

## SELECTING THE MOST PROMISING NON-WOOD FOREST PRODUCTS FOR BACĂU COUNTY BY USING THE ANALYTICAL HIERARCHY PROCESS

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### INTRODUCTION

During the last decades, non-wood forest products have attracted the interest towards their significant potential in ensuring food security, improving nutrition, attending health, increasing their added value as well as in improving social wealth on a local level, offering job opportunities, improving the economy or preserving forest resources (Gurung, 2017).

At the present moment, the population has started to acknowledge at a global level the benefits of natural products in maintaining a balanced lifestyle; as such, the tendencies tend towards a consumption increase of different NWFPs (Kurttila et al. 2018).

In addition, besides the increase in their consumption and popularity, the harvesting and capitalization of NWFPs is an important aspect taken into account when planning the management of forests.

Non-wood forest products include edible mushrooms, seeds, forest fruits, medicinal plants, aromatic plants, resin, tannin, fibers, bark, oils, etc. (Corlățeanu, 1984).

Bacău County presents a high diversity of ecosystems (Stoica, 2009), being a representative county for Romania in regard with the variety of NWFPs. According to data and estimations from annual reports provided by Bacău Forest District, we can observe that forest fruits are very requested, followed by sea buckthorn fruits (*Hippophaë rhamnoides* L.) and brier fruits (*Rosa canina* L.) (Vasile et al., 2016). In 2018, 53,9 tons of sea buckthorn were obtained and delivered, as well as 79,5 tons of brier and 1,7 tons of raspberry (RNP, 2018).

Furthermore, edible mushrooms are also highly appreciated, one of the most frequently harvested and representative mushrooms from this county being *Armillaria mellea* (Vahl) P. Kumm (honey fungus) (Vasile et al., 2017).

Even though they are well represented in the county's forest fund, medicinal plants are not as intensely harvested in comparison with other counties, the quantities being even insignificant (Vasile et al., 2015).

As such, the aim of this study was to highlight the most important non-wood forest products from Bacău County.

### MATERIAL AND METHODS

Bacău County is situated in the North-East development region, occupying a surface of 6621 km<sup>2</sup> (Figure 1).



Figure 1. Location of Bacău County

On its territory, the relief is developed in levels, a fact that influences both the distribution of temperatures, precipitations and vegetation. The air's average temperatures vary between 12-20°C in July and can reach -7°C and - 4°C in January, while average precipitations range between 400 and 1400 mm.

According to the last statistical data, Bacău County is amongst the counties with the largest forest fund surfaces from the country (270167 hectares), as well as the one in which the largest regenerated surfaces can be found (868 hectares) (INS 2017).

The forest fund's composition is represented by broad-leaved forests (65,1%), followed by resinous ones (33,1%). The distribution on phytoclimatic levels as well as the altitude favor the installation of common beech stands. As such, common beech forests occupy the largest surface of the forest fund – over 40%, being followed by Norway Spruce and fir.

Forests from Bacău County are predominantly situated near villages, so that almost 60% of the forest fund is managed by Bacău Forest Directorate through its 14 forest districts, namely Bacău, Ciobănuș, Căiuți, Comănești, Dărmănești, Fântânele, Livezi, Mănăstirea Cașin, Moinești, Oituz, Sascut, Târgu Ocna, Traian and Zeletin.

Data regarding the non-wood products from Bacău Forest Directorate were obtained by consulting the following documents: forest management plans, reports from ROMSILVA – the National Forest Registry, as well as reports from the National Statistical Institute.

Subsequently, the analytical hierarchical concept developed by Saaty (2008) was used in order to classify the NWFP's potential. This model implies the following steps: i) comparing alternative pairs based on each criterion in order to organize them based on that specific factor; ii) comparing criterion pairs and iii) creating a performance matrix and calculating alternative scores for all criteria used.

AHP processing will attribute a percentage for each criterion of each level based on its importance in the level hierarchy. The used scale is composed of absolute numbers, from 1 to 8.

Once the alternatives were identified, the criteria that must be analyzed for selecting the available alternatives were selected. In the present case, the chosen criteria were: 1. harvesting period, 2. harvested quantity/ worker/8 hours, 3. harvesting cost, 4. harvesting, knowledge 5. tools needed for harvesting, 6. 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 centre). The same set of criteria was also used by Enescu et. al (2017, 2018a, 2018b), in order to establish the NWFP's potential from Maramureș, Timiș and Prahova Counties.

Furthermore, the eight alternatives were grouped on non-wood product categories, based on the methodology proposed by the COST FP1203 European network, as follows: mushrooms and truffles, tree products, understory plants and animal origin products.

The AHP technique also involves the usage of the Expert Choice Desktop software, specially adapted for mathematical calculations and for representing graphically the proposed alternatives.

## RESULTS AND DISCUSSION

Based on the data supplied by management plants, eight NWFPs were identified and selected, namely: truffles (*Tuber* spp.), penny bun (*Boletus edulis*), coniferous foliage, blackberries (*Rubus* spp.), wild cherry (*Prunus avium*), common nettle (*Urtica dioica*), honey and wild boar (*Sus scrofa*). Table number 1 details the AHP alternative ranking.

Based on the AHP results, the most important non-wood forest products from Bacău County were truffles and penny bun, while the least important ones were coniferous foliage and common nettle (Figure 2).

Table 1. AHP alternative ranking

Criterion	Mushrooms		Tree products	Understory plants			Animal origin	
	Truffles ( <i>Tuber</i> sp.)	Penny Bun ( <i>Boletus edulis</i> )	Coniferous foliage	Blackberries ( <i>Rubus</i> sp.)	Wild cherry ( <i>Prunus avium</i> )	Common nettle ( <i>Urtica dioica</i> )	Honey	Wild boar ( <i>Sus scrofa</i> )
1	5	4	8	2	1	6	3	7
2	4	6	7	3	8	2	5	1
3	6	5	2	3	4	1	7	8
4	7	8	1	4	2	3	5	6
5	8	5	4	2	3	1	7	6
6	8	5	2	3	4	1	7	6
7	7	3	2	4	5	1	8	6
8	6	8	1	5	4	3	2	7
9	5	7	6	1	4	2	3	8
10	7	8	1	5	6	2	3	4
11	7	8	1	5	6	2	4	3
12	8	7	1	6	5	2	3	4
13	6	5	2	4	7	1	8	3
14	6	7	2	4	5	1	8	3
15	6	7	2	4	5	1	8	3
16	8	5	2	3	4	1	7	6
17	8	6	2	3	5	1	4	7
18	6	5	1	4	2	3	8	7
19	2	8	3	6	4	1	5	7

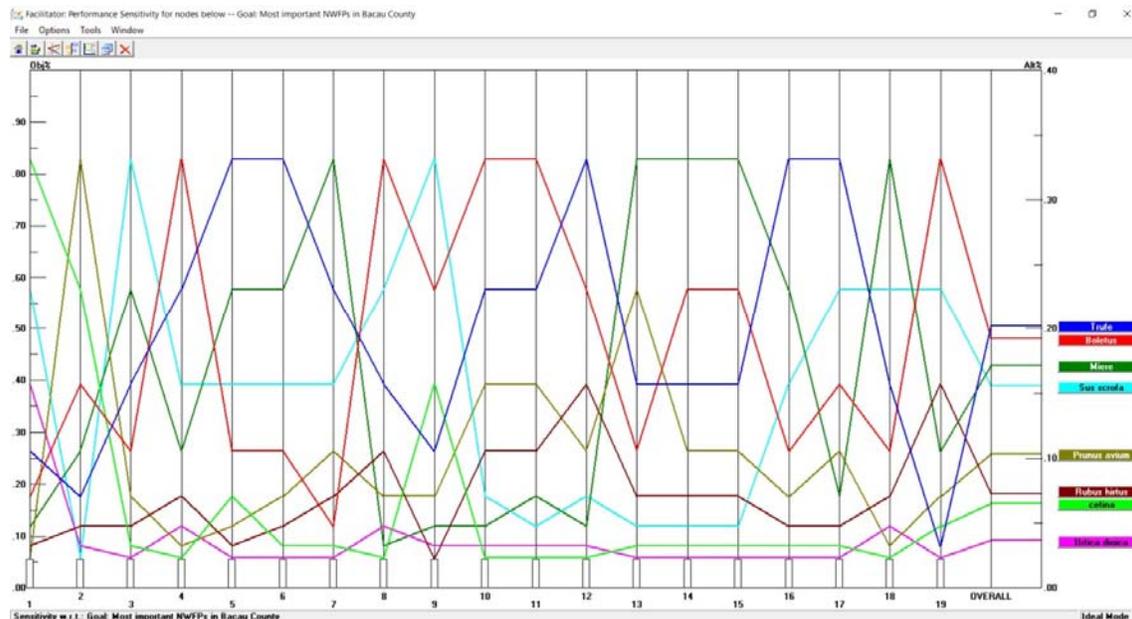


Figure 2. The ranking of the eight NWFPs

The truffles' name (*Tuber* sp.) derives from the Latin word *Tuber*, meaning up growth, swelling or tumor. They are mushrooms that grow in the soil and cannot be seen easily, a fact that makes their harvesting difficult. As such, specially trained dogs are required for this activity. In addition, certain harvesting rules must be honored so that their habitat is not destroyed: harvesting should be done only in the periods recognized and allowed for each species; specially trained dogs must be used and not rakes or hoes; only mature truffles can be harvested, etc. (Dincă & Dincă, 2012). Truffle plantations can be created for one or more tree and shrub species, such as: *Carpinus betulus* - hornbeam, *Corylus avellana* - hazel, *Corylus colurna* - Turkish hazel, *Fagus sylvatica* - common beech, *Quercus ilex* - cliff oak, *Quercus pubescens* - soft oak, *Quercus petraea ssp. petraea* - holmn, *Tilia cordata* - hill linden, *Cedrus atlantica* - cedar, *Pinus nigra austriaca* - Austrian black pine (Dincă & Dincă, 2014). However, for our country, truffle resources depend on forest soils characterized by an elevated pH, well aerated and with a constant humidity (Dincă & Dincă, 2015).

More than that, truffles proved to be the product with the highest potential for both Bihor (Timiș-Gânsac et al., 2019) and Brașov counties (Enescu et al., 2017).

Due to its rich and varied melliferous basis, Bacău County can significantly contribute to high economic benefits, as honey is situated in the hierarchy's third position.

Honey is a very requested resource both on the national and international market, being a valuable product as both food source and medicine (Kohsaka et al., 2017).

In 2018, Romania has occupied the first place in the European Union for honey production, with a total quantity of 30,9 thousand tons (European Comision, 2019). In addition to honey, numerous products obtained for it are requested and commercialized on the market such as pollen, royal jelly, propolis, wax and bee venom (Güngör & Sen, 2018). These derived products are used in preparing a large array of nutritive and/or medicinal supplements, as well as in the cosmetic industry.

A varied portfolio of derived products, the product's "celebrity" on the market, its high potential and the large market request as well as extremely developed harvesting processes are criteria that have made honey obtain a maximum tally and a promising position in the classification.

Amongst all NWFPs included in the study, savin has the longest harvesting period. This product can be obtained all year long in considerable quantities through cultural exploitations and operations. The savin production varies on the species, tree's age, consistency, altitude, slope exposition, etc. In present conditions and at Bacău County's level, Norway spruce and fir are representative for their savin economic value. Estimates show that the average savin production has reached 20860 kg/ha for Norway spruce stands, and 25185 kg/ha for fir stands (Corlățeanu, 1984).

Through its industrial capitalization, the following products can be obtained from savin: volatile (etheric) oils, wax, chlorophyll or fodder flour. However, in comparison with the other analyzed products, savin has the lowest portfolio of derived products, due to the fact that currently it is not used at its potential (criterion 18).

In the past, gathering coniferous stings (especially from Norway spruces) was a common activity as they were used as organic material for agricultural cultures or as prime material for preparing compost or even as animal bedding (Ciesla 1998).

Even though savin contains numerous valuable chemical substances (Beldeanu, 2008), only a small part is capitalized presently. A major setback in the potential usage of this product is also posed by problems in harvesting and delivering savin (Sahin & Yalcin, 2017).

## CONCLUSIONS

Forests from Bacău County can be managed for obtaining a large array of non-wood forest product. This aspect is favored by the relief's variety (mountains, hills, basins and meadows), the high degree of coverage with forest vegetation and the diversity of species (common beech, fir, holm, oak, poplar, birch, hornbeam, corn, hawthorn, field maple, etc.)

Knowing the potential of counties rich in NWFPs is essential for a proper management of these resources.

The final classification, established through the AHP technique, shows that edible mushrooms are the products with the highest potential for Bacău County. Honey also has a high potential and can be seen as an opportunity for diversifying the county's portfolio of products. The last two positions are occupied by savin and nettle but with a prominent difference between them. Both have long harvesting periods, the lowest market request and potential, the lowest prices for raw and derived products as well as the least varied portfolio of derived products.

A re-orientation of forest economy is essential for the future, taking into account the potential of non-wood forest products from Bacău County.

## ABSTRACT

A significant and growing demand for natural resources of vegetal origin (other than wood) provided by the forest (non-wood forest products) is present nowadays.

The goal of this article is to establish the most promising non-wood forest products (NWFPs) from Bacău County. Choosing the most promising NWFPs for Bacău County was made based on a selection criteria prioritized by the Analytic Hierarchy Process (AHP) model. In order to facilitate the pairwise comparisons process used in the AHP technique, we have selected eight NWFPs, namely: truffles (*Tuber* sp.), penny bun (*Boletus edulis*), coniferous foliage, blackberries (*Rubus* sp.), wild cherry (*Prunus avium*), common nettle (*Urtica dioica*), honey and wild boar (*Sus scrofa*).

The sensitivity analysis has indicated that truffles, are the products with the highest potential, while the common nettle has the lowest potential.

Furthermore, this model provides relevant information on how to manage these resources in the future.

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