could be assumed that rural tourism and its varieties possess huge potential. Some estimations show that share of rural tourism ranges from 12 to 30% of the worldwide tourist flow. Over the last 2 decades its annual growth rate (10–15%) over-sizes the growth rate of the entire European tourism product (4–5%), (Ivolga and Shakhramanian, 2019).

As (Jeločnik et al., 2018) argues the rural tourism is often perceived as a vacation in generally driven by the tourists' aspiration to closely "taste" the certain countryside, available nature, local heritage, tradition, and way of living. It is usually focused to rural settlements. Deeply reconsidered, it could be directly linked to on-farm activities and accommodation offered by the farmer (Jeločnik et al., 2018). Agro-tourism considers the connection of agricultural activities with the tourist offer, when integrated services are provided on farms. Agro-tourism is described as a specific experience that provides tourists with rest and acquaintance with traditional heritage, natural, historical, and cultural sights, and with the possibility of active participation in the implementation of agricultural activities on the farm (Žunić, 2011).

Agro-tourism is linked to the activities that are exercised on farm estate and includes the possibility of active participation of tourists in their implementation. Regarded in such manner, it represents a form of sustainable touristic development of rural areas. Tourists are offered opportunities to get acquainted with the local tradition, customs, and culture, which points to the social aspect of agro-tourism. The environmental aspect of agro-tourism is contained in the introduction to local natural resources, and the tourist offer is based on a serene and intact environment. Tourists are offered local products and visits to various facilities within the area, which realizes the economic aspects of agro-tourism. Based on the aforementioned points, the assessment of the agro-tourism offer must take into account the social, economic, and environmental aspect that a certain facility has at its disposal (Lun et al., 2016) in function of agro-tourism.

Agro-tourism could be considered as a component of farm economic sustainability that derives from the fact that among the other profitable activities linked to the certain farm (such are selling of agri-food products and agro-services, fishery, forestry, and selling of the timber and handicrafts), agro-touristic offer might also appear (Subić et al., 2015). As (Privitera, 2010) highlights many contemporary farmers has extended the basically farm activities to agro-tourism activities as a supplementary income source and new entrepreneurial possibilities to value the agricultural potential. In this context, as it already argued by (Privitera, 2010), they find several benefits in implementing agro-tourism, such as strengthening of farm stability and initiation of overall economic impact to local rural community (primarily by affecting the local unemployment and fulfilling the local budget), promoting the educational and certification programs that will engage the young people to farming and nature (Privitera, 2010).

In Bosnia and Herzegovina (BiH), it is being progressively invested in the improvement of the agro-tourism offer (Puška et al., 2020a). On the other hand, the offer is still quite scarce and should be subjected to more intensive development. A good example is either Italy, where over 23,000 farms offer agro-tourism services, which have effect on the generation of income of more than a billion euros per year on these farms (Palmi and Lezzi, 2020), or Poland, where in 2016 agro-tourism services were provided on more of 8,200 farms (Roman et al., 2020). Compared to these countries, agro-tourism in BiH is in its infancy. On the other hand, understanding the farms in BiH, before all those one involved in agro-tourism, as some kind of SMEs active in rural areas, it should be noticed that although they are among the key factors responsible for rural areas development, they are also affected by the lack of local population and its unfavorable age and educational structure, making the rural territories less attractive for living and entrepreneurial ventures (Zubović et al., 2019).

The main goal of this study is to evaluate the agro-tourism offer in BiH. The research would realize the capacity of the current agro-tourism offer in BiH from the perspective of sustainability, determine its pros and cons, and then give certain recommendations for the viable development of observed sub-sector. Research outcomes are both in function of improving the current offer, and directing new providers of agro-tourism services toward the elements of sustainable development that would strengthen rural areas in BiH. The research should provide answers to the following questions:

1) What are the available capacities of the current offer of sustainable agro-tourism in BiH?
2) What should the observed capacities in agro-tourism adjust in order to improve their business?
3) On what basis should the future agro-tourism offer in BiH be developed?

# Literature review

An intensive review of the available literature identified theoretical gaps, so an overview of existing analytical methods and possible evaluation attributes is given.

## Sustainable agro-tourism

Agro-tourism represents a diverse offer of carrying out agricultural activities, most often on small- and medium-sized farms (Giaccio et al., 2018). Agro-tourism is not such a new phenomenon in the global tourist offer, as this category has been practiced since the beginning of the XX century (Gil Arroyo et al., 2013). Agro-tourism has taken advantage of the diversity of agricultural activities carried out on the farm by adapting them to the requirements of tourists. Agro-tourism is the integration of agriculture and tourism. It is representative, but not the only form of rural tourism, that is, tourism that occurs within the rural areas (Puška et al., 2020a). Agro-tourism is a form of multifunctionality in the agriculture, which presupposes the preservation of rural landscapes and biodiversity, whereby has an effect on the strengthening of employment and provides sustainability to rural territories (Palmi and Lezzi, 2020). The idea of agro-multifunctionality deeply involves rural development and agroecology, using thus agriculture as a generator of rural economy and local community development (Lopez i Gelats et al., 2015). Farmers use this multifunctionality in order to make full integration of farm revenues and to boost tourist awareness of the role of agriculture in preserving the available environment, natural resources, cultural heritage, traditions and customs, and local identity within the rural territories (Giaccio et al., 2018; Puška et al., 2020a). In any case, agro-tourism is a multilayered and highly differentiated issue that is usually impacted by the characteristics of certain rural territory and used the mechanism that links the offered tourism products with available local resources (Mastronardi et al., 2015).

Likewise, agro-tourism provides different recreational activities and tourist services, both on and off the farms, either during the season or throughout the entire year (Roman et al., 2020). It uses the available natural resources of the farms and rural areas, and through social interaction transforms them into a unique tourist offer, creating certain economic benefits. Although the original definition of sustainability is quite broad, it primarily implies three aspects: socio-cultural, environmental, and economic sustainability (Valdivia and Barbieri, 2014). In recent decades, with aim to grow and develop independently, agro-tourism has given priority to sustainability, rounding off all three dimensions of sustainability of farms and rural communities into a single plane (Tseng et al., 2019; Adamov et al., 2020). Therefore, the basic preconditions of sustainable development of agro-tourism are the attractiveness of rural areas through synergetic action and optimal use of the available natural, social, and economic factors (Ammirato and Felicetti, 2014; Roman et al., 2020).

Essentially, the agro-tourism service is focused on three key characteristics, the active stay of tourists on the farm, their contact with agriculture, and the level of previous experience of tourists with carrying out the activities on the farm (Phillip et al., 2010). Tourists stay on the farm for relaxation, enjoyment, educational effect, and active participation in the work process (Puška et al., 2020a). Through social contact with the farmer, tourists deepen their knowledge, and through active participation in daily work, a sort of occupational therapy, they directly influence the economic strengthening of the given farm. Agro-tourism is among the rare features of non-agricultural activities that initiates the progress of agriculture (Roman et al., 2020).

Tourism development should be based on the principles of sustainability (Prevolšek et al., 2020). Sustainable tourism implies the establishment of a relationship between tourism, environmental protection, and economic interests (Županović and Krivokapić, 2020). Agritourism needs to be implemented by respecting the pillars of sustainability. They are economic, social, and environmental factors. When applying agritourism, it is necessary to take advantage of the ecological conditions that prevail in rural areas. Moreover, the population of these areas should be included as much as possible in its implementation. Agritourism has the potential for sustainability, but this needs to be further emphasized in this type of tourism. By applying the principle of sustainability, agritourism is used to promote sustainable development, local culture and customs and not only for the economic affects that will be obtained from the application of this type of tourism (Puška et al., 2020a). The development of sustainable agritourism in a certain area should not be viewed individually but within the subsystem of overall sustainable development of the country (Županović and Vulević, 2019). Sustainability should therefore be applied in all types of tourism and not only in agritourism in order to achieve certain tourism developments in a country.

# Methodology

## Initial methodological assumptions

The evaluation of the current agro-tourism offer in BiH would be carried out with the help of expert assessment. In this way, the knowledge and skills of available human capital would be best used to assess agro-tourism capacities in BiH. The assessment would provide a basis for deriving recommendations for improving the existing agro-tourism offer for all interested parties. The methodological framework for evaluating the sustainability of agro-tourism presupposed the application of an innovative and extended assessment of a fuzzy logic model. Precisely, an integrated new hybrid approach bases on the two fuzzy methods: PIPRECIA method (PIvot Pairwise RElative Criteria Importance Assessment) and MARCOS method (Measurement of Alternatives and Ranking according to COmpromise Solution) were proposed and applied. In this process the calculus for the fuzzy PIPRECIA and fuzzy MARCOS methods were integrated and performed via the Microsoft Excel spreadsheet program. Thus, this methodology extends and develops an integrated planning approach of using the fuzzy logic based on applying the hybrid PIPRECIA and MARCOS methods as in (Puška et al., 2021a) for improving the sustainable agro-touristic offer in Bosnia and Herzegovina. Thus, this methodology extends and develops an integrated planning approach of using the fuzzy logic based on applying the hybrid PIPRECIA and MARCOS methods as in (Puška et al., 2021a) for improving the sustainable agro-touristic offer in Bosnia and Herzegovina. By the use of a fuzzy approach and linguistic values, the assessment would be closer to the human way of thinking.

From the methodological approach perspective, the research and its nearing to human thinking was relied to the use of fuzzy logic, specifically the fuzzy PIPRECIA and fuzzy MARCOS methods. By integrating these methods, the assessment of the existing agro-tourism offer on randomly selected accommodation capacities was performed. The methodological framework of the assessment was applied over the four phases (Table 1).

The initial phase of the research includes the definition of the subject and goal of the research (presented in the introductory notes of this article). Research in relation to this article was conducted during the period August–September 2020. As the aim of the study was to evaluate the agro-tourism offer of BiH, which requires an expert assessment, three participants with different expertise were selected in the expert group (two experts with background in rural development and one in tourism). All experts possess a long-term experience verified through participation in various rural tourism development projects. It was planned to include more experts in the research, but due to the pandemic caused by the COVID-19 virus, three experts were included who were able to visit these destinations. Together with the experts, a selection of criteria for assessing the sustainability of agro-tourism facilities was made (Table 2), and according to the aspects of sustainability, the criteria were grouped around the economic, environmental, and social impacts. Subsequently, in order to even out the selected criteria by importance, they were assigned the same number of sub-criteria (six sub-criteria each).

Afterward alternatives, that is, farms focused on agro-tourism, were expertly selected, which were evaluated by the use of selected criteria (six farms were selected), and based on which an assessment of the current state of sustainability of agro-tourism offer in BiH was given. It should be noted that the non-existence of a single register of agro-tourism capacities in BiH conditioned the formation of a primary set, which was based on the register of agro-tourism facilities found on the websites *alterural.ba* and *bhselo.ba*, which are tools for the promotion of villages and tourism in BiH. The primary set consisted of 27 rural households that also provide tourist services. The facilities were at first listed alphabetically, and a sample of six facilities was subsequently selected using a random number generator. These facilities are: agro-tourism Matuško (A1), rural household Čardaklije (A2), rural household Ibrišimović

TABLE 1 Methodological framework.

| | |
|---|---|
| Phase 1: initial phase | Defining the subject and goal of the research<br>Forming an expert group<br>Defining alternatives and criteria<br>Forming questionnaire<br>Collecting data from experts |
| Phase 2: setting the weight of the criteria | Evaluating criteria in relation to the first criterion<br>Evaluating criteria in relation to the last criterion<br>Calculating values of mean criteria and sub-criteria<br>Implementing fuzzy PIPRECIA method<br>Determining the weight of criteria and sub-criteria<br>Determining the final values of the sub-criteria |
| Phase 3: ranking the agro-tourism facilities | Establishing the initial decision matrix<br>Expanding the initial decision matrix<br>Normalizing the initial decision matrix<br>Weighting the normalized decision matrix<br>Implementing the other steps of the fuzzy MARCOS method<br>Ranking alternatives |
| Phase 4: conducting sensitivity analysis | Ranking by other fuzzy methods<br>Comparing rankings performed by other fuzzy methods<br>Scenario and weight forming for sub-criteria<br>Ranking alternatives for each scenario<br>Analyzing the gained results |

Source: Developed by the authors.

(A3), rural household Kovačević (A4), rural tourism Ziličina (A5), and rural household Šadrvan (A6) (Figure 1).

Upon definition of the criteria and alternatives, an adequate questionnaire was developed as well, which consisted of two parts, and were given to the experts to fill them in. The first part of the questionnaire was in the function of determining the weight of the main criteria of the model. As the fuzzy PIPRECIA method is used for this purpose, the experts evaluated the primary and sub-criteria, according to the first–last criterion method. The weight of the expertise lies in the subjective decision whether the (sub) criteria are better or worse than the first or last criterion. The second part of the questionnaire was in the function of evaluating alternatives with defined sub-criteria. As six sub-criteria for each of the primary criteria were included in the research, the evaluation of alternatives was based on the sum of 18 sub-criteria. The expert assigned a certain linguistic value to each alternative, according to an individual sub-criterion. Experts looked at alternatives based on sustainability criteria and gave each one of them certain ratings from very bad (VB) to very good (VG), depending on how they applied sustainability in their business. Through the second phase of the research, the weight of individual criteria and sub-criteria was determined. Upon the evaluation of the criteria, their value was determined by the fuzzy scale. Then, as the research included three experts, the mean values for each criterion were calculated to give each expert equal importance in decision-making. This was followed by the application of the fuzzy PIPRECIA method, in which the weights of the main and auxiliary criteria were calculated. The final weights were obtained by the product of the weights of the main and auxiliary criteria.

The third phase of the research assumed the ranking of agro-tourist facilities/capacities. The phase was initiated by forming of an initial decision matrix based on expert responses. Experts rated each facility with a linguistic value, ranging from very bad (VB) to very good (VG), by the use of seven degrees scale. Upon collection of the linguistic values, they were transformed into the corresponding fuzzy numbers, determined by the membership function of the fuzzy number (Table 3). Afterward, the mean values of fuzzy numbers were calculated, which harmonized the views of experts for individual agro-tourism capacities. This is how the initial decision matrix was formed, which was subsequently expanded, normalized, and weighted. The process of weighting of the normalized decision matrix is carried out by multiplying the normalized values with the appropriate weights for individual sub-criteria. This activity is followed by the steps of the fuzzy MARCOS method, that is, ranking of alternatives.

As like in some previous research (Puška et al., 2021), the fourth phase involves the sensitivity analysis je provedena evaluacijom rezultata I poređenjem sa rezultatima dobivenim drugim metodama te provođenjem 19 scenarija.

## Fuzzy logic and operations on fuzzy numbers

Classical logic is applicable only in working with accurate and complete information. If we have inaccurate or incomplete information, fuzzy logic is used, in which it is first necessary to determine the membership function $\mu_{\tilde{A}}(x)$ (Stojić et al., 2018). The membership function shows how

TABLE 2 Decision criteria.

| Id | Criteria | Definition | Source |
|---|---|---|---|
| C1 | Economic criteria | | |
| C11 | Price of tourist services and products | Monetary expression of the value of services and products | (Pulido Fernandez and Lopez Sanchez, 2016; Buiga et al., 2017; He et al., 2019) |
| C12 | Quality of services | Manner in which the service characteristic meets customer requirements | (Johann and Anastassova, 2014; Razniak, 2014; Zhang et al., 2019) |
| C13 | Attractiveness of services for tourists | Attraction of the service to the tourists | (Lee, 2016; Romao et al., 2018; Puška et al., 2019) |
| C14 | Traffic connectivity | Farm traffic connectivity | (Bandoi et al., 2008; Lee, 2016; Hopkins, 2020) |
| C15 | Accommodation facilities | Total number of tourists that can be accommodated on the farm | (Warren et al., 2017; Spenceley, 2019) |
| C16 | Gastronomic offer | Totality of food and beverages offered on the farm | (Wang, 2015; Zhang et al., 2019; Puška et al., 2020a) |
| C2 | Environmental criteria | | |
| C21 | Geographical characteristics | A set of all geographical features on the farm site | (Jovicic, 2019; Muresan et al., 2019) |
| C22 | Availability of natural resources | Availability of natural resources on the farm and its surroundings | [38, 33)] |
| C23 | Quality of natural resources | Level of preservation of the natural environment on the site of the farm | (Muresan et al., 2019; Prevolšek et al., 2020) |
| C24 | Cleanliness and organization | Maintaining hygiene and organization of the farm | (Rozman et al., 2009; Lee, 2016; Puška et al., 2020a) |
| C25 | Landscape | Specificity of the territory at which the farm is located | (Rozman et al., 2009; Prevolšek et al., 2020) |
| C26 | Diversity of agricultural resources | Availability of agricultural products (fruits, vegetables, forests, meadows, *etc.*) | (Muresan et al., 2019; Zhang et al., 2019) |
| C3 | Social criteria | | |
| C31 | Offer of domestic products | Possibility of offering domestic products to tourists | (Razniak, 2014; Prevolšek et al., 2020) |
| C32 | Transfer of knowledge related to tradition and customs | Possibility of transferring knowledge about the customs and traditions of the rural area where the farm is located | (Muresan et al., 2019; Zhang et al., 2019) |
| C33 | Availability of events | Organization of the events at the farm site or in the immediate vicinity | (Lawton and Weaver, 2015; Puška et al., 2020a; Prevolšek et al., 2020) |
| C34 | Participation of tourists | Possibility for tourists to participate in everyday activities on the farm | (Lee, 2016; Puška et al., 2020a; Prevolšek et al., 2020) |
| C35 | Availability of tourist attractions | Availability of tourist attractions on the farm site or in the immediate vicinity | (Lee, 2016; Romao et al., 2018; Muresan et al., 2019) |
| C36 | Impact on community development | Contribution of farm to the development of the local community | (Bandoi et al., 2008; Romao et al., 2018; Prevolšek et al., 2020) |

Source: Developed by the authors.

much an individual element fulfills the condition of belonging to set A (Klement and Mesiar, 2018). In classical logic, the membership function $\mu_{\tilde{A}}(x)$ can take only two values, one and zero, while in fuzzy logic it can take any value in the interval from zero to one (Chatterjee et al., 2019). Therefore, if the statement has "more truth" it will to a greater extent meet the conditions of belonging to set A, that is, 0≤ $\mu_{\tilde{A}}(x)$ ≤1 will be valid for each element from set A. The application of fuzzy logic in practice is often called fuzzification. The commonly used form of triangular fuzzy numbers is visible in next figure (Figure 1 and Figure 2).

Mentioned numbers take the form T ($m_1$, $m_2$, $m_3$) (Zhang et al., 2013). First and third values ($m_1$ or $m_3$) reflect the left or right distribution of the confidence interval of fuzzy number T, while second value ($m_2$) points the spot where the fuzzy number membership function reaches the maximum, that is, equals to 1 (Božanić et al., 2016; Chatterjee et al., 2019).

Over two fuzzy sets $A_1^I = (m_1, m_2, m_3)$ and $A_2^I = (n_1, n_2, n_3)$, it is possible to perform basic mathematical operations (Vesković et al., 2020):

Addition:

$$A_1^I + A_2^I = (m_1, m_2, m_3) + (n_1, n_2, n_3) = (m_1 + n_1, m_2 + n_2, m_3 + n_3). \tag{1}$$

Subtraction:

$$A_1^I - A_2^I = (m_1, m_2, m_3) - (n_1, n_2, n_3) = (m_1 - n_1, m_2 - n_2, m_3 - n_3). \tag{2}$$

Multiplication:

$$A_1^I \times A_2^I = (m_1, m_2, m_3) \times (n_1, n_2, n_3) = (m_1 \times n_1, m_2 \times n_2, m_3 \times n_3). \tag{3}$$

Division:


FIGURE 1
Area of the reviewed agritourism facilities in BiH. Source: authors' own processing based on Tešanj (2022).

$$A_1^I \div A_2^I = (m_1, m_2, m_3) \div (n_1, n_2, n_3) = (m_1 \div n_1, m_2 \div n_2, m_3 \div n_3). \quad (4)$$

## Fuzzy PIPRECIA method

The PIPRECIA methodological framework is established by (Stanujkić et al., 2017). Its advantage over similar methods is possibility of criteria assessment without prior sorting by significance (Stević et al., 2018). The method shows certain advantages in the case of group decision-making (Đalić et al., 2020). The application of the fuzzy PIPRECIA method involves the following steps (Nedeljković et al., 2021a):

Step 1: forming a set of criteria for comparison and nominating a decision-making team. The criteria are not classified.

TABLE 3 Fuzzy number membership function.

| Linguistic value | Fuzzy number |
|---|---|
| Very bad (VB) | (0,0,1) |
| Bad (B) | (0,1,3) |
| Medium bad (MB) | (1,3,5) |
| Medium (M) | (3,5,7) |
| Medium good (MG) | (5,7,9) |
| Good (G) | (7,9,10) |
| Very good (VG) | (9,10,10) |

Source (Mijajlović et al., 2020).

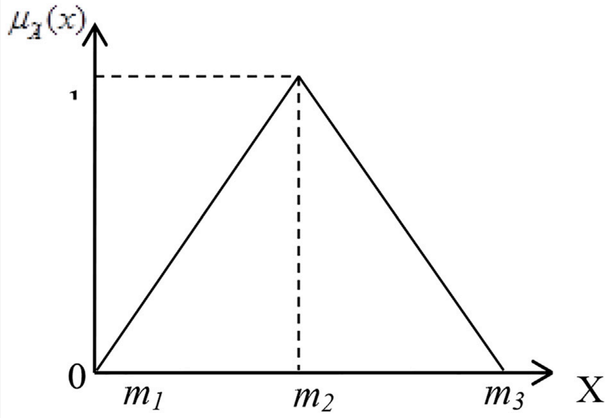


FIGURE 2
Triangular fuzzy numbers. Source: based on the study by (Božanić et al., 2016).

Step 2: each expert estimates the criteria individually, first by evaluating the other criteria with the first one, determining their importance in relation to the first criterion. When comparing, it is necessary to ensure that the defined value scales do not have a value of two. If the decision maker estimates that the value of other criteria is greater than the value of the criterion, used for direct comparison, they are assigned a value in the range between 1 and 2, or if a value is less than the value of criterion, they are assigned a value in the range between 0 and 1 (Expression 5).

$$\overline{s_j^r} = \begin{cases} > \bar{1}\ if\ C_j > C_{j-1} \\ = \bar{1}\ if\ C_j = C_{j-1} \\ < \bar{1}\ if\ C_j < C_{j-1} \end{cases}. \quad (5)$$

In which $s_j^r$ indicates the assessment of the criteria by the $r$th expert.

Obtaining the matrix $\overline{s_j^r}$ requires the calculation of the average matrix $\overline{s_j^r}$, by using a geometric mean. Experts assess the criteria based on previously determined scales (Stević et al., 2018).

Step 3: determining the coefficient $\overline{k_j}$

$$\overline{k_j} = \begin{cases} = 1\ if\ j = 1 \\ 2 - \overline{s_j}\ if\ j > 1 \end{cases}. \quad (6)$$

Step 4: defining the fuzzy weight $\overline{q_j}$

$$\overline{q_j} = \begin{cases} = \bar{1}\ if\ j = 1 \\ \dfrac{\overline{q_{j-1}}}{\overline{k_j}}\ if\ j > 1 \end{cases}. \quad (7)$$

Step 5: defining the criterion's relative weight $\overline{w_j}$

$$\overline{w_j} = \frac{\overline{q_j}}{\sum_{j=1}^{n} \overline{q_j}}. \quad (8)$$

Next steps require application of the inverse methodological framework to the fuzzy PIPRECIA method, when comparing the criteria with the last criterion, while calculating the values of their weights. Therefore, step 6. assumes comparing the criteria with the last criterion.

$$\overline{s_j^{r'}} = \begin{cases} > \bar{1}\ if\ C_j > C_{j+1} \\ = \bar{1}\ if\ C_j = C_{j+1} \\ < \bar{1}\ if\ C_j < C_{j+1} \end{cases}. \quad (9)$$

Generating a matrix $\overline{s_j^{r'}}$ requires calculating the average matrix $\overline{s_j^{r'}}$, with the use of geometric mean.

Step 7: defining the coefficient $\overline{k_j'}$

$$\overline{k_j'} = \begin{cases} = 1\ if\ j = n \\ 2 - \overline{s_j'}\ if\ j > n \end{cases}. \quad (10)$$

Step 8: defining the fuzzy weight $\overline{q_j'}$

$$\overline{q_j'} = \begin{cases} = \bar{1}\ if\ j = n \\ \dfrac{\overline{q_{j-1}'}}{\overline{k_j}}\ if\ j > n \end{cases}. \quad (11)$$

Step 9: defining the relative weight of the criterion $\overline{w_j'}$

$$\overline{\boldsymbol{w_j}} = \frac{\overline{\boldsymbol{q_j'}}}{\sum_{j=1}^{n} \overline{\boldsymbol{q_j'}}}. \quad (12)$$

Determining the final weight of the criteria (step 10) requires the defuzzification of the fuzzy values $\overline{w_j}$ and $\overline{w_j'}$.

$$\overline{w_j''} = 1/2\, \frac{\bar{w}_j + \overline{w_j'}}{2}. \quad (13)$$

## Fuzzy MARCOS method

The MARCOS method was established by Stević et al. (Stević et al., 2020). This method uses compromise ranking in relation to the ideal (AI) and anti-ideal solution (AAI) (Nedeljković et al., 2021b). Based on that, the utility function is used to rank alternatives (Puška et al., 2020b). The best alternative is the closest AI, that is, simultaneously the furthest from the AAI (Stević and Brković, 2020). A fuzzy version of the MARCOS methodological framework was established by Stanković et al. (Stanković et al., 2020). The application of the MARCOS method is described through the next steps (Puška et al., 2021):

Step 1: creation of the initial fuzzy decision matrix (IFDM).

Step 2: extending the IFDM by adding anti-ideal (AAI) and ideal solutions (AI). AAI is mathematically expressed as:

$$\mathrm{AAI} = \min_{j}\ \mathrm{x_{ij}}\ \mathrm{if}\ \mathrm{j} \in \mathrm{B}\ \mathrm{and}\ \max_{j}\ \mathrm{x_{ij}}\ \mathrm{if}\ \mathrm{j} \in \mathrm{C}. \tag{14}$$

AI is expressed by the following expression:

$$\mathrm{AI} = \max_{j}\ \mathrm{x_{ij}}\ \mathrm{if}\ \mathrm{j} \in \mathrm{B}\ \mathrm{and\ if}\ \min_{j}\ \mathrm{x_{ij}}\ \mathrm{j} \in \mathrm{C}. \tag{15}$$

Symbol B reflects to the advantage of criterion that requires maximization. In the contrary, symbol C reflects to the cost of the criterion that requires minimization. Through step 3, the IFDM is normalized, and depending on the criterion, one of the following expressions is used:

$$\tilde{n} = \left(n_{ij}^{l}, n_{ij}^{m}, n_{ij}^{u}\right) = \left(\frac{x_{id}^{l}}{x_{ij}^{u}}, \frac{x_{id}^{l}}{x_{ij}^{m}}, \frac{x_{id}^{l}}{x_{ij}^{l}}\right) if\ j \in c \tag{16}$$

$$\tilde{n} = \left(n_{ij}^{l}, n_{ij}^{m}, n_{ij}^{u}\right) = \left(\frac{x_{ij}^{l}}{x_{id}^{u}}, \frac{x_{ij}^{m}}{x_{id}^{u}}, \frac{x_{ij}^{u}}{x_{id}^{u}}\right) if\ j \in B. \tag{17}$$

In this expression, the first, second, and third fuzzy numbers are represented by *l*, *m*, and *u*, respectively.

Step 4: weights the normalized decision matrix, which is expressed by the next formula:

$$\tilde{v}_{ij} = \left(v_{ij}^{l}, v_{ij}^{m}, v_{ij}^{u}\right) = \tilde{n}_{j} \times \tilde{w}_{j}. \tag{18}$$

Through step 5, the determination of the *Si* matrix is performed, which considers the summing of all alternative's values, covering both AAI and AI. It is represented by the following formula:

$$\mathrm{S_i} = \sum_{i=1}^{n} \mathrm{v_{ij}}. \tag{19}$$

Step 6: assumes determining of the degree of usefulness *Ki* in relation to AAI and AI, applying the next formula:

$$\tilde{K}_i^- = \left(\frac{\tilde{S}_i}{\tilde{S}_{ai}}\right) = \left(\frac{s_i^{\mathrm{l}}}{s_{ai}^{\mathrm{u}}}, \frac{s_i^{\mathrm{m}}}{s_{ai}^{\mathrm{u}}}, \frac{s_i^{\mathrm{u}}}{s_{ai}^{\mathrm{u}}}\right) \tag{20}$$

$$\tilde{K}_i^+ = \left(\frac{\tilde{S}_i}{\tilde{S}_{id}}\right) = \left(\frac{s_i^{\mathrm{l}}}{s_{id}^{\mathrm{u}}}, \frac{s_i^{\mathrm{m}}}{s_{id}^{\mathrm{u}}}, \frac{s_i^{\mathrm{u}}}{s_{id}^{\mathrm{u}}}\right). \tag{21}$$

In the following step 7: the fuzzy matrix $\tilde{T}_i$ is calculated by the following expression:

$$\tilde{T}_i = \tilde{t}_i = \left(t_i^{l}, t_i^{m}, t_i^{u}\right) = \tilde{k}_i^- + \tilde{k}_i^+ = \left(\tilde{k}_i^{-l} + \tilde{k}_i^{+l}, \tilde{k}_i^{-m} + \tilde{k}_i^{+m}, \tilde{k}_i^{-u} + \tilde{k}_i^{+u}\right). \tag{22}$$

Then the value of the fuzzy number $\tilde{D}$ is determined with the expression:

$$\tilde{D} = \left(d^{l}, d^{m}, d^{u}\right) = \max{}_{i}\tilde{t}_{ij}. \tag{23}$$

Through step 8, the fuzzy numbers go through defuzzification by the following expression:

$$df_{def} = \frac{l + 4m + u}{6}. \tag{24}$$

Step 9 defined the utility function *f(Ki)*, by aggregating the several utility functions in line to AAI and AI.

1) Utility function related to anti-ideal solution (AAI)

$$f\left(\tilde{k}_i^+\right) = \frac{\tilde{k}_i^-}{df_{def}}. \tag{25}$$

2) Utility function related to ideal solution (AI)

$$f\left(\tilde{k}_i^-\right) = \frac{\tilde{k}_i^+}{df_{def}}. \tag{26}$$

Step 10: determines the final utility function:

$$f\left(K_i\right) = \frac{K_i^+ + K_i^-}{1 + \frac{1-f\left(K_i^+\right)}{f\left(K_i^+\right)} + \frac{1-f\left(K_i^-\right)}{f\left(K_i^-\right)}}. \tag{27}$$

During step 10. the ranking of alternatives is performed. The best alternative takes the highest value. In contrary to that, the worst alternative obtains the lowest value.

## Research results

According to the previously defined methodological framework, first the weight of the criteria and sub-criteria is determined by the fuzzy PIPRECIA method, followed by the ranking of selected agro-tourism facilities. The example of the main criteria will further explain in more detail, the use of this method. Initially, each of the experts, that is, decision makers (DM), evaluates the main criteria by mutually comparing them with the first criterion (Table 5). In order to obtain aggregate scores for each DM, a geometric mean (GM) was used, according to which the same importance was given to each of the experts. Then, the main criteria are evaluated by the inverse fuzzy PIPRECIA method, where the criteria are compared with the last criterion (Table 4).

Upon calculating the average grades by the experts, using the geometric mean, the other phases of the PIPRECIA method are performed. The final values of the weights of the key criteria are calculated by applying Expression 13 i.e.

Results which show that the expert assessment assigned the highest value to the economic criterion (w = 0.355), then

TABLE 4 Assessment of the key criteria using the fuzzy PIPRECIA method.

| PIPRECIA | C1 | C2 | | | C3 | | |
|---|---|---|---|---|---|---|---|
| DM1 | | 0.667 | 1.000 | 1.000 | 0.400 | 0.500 | 0.667 |
| DM2 | | 1.000 | 1.000 | 1.000 | 1.100 | 1.150 | 1.200 |
| DM3 | | 0.667 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| GM | | 0.763 | 1.000 | 1.000 | 0.761 | 0.832 | 0.928 |
| **PIPRECIA-I** | **C3** | **C2** | | | **C1** | | |
| DM1 | | 1.100 | 1.150 | 1.200 | 1.200 | 1.300 | 1.350 |
| DM2 | | 0.500 | 0.667 | 1.000 | 0.500 | 0.667 | 1.000 |
| DM3 | | 0.667 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| GM | | 0.716 | 0.915 | 1.063 | 0.843 | 0.954 | 1.105 |

Source: According to authors calculations.

follows the ecological criterion (w = 0.337), and the lowest importance to the social criterion (w = 0.314) were obtained. As there is no significant difference between the observed weights, it cannot be said that some of the criteria are substantially more important than other criteria.

The next step is to calculate the weight of the sub-criteria. Based on the expert assessment, Table 5 is formed, and the steps of the PIPRECIA method are performed.

The results show that in the code economic criteria the greatest importance, according to experts, was given to sub-criterion C12 - quality of services (w = 0.166), while the least importance was given to sub-criterion C14 - traffic connection (w = 0.149). In the group of environmental criteria, the greatest importance is assigned to sub-criteria C23—the quality of natural resources and C24 - cleanliness and tidiness (w = 0.162), while the least important is given to the criterion C21 - geographical characteristics (w = 0.153) (Table 6). In the group of social criteria, the experts gave the greatest importance to the criterion C35 - accessibility of tourist attractions (0.161), while the least importance belongs to the criterion C32 - learning about traditions and customs (w = 0.152). Weights are used to rank alternatives using the MARCOS method.

The next step is to evaluate the value of the alternatives based on the observed sub-criteria *via* the linguistic value (Table 7). The linguistic values are then transformed into fuzzy numbers using the affiliation function (Table 3). Then the obtained values for alternatives are averaged according to the pre-defined (sub) criteria, that is, IFDM is established (the first step of the implementation of the fuzzy MARCOS method). After that, the steps of the fuzzy MARCOS method are performed, that is, formation of the initial decision matrix, normalization of this uterus, expansion with AI and AII, and aggravation of normalized fuzzy numbers.

This is followed by the calculation of utility functions, then followed by defuzzification of the maximum values of the fuzzy numbers and calculation of the values for $df_{\text{crisp}}$ ($df_{\text{crisp}}$ = 2.22). The final utility function is then calculated (Table 8).

The calculated values for the final utility function allow the ranking of the observed alternatives. The obtained results show that, according to the expert assessment, the best ranked alternative is A6—rural household "Šadrvan," while the worst ranked alternative is A3—rural household "Kovačević." In order to determine the advantages and disadvantages of the observed alternatives, which would be used for providing a competitive advantage, a sensitivity analysis is conducted.

## Sensitivity analysis

The first step of sensitivity analysis is to evaluate the results with other MCDA (multiple-criteria decision analysis) methods. The second step is described by the values presented in Table 9, which differentiates good and bad characteristics of the observed agro-tourism capacities.

As in some previous research based on the same methodological framework (Puška et al., 2021), the realization of the first step of the sensitivity analysis included six fuzzy methods and that: WASPAS (weighted aggregated sum product assessment), fuzzy SAW (simple additive weighting technique), fuzzy MABAC (multi-attributive border approximation area comparison), fuzzy ARAS (additive ratio assessment) and fuzzy TOPSIS (technique for order performance by similarity to ideal solution). (Puška et al., 2021). The results show that there is no difference in application of the different fuzzy methods considered, and the ranking is maintained the same for all methods applied, which comes in line and confirm the results of the fuzzy MARCOS method application (Figure 3).

The realization of the second step of sensitivity analysis uključuje 19 scenarija. Najprije je određenom kriteriju data važnost veća šest puta (privih 18 scenarija) te je svim kriterija data ista važnost (19-ti scenario) (Table 9). Rangiranje alternativa sa ovim scenarijima se vrši koristeći metodu fuzzy MARCOS.

The results show that there are different rank orders of alternatives (Figure 4). In the tested circumstances, the alternative A6 shows the best values of indicators in 14 scenarios, and retains the first place in the ranking. The mentioned alternative showed the highest sensitivity in the implementation of scenarios 8 and 18, when it was ranked as third. On the other hand, alternative A6 cannot affect sub-criterion C22—availability of natural resources, but can take certain actions to make the best use of certain advantages that would make natural resources available to visitors of this agro-tourism facility. Primarily, it is necessary to work on improving the environmental conditions and maintaining the tidiness of the farm environment. These activities must be carried out in coordination with the local self-government, given that the improvement of the agricultural environment (alternative A6)

TABLE 5 Evaluation of sub-criteria by fuzzy PIPRECIA method.

| Economic criterion (sub-criteria) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PIPR. | C11 | C12 | | | C13 | | | C14 | | | C15 | | | C16 | | |
| DM1 | | 1.10 | 1.15 | 1.20 | 0.67 | 1.00 | 1.00 | 0.67 | 1.00 | 1.00 | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.05 |
| DM2 | | 1.10 | 1.15 | 1.20 | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.00 | 1.10 | 1.15 | 1.20 | 1.00 | 1.00 | 1.00 |
| DM3 | | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.00 | 0.67 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| GM | | 1.07 | 1.10 | 1.15 | 0.87 | 1.00 | 1.02 | 0.76 | 1.00 | 1.00 | 1.03 | 1.05 | 1.08 | 1.00 | 1.00 | 1.02 |
| PIPR.-I | C16 | C15 | | | C14 | | | C13 | | | C12 | | | C11 | | |
| DM1 | | 1.00 | 1.00 | 1.00 | 0.50 | 0.67 | 1.00 | 0.50 | 0.67 | 1.00 | 1.00 | 1.00 | 1.05 | 0.67 | 1.00 | 1.00 |
| DM2 | | 1.10 | 1.15 | 1.20 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.05 | 1.10 | 1.15 | 1.20 | 1.00 | 1.00 | 1.00 |
| DM3 | | 1.00 | 1.00 | 1.00 | 0.67 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.00 |
| GM | | 1.03 | 1.05 | 1.06 | 0.69 | 0.87 | 1.00 | 0.79 | 0.87 | 1.02 | 1.03 | 1.05 | 1.10 | 0.87 | 1.00 | 1.00 |
| Environmental criterion (sub-criteria) | | | | | | | | | | | | | | | | |
| PIPR | C21 | C22 | | | C23 | | | C24 | | | C25 | | | C26 | | |
| DM1 | | 1.10 | 1.15 | 1.20 | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.00 |
| DM2 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.00 | 0.67 | 1.00 | 1.00 | 1.00 | 1.00 | 1.05 |
| DM3 | | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.00 |
| GM | | 1.03 | 1.05 | 1.08 | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.03 | 0.87 | 1.00 | 1.03 | 1.00 | 1.00 | 1.02 |
| PIPR.-I | C26 | C25 | | | C24 | | | C23 | | | C22 | | | C21 | | |
| DM1 | | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.05 | 1.10 | 1.15 | 1.20 | 1.00 | 1.00 | 1.00 |
| DM2 | | 0.50 | 0.67 | 1.00 | 0.67 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.67 | 1.00 | 1.00 | 0.67 | 1.00 | 1.00 |
| DM3 | | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.00 |
| GM | | 0.79 | 0.87 | 1.03 | 0.87 | 1.00 | 1.03 | 1.00 | 1.00 | 1.03 | 0.90 | 1.05 | 1.08 | 0.87 | 1.00 | 1.00 |
| Social criterion (sub-criteria) | | | | | | | | | | | | | | | | |
| PIPR. | C31 | C32 | | | C33 | | | C34 | | | C35 | | | C36 | | |
| DM1 | | 0.67 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.67 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.67 | 1.00 | 1.00 |
| DM2 | | 0.67 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| DM3 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.05 | 0.67 | 1.00 | 1.00 |
| GM | | 0.76 | 1.00 | 1.00 | 1.00 | 1.00 | 1.02 | 0.87 | 1.00 | 1.02 | 1.00 | 1.00 | 1.02 | 0.76 | 1.00 | 1.00 |
| PIPR.-I | C36 | C35 | | | C34 | | | C33 | | | C32 | | | C31 | | |
| DM1 | | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.05 |
| DM2 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.00 | 0.67 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| DM3 | | 1.10 | 1.15 | 1.20 | 1.00 | 1.00 | 1.05 | 1.10 | 1.15 | 1.20 | 1.00 | 1.00 | 1.05 | 1.00 | 1.00 | 1.05 |
| GM | | 1.03 | 1.05 | 1.08 | 1.00 | 1.00 | 1.03 | 1.03 | 1.05 | 1.08 | 0.87 | 1.00 | 1.02 | 1.00 | 1.00 | 1.03 |

Source: According to authors calculations.

TABLE 6 Weight values of sub-criteria.

| Sub-criterion | Weight | Sub-criterion | Weight | Sub-criterion | Weight |
|---|---|---|---|---|---|
| C11 | 0.153 | C21 | 0.153 | C31 | 0.155 |
| C12 | 0.166 | C22 | 0.160 | C32 | 0.152 |
| C13 | 0.158 | C23 | 0.162 | C33 | 0.156 |
| C14 | 0.149 | C24 | 0.162 | C34 | 0.156 |
| C15 | 0.157 | C25 | 0.154 | C35 | 0.161 |
| C16 | 0.157 | C26 | 0.155 | C36 | 0.159 |

Source: According to authors calculations.

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TABLE 7 Initial (starting) decision matrix.

| DM1 | $C_{11}$ | $C_{12}$ | $C_{13}$ | $C_{14}$ | $C_{15}$ | $C_{16}$ | $C_{21}$ | $C_{22}$ | $C_{23}$ | $C_{24}$ | $C_{25}$ | $C_{26}$ | $C_{31}$ | $C_{32}$ | $C_{33}$ | $C_{34}$ | $C_{35}$ | $C_{36}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A1 | M | MG | MG | M | MG | MG | G | MG | MG | G | MG | M | M | MG | G | MG | MG | MB |
| A2 | MG | MG | M | M | MG | MG | G | MG | MG | G | MG | M | M | MG | MG | M | MG | M |
| A3 | MB | M | M | M | MG | M | MG | MG | M | MG | MG | MG | M | M | M | M | MB | MB |
| A4 | MG | M | M | MB | G | G | VG | G | M | VG | VG | M | M | M | M | MB | M | M |
| A5 | M | MG | MG | MG | G | MG | G | MG | MG | VG | G | MG | MG | MB | M | M | M | MB |
| A6 | MG | G | MG | MG | G | MG | G | MG | MG | G | VG | MG | M | M | M | M | MG | MB |
| DM2 | $C_{11}$ | $C_{12}$ | $C_{13}$ | $C_{14}$ | $C_{15}$ | $C_{16}$ | $C_{21}$ | $C_{22}$ | $C_{23}$ | $C_{24}$ | $C_{25}$ | $C_{26}$ | $C_{31}$ | $C_{32}$ | $C_{33}$ | $C_{34}$ | $C_{35}$ | $C_{36}$ |
| A1 | G | MG | MG | MG | G | MG | MG | MG | MG | MG | G | G | MG | M | M | MG | G | MG |
| A2 | MG | M | G | M | G | MG | MG | MG | MG | MG | G | VG | M | M | M | MG | G | MG |
| A3 | MG | M | MG | M | VG | MG | MG | M | M | M | G | G | M | MG | M | G | G | MG |
| A4 | MG | M | MG | MG | G | M | G | G | M | M | VG | G | M | MG | M | G | MG | M |
| A5 | MG | MG | MG | G | VG | M | G | M | G | MG | G | VG | MG | G | MG | G | MG | M |
| A6 | G | MG | M | G | G | G | G | MG | VG | MG | G | VG | G | G | MG | G | MG | MB |
| DM3 | $C_{11}$ | $C_{12}$ | $C_{13}$ | $C_{14}$ | $C_{15}$ | $C_{16}$ | $C_{21}$ | $C_{22}$ | $C_{23}$ | $C_{24}$ | $C_{25}$ | $C_{26}$ | $C_{31}$ | $C_{32}$ | $C_{33}$ | $C_{34}$ | $C_{35}$ | $C_{36}$ |
| A1 | MG | MG | MG | M | MG | MG | MG | MG | MG | M | MG | G | M | MG | MG | MB | MG | MB |
| A2 | MG | M | MG | MG | G | MG | M | G | M | M | G | G | MB | M | M | MG | MG | MB |
| A3 | G | M | MG | M | MG | G | M | G | M | MG | G | MG | MG | M | M | MG | MG | MB |
| A4 | M | M | M | M | MG | G | MG | G | G | G | G | MG | G | MB | M | M | MG | M |
| A5 | G | MG | G | M | MG | G | G | G | MG | MG | MG | MG | MG | MG | M | MG | G | M |
| A6 | MG | G | G | M | G | MG | G | M | G | G | M | G | MG | G | M | M | MG | M |

Source: According to authors calculations.

TABLE 8 Defuzzification and final results.

| Alternative | $d\tilde{K}_i^-$ | $d\tilde{K}_i^+$ | $df\,(\tilde{K}_i^-)$ | $df\,(\tilde{K}_i^+)$ | $K_i$ | Rank |
|---|---|---|---|---|---|---|
| A1 | 0.898 | 1.161 | 0.523 | 0.405 | 0.609 | 3 |
| A2 | 0.880 | 1.139 | 0.513 | 0.397 | 0.582 | 4 |
| A3 | 0.821 | 1.061 | 0.478 | 0.370 | 0.496 | 6 |
| A4 | 0.869 | 1.124 | 0.507 | 0.391 | 0.565 | 5 |
| A5 | 0.945 | 1.223 | 0.551 | 0.426 | 0.685 | 2 |
| A6 | 0.967 | 1.252 | 0.564 | 0.436 | 0.723 | 1 |

Source: According to authors calculations.

is directly related to the complete space and available natural resources of the local rural community. There is a need to invest in the development of available offer in alternative A6, as well as strengthening its connections to the local community, which was a negative side of the alternative stemming from scenario 18. Also, improving the quality and attractiveness of the rendered services would increase the participation of tourists in everyday work on the farm, and an alternative would secure the first place in the rankings in all scenarios.

Alternative A5 was ranked as the first in four scenarios, showing the best characteristics related to the landscape, attractiveness of services offered to the tourists, the participation of tourists in agricultural activities and the impact on local community development. The biggest disadvantage of the A5 alternative is related to the presence (lack) of local events. In order to strengthen its offer and the attractiveness, the A5 alternative should benchmark the offer of the A6 alternative, adopting all its advantages. In the group of observed alternatives, alternative A4 showed the highest sensitivity to changes in the weight of the sub-criteria. It showed the best results in scenario 8, primarily the best availability of natural resources, but generally showed that tourists do not participate sufficiently in agricultural activities, which is most obvious in scenario 16. It should be noted that alternative A3 showed the worst results in the largest number of the developed scenarios. According to the expert assessment and based on the conducted analyzes, the observed agro-tourism capacities ought to gain the mutual insight in the current offer of individual alternatives, in order to influence the sustainable improvement of their offer and business results by selecting and copying the best solutions.

## Discussion of the research results

Sustainability criteria were used during the evaluation of the offer of agro-tourism in BiH, with three main criteria being applied, which were later individually broken down into six sub-criteria. In this way, the quality of sustainability of the agro-

TABLE 9 Sensitivity analysis scenarios.

| Scenario | $C_{11}$ | $C_{12}$ | $C_{13}$ | $C_{14}$ | $C_{15}$ | $C_{16}$ | $C_{21}$ | $C_{22}$ | $C_{23}$ | $C_{24}$ | $C_{25}$ | $C_{26}$ | $C_{31}$ | $C_{32}$ | $C_{33}$ | $C_{34}$ | $C_{35}$ | $C_{36}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.24 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |
| 2 | 0.04 | 0.24 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |
| 3 | 0.04 | 0.04 | 0.24 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| 18 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.24 |
| 19 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |

Source: According to authors calculations.

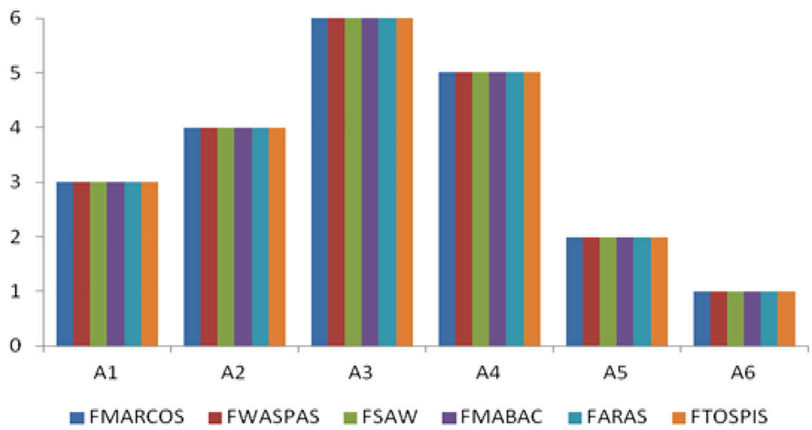


FIGURE 3
Ranking of the alternatives using different fuzzy methods. Source: according to authors calculations.

tourism offer in BiH was regarded. Based on the expert assessments, two sub-criteria in the observed agro-tourism facilities stand out, namely, C15 (accommodation capacities) and C25 (landscape), which must be regarded as crucial when promoting available tourist services. This is supported by the fact that BiH has a great natural wealth, which can be used by more aggressive tourism promotion (Puška et al., 2019). On the other hand, a significant negative deviation in the assessment was shown in sub-criterion C36 (impact on community development), which is explained by the underdevelopment of the agro-tourism offer in BiH, as opposed to some other countries, such as Italy (Palmi and Lezzi, 2020) or Poland (Roman et al., 2020), in which this type of tourism is quite widespread.

From the perspective of further development of this type of tourism in BiH, there is a need for significant public support. First, through subsidies and donations, farmers should be helped to make better use of available resources, and to diversify their activities toward the tourist services, since with the expansion of the farm's portfolio of activities the sustainability and competitiveness of rural areas strengthens as well (Puška et al., 2020a). Therefore, the diversification of agricultural activities should be strongly linked to the principles of sustainability that would simultaneously have effect on the economic growth of a country (in this case BiH) and reducing poverty of the local population (Ciolac et al., 2019), while considering proactive approach to preserving available natural resources of BiH. With the increase of the local agro-tourism offer, the growth of the impact on the development of local rural communities can be expected. With the currently available agro-tourism facilities, this impact is quite weak, resulting in criterion being rated lower.

Upon the analysis of grades of all sub-criteria of some of the basic criteria for all agro-tourism facilities, it is suggestive that the best grades are assigned to environmental criteria, followed by economic criteria, that is the worst were assigned to social criteria. For this reason, it is necessary to strengthen the social criteria in all agro-tourism facilities, which would lead, with the existing level of environmental criteria, to a more complex and noticeable step forward in the rural development (Prayukvong et al., 2015), and consequently would improve the economic

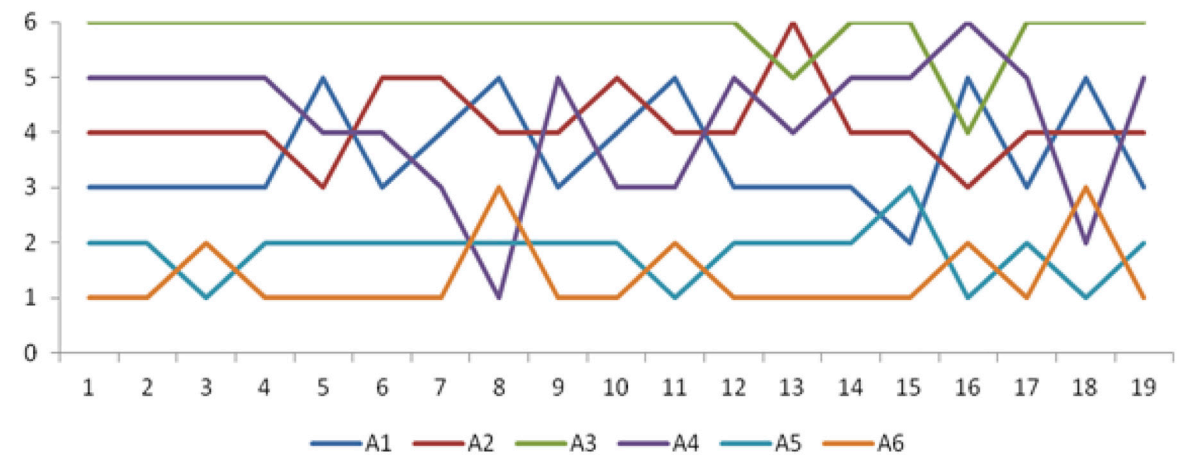


FIGURE 4
Ranking of alternatives upon conducting sensitivity analysis
Source: according to authors calculations.

criteria, which would further have effect on the quality and intensity of development of rural areas in BiH.

Within the group of social criteria, those aimed at organizing events in rural communities and active participation of tourists in the implementation of agricultural activities during their stay on the farm, should particularly be strengthened (this would make their stay more attractive and dynamic) (Barbieri, 2013). The aforementioned point reflects the direct support of agro-tourism in preserving the local identity, traditions, and customs of a given rural area (Puška et al., 2020a).

The basis for the development of agro-tourism in BiH should be contained in the available environmental characteristics of the facilities in offer. Therefore, it is necessary to direct the promotional activities toward highlighting the available natural resources of BiH, and subsequently toward the development of social capital, which is active in agro-tourism.

The results of the research resulted from the integration of two fuzzy methods, which have not been used synergistically in previous research (the fuzzy MARCOS method has not been used hybridly with the fuzzy PIPRECIA method before). Subsequent sensitivity analysis proved that this innovative methodology does not deviate from the previously used fuzzy methods in terms of the results. With the change of the weights of the sub-criteria, results were obtained, which show that the best characteristics are possessed by the A5 and A6 facilities, and that they should serve as an example to other facilities, in their efforts to advance their offer. Also, the performed sensitivity analysis marked those characteristics of individual facilities, which need to be further improved or used more intensively in order to attract new tourists.

The development of the available agro-tourism offer in BiH requires additional investments, primarily in the construction of infrastructure (mainly traffic infrastructure). An integrative approach to the improvement of the agro-tourism offer simultaneously requires additional investments in marketing activities (above all, more informative and meaningful acquaintance of tourists with the potentials and possibilities of this type of tourism). The presence of natural resources in BiH has been proven, which should have a more noticeable function in attracting additional tourists. All this requires a symbiotic response from the local rural communities that would support an increase in available accommodation capacity.

## Conclusion

Each country strives to improve the available rural areas by consistently applying the concept of sustainability. In conditions of agricultural instability, with the aim of business sustainability and income stabilization, in order to survive, farmers usually resort to diversification of their activities, introducing in some cases the possibility of visits of the tourists to the agroturističkim objektima. The article presents one of the ways of expert assessment of the state of an activity (specifically agro-tourism), with the application of fuzzy logic, which could later be used to improve this activity. For this purpose, a hybrid methodological framework has been developed, which included the application of the fuzzy PIPRECIA (determination of weights of main and sub-criteria) and fuzzy MARCOS methods (ranking of selected agro-tourism capacities). The research included six out of the 27 available agro-tourism facilities. An expert assessment based on sustainability criteria ranked the observed facilities. The best results were exhibited by the rural household "Šadrvan,"and the worst by the rural household "Kovačević." The obtained evaluation results were confirmed through the application of other MCDA methods, as well as through the sensitivity analysis (proof of the relevance of the sustainability assessment using the fuzzy MARCOS method).

According to the expert assessment and the sensitivity analysis, the necessary portfolio of information was obtained, which may be used in the function of improving the sustainability of agro-tourism in BiH. Each of the observed tourist capacities should be aware of its advantages and disadvantages that it needs to correct in order to strengthen its competitiveness and business results. Of course, facilities that were not included in the research can use the obtained results in order to achieve above-average business results. They could simply compare their own to other people's tourist offer, and in relation to the indicators of ranked agricultural objects, determine their place on the market and available maneuver space for potential improvements. BiH has good economic and environmental factors, but social factors need to be improved. In order to implement sustainability in the operation of agritourism facilities, greater involvement of the local population is needed in order to connect this offer with local producers and tourists, and then offer these products. Tourists should be more involved and organize visits to orchards or vegetable gardens where they would participate and get acquainted with agricultural activities in the area.

In line with the high level of flexibility of the used methodological framework, future research can be focused on assessing the sustainability of another sub-segment of the economy, by making necessary modifications to the model, that is, adjusting the selected evaluation criteria to the specifics of the research activity and research goals.

## Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material; further inquiries can be directed to the corresponding author.

## Author contributions

Conceptualization: AP, MN, JA, DN, and MJ; methodology: AP and MN; software and validation: AP and MN; formal analysis: AP, MJ, JA, DN, and MN; investigation and resources: MJ, JS, AP, and MN; literature review: MJ, JS, AP, and MN; writing—original draft preparation: MN, MJ, AP, and JS; writing–review and editing: MJ and AP; visualization: JS; supervision: AP; project administration: MJ; and funding acquisition: DN and JS. All authors have read and agreed to the published version of the manuscript.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Publisher's note



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