Employing an Analytic Hierarchy Process to Prioritize the Most Important Non-wood Forest Products from Sălaj County

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Abstract

The main purpose of the present paper is to highlight the most important non-wood forest products (NWFPs) from Sălaj County. For this purpose, a set of 19 criteria was taken into consideration and the analytic hierarchy process was applied to establish criteria weights. Subsequently, the method was tested by using Expert Choice software. The selected NWFPs were: honey fungus [*Armillaria mellea* (Vahl) P.Kumm.], parasol mushroom [*Macrolepiota procera* (Scop.) Singer], acorns, *Tilia* flowers, wild strawberry (*Fragaria vesca* L.), St John's wort (*Hypericum perforatum* L.), European roe deer (*Capreolus capreolus* L.) and European pine marten (*Martes martes* L.). The two NWFPs with the highest potential were European roe deer and honey fungus, while the less important ones were *Tilia* flowers and St John's wort. Sălaj County has great potential, diversity and distribution of the NWFPs, but this sector is underdeveloped and disorganized. This approach provides forest managers with information to develop further NWFP management strategies.

Keywords: analytic hierarchy process, forest management, non-wood forest products, Sălaj County

Introduction

Recent demand trends for healthy food and organic products is increasing (Delić *et al.*, 2017). In this context, non-wood forest products (NWFPs) gain recognition due to the excellent chemical and sanogenic properties. Moreover, these products can provide a supplementary source of income in the forestry sector (Kilchling *et al.*, 2009).

As a result, there are ongoing international efforts to guide the management of forests towards the production of NWFPs (Kurttila *et al.*, 2018). Numerous studies suggested that NWFPs

orientated forest management can be a much more profitable alternative than timber production (De-Miguel *et al.*, 2014; Mumcu Küçüker and Başkent, 2017; Tahvanainen *et al.*, 2018).

The range of NWFPs is very varied (edible mushrooms, berries, medicinal herbs, forest seeds, essential oils, honey, cork, resin, game species) and as a consequence, it has been also developed a large portfolio of derived products.

Romania is a rich country in NWFPs (MEWF 2016a), aspect favored by the varied physiographic, climatic and edaphic conditions. It

is estimated that by selling these types of products, the National Forest Administration (NFA) realizes between 20% and 30% of the annual turnover (Cofari, 2010). Among the counties that harvest high quantities of NWFPs are found in Maramures (Enescu *et al.*, 2017), Prahova (Enescu *et al.*, 2018) and Bihor (Timis-Gânsac *et al.*, 2019). Other counties like Dolj (Cântar *et al.*, 2018), Gorj (Vechiu *et al.*, 2018) or Timis (Enescu *et al.*, 2018) have less potential for mobilizing high quantities due to the smaller administrated forest fund.

The last category includes also Sălaj County, with an afforestation percentage of 25% of the total county area (MWF, 2017). According to the most recent statistics (NFA, 2018), Salaj Forest Directorate (SFD) has commercialized 20,8 tones of dog rose fruits and 2,5 tones of game meat. In the past, the harvesting plan included also considerable quantities of wild garlic (Vasile *et al.*, 2016a), raspberries and blackberries (Vasile *et al.*, 2016b).

The aim of this study was to highlight the most promising non-wood forest products for Salaj County.

Materials and methods

Sălaj County is situated in the North-West development region (Fig. 1) and has 94.5 thousand hectares of forests, 64.6 thousand hectares being administrated by SFD (29.7 thousand hectares are public state property and the rest private property) (NIS, 2018; NFA, 2018) through its five subunits (Almas, Ileanda, Jibou, Cehu Silvaniei and Zalău).

The vegetation that constitutes the forests managed by SFD varies with the altitude and the stationary elements and are mainly composed by pedunculate oak, sessile oak, turkey oak and beech, mixed with resinous trees, sycamore, hornbeam, lime trees, wild cherry trees and a

varied range of shrubs (blackthorn, hawthorn, dog rose, blackberry, common dogwood).

First, information from forest management plans and statistical data published by the National Institute of Statistics (NIS) and NFA were analyzed in order to determine the list of NWFPs commercialized in Sălaj County.

Secondly, a set of 19 criteria was taken into consideration and the analytic hierarchy process designed by Saaty (2008) was applied to establish criteria weights.

The following 19 criteria were considered: 1. harvesting period; 2. harvested quantity/worker/8 hours; 3. harvesting cost; 4. harvesting knowledge; 5. tools needed for harvesting; 6. the complexity of the harvesting process; 7. development of the harvesting process; 8. knowledge for recognition; 9. distribution range; 10. biotic threats; 11. abiotic threats; 12. Perishability; 13. market potential; 14. market demand; 15. 'celebrity' of the product on market; 16. the price of the raw product; 17. the price of the derived product; 18. portfolio of derived products and 19. transport (harvesting - storage center). Three experts compared every pair of criteria and evaluated them with notes from 1 to 8.

Based on COST Action European non-wood forest products network classification the NWFPs were organized into four groups: mushrooms, tree products, understory plants and animal origin products. In order to facilitate the pair-wise comparisons in the application of the Analytic Hierarchy Process (AHP) were selected only eight NWFPs, two for each group.

In addition, the performance sensitivity analysis was carried out by specialized software (Expert Choice).

Results and discussions

From the preliminary list were identified as NWFPs with commercial potential for Sălaj County honey fungus [*Armillaria mellea* (Vahl) P.Kumm.], parasol mushroom [*Macrolepiota procera* (Scop.) Singer], acorns, *Tilia* flowers, wild strawberry (*Fragaria vesca* L.), St John's wort (*Hypericum perforatum* L.), European roe deer (*Capreolus capreolus* L.) and European pine marten (*Martes martes* L.). The AHP alternative ranking along with the scores of the criteria are rendered in Table 1.

It is noted from Figure 2, that the most promising NWFPs for Salaj County were European

Figure 1. Location of Sălaj County

Table 1. AHP alternative ranking

Criterion	Mushrooms		Tree products		Understory plants		Animal origin	
	<i>Armillaria mellea</i>	<i>Macrolepiota procera</i>	Acorn	<i>Tilia</i> flowers	<i>Fragaria vesca</i>	<i>Hypericum perforatum</i>	<i>Capreolus capreolus</i>	<i>Martes martes</i>
1	7	4	8	2	1	3	6	5
2	6	4	1	7	8	5	3	2
3	7	6	8	3	4	5	2	1
4	4	3	5	6	2	1	8	7
5	7	6	4	1	2	3	8	5
6	6	5	4	3	2	1	8	7
7	3	4	5	6	2	1	7	8
8	3	4	6	5	2	1	7	8
9	7	2	5	6	1	8	4	3
10	7	6	2	5	8	3	4	1
11	8	4	3	2	6	1	7	5
12	4	5	2	3	6	1	8	7
13	4	5	3	2	6	1	8	7
14	7	6	3	2	8	1	5	4
15	7	6	1	4	8	5	3	2
16	8	6	1	4	5	3	7	2
17	4	3	5	1	6	2	8	7
18	4	3	6	7	8	5	1	2
19	2	3	6	5	4	1	8	7

Figure 2. The ranking of the eight NWFPs

roe deer and honey fungus, while the less promising ones were *Tilia* flowers and St John's wort.

Armillaria mellea is among the edible mushrooms that are the object of current collection

by forestry units from all over the country. The most significant quantities are harvested especially from the forest funds of Bacău, Maramures, Mures, Neamt and Suceava counties (Vasile *et al.*, 2017). It grows on the trunks and roots of living or dead

trees, in deciduous and softwood forests, usually forming large groups (Beldeanu, 2008). Overall, it exhibits stronger fructification in hilly and mountainous regions than in the plain areas.

The collection of this mushroom is old and is confirmed by the numerous toponyms associated with its name (Dincă *et al.*, 2016).

In similar studies, the honey fungus is frequently chosen among the eight alternatives and usually obtained high score being placed at the top of the hierarchy (Enescu *et al.*, 2017) or on intermediate positions (Enescu *et al.*, 2018).

According to the 'Performance Sensitivity' analysis, the honey fungus is surpassed by European roe deer, the main drawbacks being the higher perishability, the lower market potential and smaller prices of the derived products.

On the other hand, the honey fungus can generate significant income due to the high price of the raw product. Also, it is a well-rated product on the market having high demand (criterion 14) as well as popularity (criterion 15).

Another product that could bring an economic contribution to the forest sector from Sălaj County is *Martes martes*. According to the law, the hunting period for the European pine marten is between 15 September and 31 March (Law no. 407/ 2006). At county level, the population size of European pine marten is estimated at 360, its mean annual quota being approximately 28 individuals (MEWF 2016b). In the past, this species was excessively hunted, especially for its valuable resulting products (fur, trophies). Its fur is considered extraordinarily luxurious, being used for clothing articles (fur wraps, collars) (Helldin, 2000).

Among all alternatives is the hardest product to recognize and has an extremely developed harvesting process.

Unlike the previous products, *Tilia* flowers are situated towards the end of the ranking. The flowers (collected with the bracts) have numerous uses and can be harvested from the three main species of linden tree (*T. cordata*, *T. platyphyllos* and *T. tomentosa*) occurring in our country. The flowers bloom between June-July and have a pleasant characteristic odor due to the essential oils containing farnesol (Veselova and Stepalova, 2016). They also contain wax, tannin, amino acids, mucilage, polysaccharides and flavonoids (Sroka and Bełz, 2009). The infusions of inflorescences are widely used for their pharmaceutical effects

(diuretic, expectorant, antispasmodic, sedative) (Kivrak *et al.*, 2017). In addition, the linden flower oil is used as a component in perfumes (Kulka, 1979). As a consequence, the portfolio of derived products is higher than most considered alternatives (scored with 7 for criterion 18). In contrast, the price of the derived product is the lowest (scored 1 for criterion 17). The quantities harvested by a worker in 8 hours are significant (scored with 7 for criterion 2), but sometimes this process can be made difficult by the height of the trees (Vasile *et al.*, 2018).

Conclusion

The NWFPs sector from Sălaj County is characterized by great potential, aspect highlighted by the diversity and distribution of NWFPs resources. As indicated by official data this sector is underdeveloped and disorganized.

The AHP methodology together with the Expert Choice software has found that the greatest potential within the NWFPs sector is assigned to European roe deer and to honey fungus. Other products considered to have good potential include strawberries and European pine marten. At the same time, the rest of the alternatives should not be neglected.

This approach will enable the forestry sector from Sălaj County to gain significant income from the capitalization of the mentioned products. Moreover, this information is useful for developing future management strategies.

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