HOW RELEVANT IS THE HIERARCHICAL-ANALYTICAL PROCESS IN THE PARTICULAR CASE OF NON-WOOD FOREST PRODUCTS FROM CĂLĂRAȘI COUNTY, ROMANIA?

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Abstract. *In Romania, the biodiversity of forest species is high, being into a constantly growing, due to the variaty of relief forms, temperate-continental climate and normally hydrological regime which creates many types of ecosystems. Beside wood products, the most popular categories of non-wood products met into the Romanian territory are the following: mushrooms, forest fruits, medicinal plants, resins and wild species, being important forest resources that can be exploited and processed. As such, the goal of the present article was to highlight the most representative NWFPs from Călărași county based on the implementation of hierarchical analytical process, the selected one's being the forest fruits. As materials, were utilised the data published in annual reports from Călărași County Forest Administration, as well as the databases from the Catalogs of National Institute of Statistics. The documentation was important to establish the range of distribution for forest fruits, the applied technology of harvesting and so on. As methods, it was used the Analytical-Hierarchy Process (AHP), by means of pairwise comparisons. The sensivity was achieved by using the Expert Choice Desktop software package. The degree of novelty is represented by this kind of multicriteria analysis, which brings essential informations about the actual state of forest fruits. It was found that the most promising forest fruis are: hazelnuts, wild pears and the acorns. The research limitations is related to the lack of detailed information about economics or ecology of NWFPs. The statistics of NWFPs are available, but the informations are poorly disseminated and are not accesible across the Europe. Originality of the paper is related to the collected databases which are unique, being utilised for the original interface of NWFPs encountered in Călărași county. Relevance comes from the idea of trading forest goods, maintaining a good collaboration with stakeholders or managers, who want to perform their economic strategy.*

Keywords*: hierarchical-analytical process (AHP), Expert Choice Desktop, harvesting period, market demand, forest fruits*

INTRODUCTION

Several European regions consider non-wood forest products as being an important resource which create income assurance, support means for livelihoods, encouraging old traditions and stimulate the competitiveness within rural communities (NICHIFOREL, 2014). The global trend towards non-wood forest products (NWFPs) from the categories of edible mushrooms, animal origin, forest fruits and medicinal plants has grown, due to the curative qualities that they dispose (BRAGĂ *ET AL.*, 2019). The new definition of NWFPs adopted within the meeting at FAO department in 1999, emphasizes them as being "goods of biological origin other than wood, derived from forests, other wooded land and trees outside forests" (FAO, 1999). According to terms and definitions promoted by FAO in 2015, NWFPs include animal origin and plants products harvested from the specific areas which are defined as forests, whether that provenance is from natural forests or plantations (bamboo, cork, Christmas tree, arabic gum) and definitively exclude those collected from stands included in agricultural systems (plantations of fruit trees, oil palms, agroforestry systems). Moreover, it excludes raw material or products derived from wood -charcoal, chips, wood for making tools, fuelwood (FAO, 2015). In the latest report published in the Europe's Forests State, it was estimated that the entire value of NWFPs is

covering almost 10% from the total value of roundwood (FOREST EUROPE, 2015). National Forest Administration-Romsilva reports annualy for valorification about 3000 tones of forest fruits, collected from the spontaneus flora of Romania (http://www.rosilva.ro/articole/fructele_de_padure__p_2512.htm).

The economic contribution of NWFPs was explored in the STARTREE project by using the UN Comtrade database for estimation of the values and volumes of them, especially in international trade, such as cork, berries, foliage, mushrooms, nuts and even honey. The estimated value of global trade was around 12 billions USD (2011) and almost 39% is represented by income of NWFPs especially from agricultural production (PETTENELLA *ET AL.*, 2014). In general, the monetary policy is not prevalent or targeted for NWFPs (LUDVIG *ET AL.*, 2016). In some case studies within main institutional structures from Europe is was found that several NWFPs specific conglomerats brought important impacts in terms of innovations (LUDVIG *ET AL.*, 2016).

The aim of the paper was to analyse the potential contribution of the most important forest fruits (berries) from Călărași County with the help of hierarchical-analytical process (AHP). Located in Southeastern Romania, on the left side of the Borcea branch of the Danube (figure 1 a, b), Călărași dominates through the chain of industries such as: food industry, the melamine chipboard industry, the steel industry, the paper industry and the prefabricated industry. In conformity with the Statistics of activities from forestry in 2018, the total area of forest from Călărași county was of 21152 hectares from which 21102 hectares of deciduous forests and 50 hectares of coniferous forests, most of them being administrated by Călărași Forest County Administration, a subunity belonging of National Forest Administration Romsilva(https://insse.ro/cms/sites/default/files/field/publicatii/statistica_activitatilor_din_silvicultura_in_anul_2018.pdf).

The forest districts which activate within the Forest County Administration mentioned above are: Călărași, Lehliu, Mitreni (http://www.rosilva.ro/unitati_silvice/calarasi__l_51.html).

The statistics brief highlight the descreasing of the fruits production in 2019 (3.7 thousand) with 5.1% smaller comparatively with year 2018. Călărași Forest County Administration, in terms of capitalization activities, it records annual revenues from the sale of berries, such as: blackberries, wild strawberries, blueberies, fruits of bird cherry, hazelnuts, wild pears and acorns. On the territory of this county, there are protected areas of national interest, classified in IUCN fourth category, avifaunistic, faunistic, floristic and forestry types, such as: Iezerul Călărași, Ostrovul Ciocănești, Ostrovul Haralambie, Ostrovul Șoimul and Ciornuleasa Forest (http://www.mmediu.ro/app/webroot/uploads/files/Anexa_nr_1.pdf).

a b

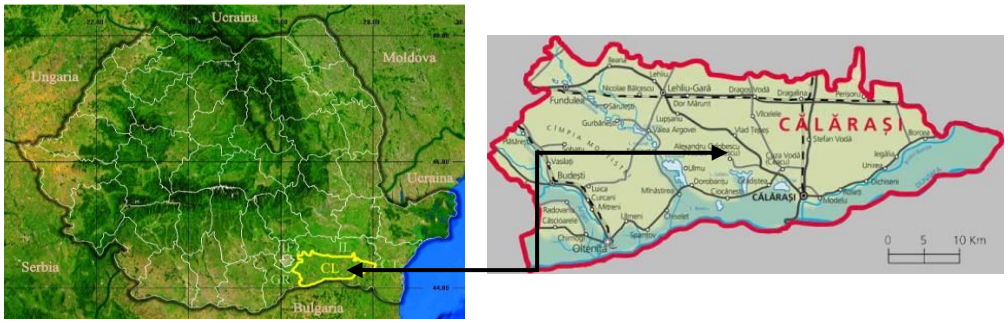

Figure 1. The location of the study:
a. the position of Călărași county on Romanian map
b. physical map of Călărași county

MATERIAL AND METHODS

Based on the consultation of forest management plans from the last decade applied for the forest districts administrated by Călărași Forest County Administration, it was constituted the needed databases in order to achieve the objectives of the present article. Also, from the chapter on the capitalization of non-wood products, the most important and common non-wood products with zonal specificity were selected. Databases considered as base materials were upgraded on the results from the registered and published annual reports on the official site of Ministry of Environment, Water and Forests (http://www.mmediu.ro/categorie/starea-padurilor/209) as well as of those after the valorification of forestry products at the level of forest districts. For the determination of the most important forests fruits, as method, it was used the implementation of analytical-hierarchical process (AHP), being considered an complex system of multicriterial analysis. This process was fundamented by the expert Thomas Saaty in 2008 (SAATY, 2008). The analysis is functional in the case of applying various methodologies to substantiate the decision-making process and contains terms from mathematics, logistics and psychology.

The AHP model is based on four steps such as:

1) decision problem decomposition into a hierarchy which is more easier to comprehend sub-problems;
2) making the pairwise comparison (each with other two) by evaluating the elements from hierarchy in time;
3) the process of converting these evaluations into numerical values;
4) calculating for each alternatives, the numerical priorities.

For the analysis, it were taken into consideration the 19th criteria which describes technological operations from the harvesting moment and until the carrying out their transport to the beneficiary (DINCĂ *ET AL.*,2019; CIONTU *ET AL.*, 2018). The criteria are presented succintly in the *Table 1*. The activity of pairwise comparison involves to usage of the absolute numbers scale which specifies whenever one object is more important than the other object, respecting the condition imposed by the criterion by which those two are compared. Absolute numbers are located into the range of the interval (1 to 8), each number designating a certain intensity of importance (i.e criterion 1-harvesting period: 1= the shortest harvesting period …8= the longest harvesting period). The sensitivity of the forest fruits was obtained through the Expert Choice Desktop program that amplifies the hierarchy notion. The hierarchical-analytical process has been successfully applied in many studies conducted in various counties in Romania, such as: Bacău (BLAGA *ET AL.*, 2019), Brăila (VECHIU *ET AL.*, 2019), Dâmbovița (BRAGĂ *ET AL.*, 2019), Arad (PLEȘCA *ET* AL., 2019), Bistrita-Năsăud (TUDOR *ET AL.*, 2020), Iași (BLAGA *ET AL.*, 2018), Vrancea (TUDOR *ET AL.*, 2019), Buzău (TUDOR *ET AL.*, 2020).

RESULTS AND DISCUSSIONS

The forest fruits represent an important resource, renewable over time, which provides an important turnover for companies that sustainable manage this activity. From the category of NWFPs, forest fruits from many forest species of plants, trees and shrubs were selected. The analyzed forest fruits (*Table 1*, Figure 2) were: blackberries (*Rubus hirtus*), wild strawberries (*Fragaria vesca*), blackthorns (*Prunus spinosa*), blueberries (*Ribes nigrum*), bird cherries (*Prunus padus*), hazelnuts (*Corylus avellana*), wild pears (*Pyrus pyraster*) and acorns (*Quercus* sp). Through the utilization of AHP, based on the opinions of 3 experts, high means of alternatives were obtained in the case of hazelnuts (6.68), acorns (5.11) and of wild pears. The

wild strawberries and blackthorns occupy low means (3.21-3.42), due to the presence of a small number of alternatives and with a reduced intensity of those importance (Figure 3).

Table 1

The repartition of alternatives number for analyzed forest fruits from Călărași county

Criterion	Species							
	Rubus hirtus	*Fragaria vesca*	*Prunus spinosa*	*Ribes nigrum*	*Prunus padus*	*Corylus avellana*	*Pyrus pyraster*	*Quercus* sp.
1.Harvesting period	6	1	5	2	3	7	4	8
2.Harvested quantity / worker / 8 hours	2	1	4	3	5	7	6	8
3.Harvesting cost	3	1	4	2	5	7	8	6
4.Knowledge for harvesting	2	1	4	3	5	6	7	8
5.Tools needed for harvesting	2	1	5	3	4	6	8	7
6.Complexity of harvesting process	2	1	5	3	4	7	8	6
7.Development of harvesting process	2	1	7	4	3	6	8	5
8.Knowledge for recognition	2	1	7	6	8	3	5	4
9.Distribution range	5	3	1	7	2	8	4	6
10.Biotic threats	7	1	2	6	8	5	3	4
11.Abiotic threats	4	2	1	6	5	7	3	8
12.Perishability	2	8	3	1	4	6	7	5
13.Market potential	7	6	2	5	3	8	1	4
14.Market demand	7	5	2	6	3	8	1	4
15.“Celebrity” of the product on market	7	6	2	5	1	8	3	4
16.The price of raw product	5	8	2	3	4	7	6	1
17.The price of the derived products	6	7	4	5	3	8	2	1
18.Portfolio of derived products	7	5	4	6	3	8	2	1
19.Transport (harvesting - storage center)	8	2	1	4	3	5	6	7

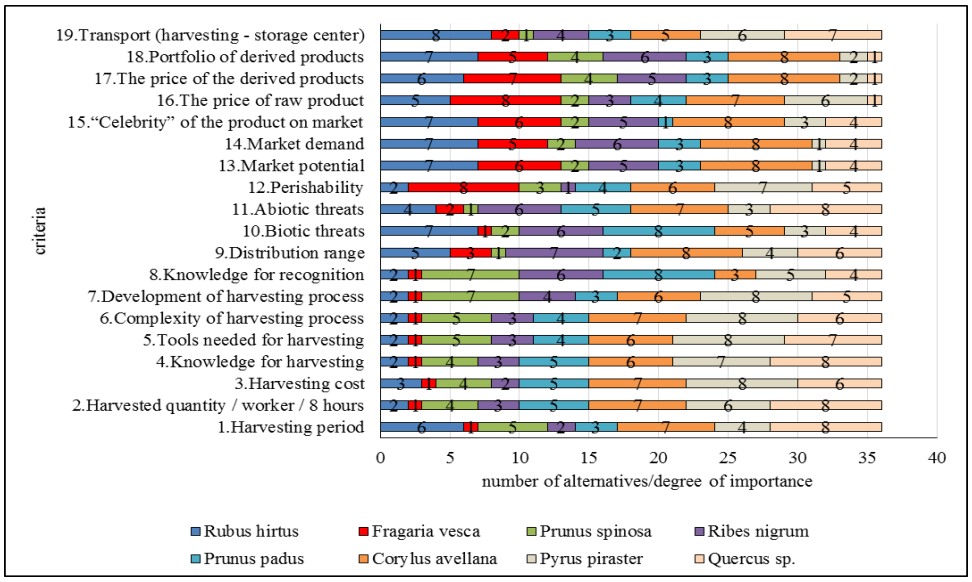

Figure 2. The distribution of alternatives on 19 well-established criteria for forest fruits located in Călărași county

Hazelnuts receive a total of 127 alternatives from experts. Among these, 42 alternatives were represented by strongly importance (number 7) and 48 obtained very strongly importance (number 8). There are also similar alternatives in the case of wild pears and acorns (92, respectively 97), 38 with very strongly importance and 14 with strongly importance compared to the fruits analyzed above.

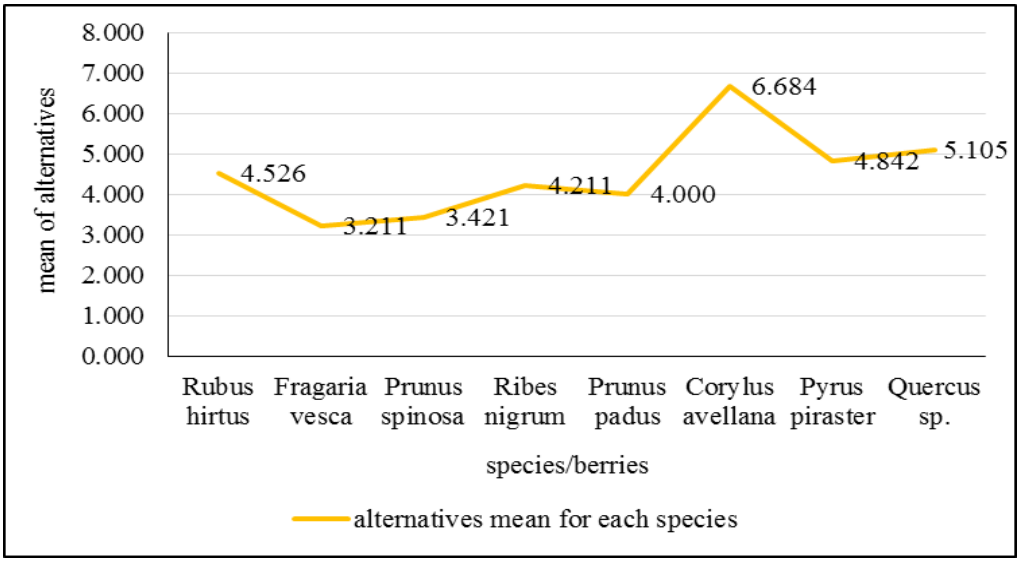

Figure 3. The distribution of alternative means

In general, hazelnuts and acorns have been found to require long harvesting periods (criterion 1) and the quantities harvested by a worker in 8 hours are quite longer (criterion 2). The costs of harvesting is also low for hazelnuts and wild pears (criteria 3). The complexity and development of the harvesting process for wild pears are high, compared with wild strawberries, where both processes are extremely low. From the forest fruits analyzed, hazelnuts brings numerous contributions in the marketing segment, through high potential and demand, as well as a wide variety of the derived products.

For the type of fruit called achene (hazelnuts and acorns), biotic or abiotic threats and perishability do not have a negative impact on them, whereas for wild pears, harmful factors of biotic or abiotic nature (criteria 11, 12), may affect the quality of the pulp of the fruit. By drawing the sensitivity diagram, the special socio-economic contribution of those three forest fruits was confirmed, being ranked on the first 3 positions (Figure 4).

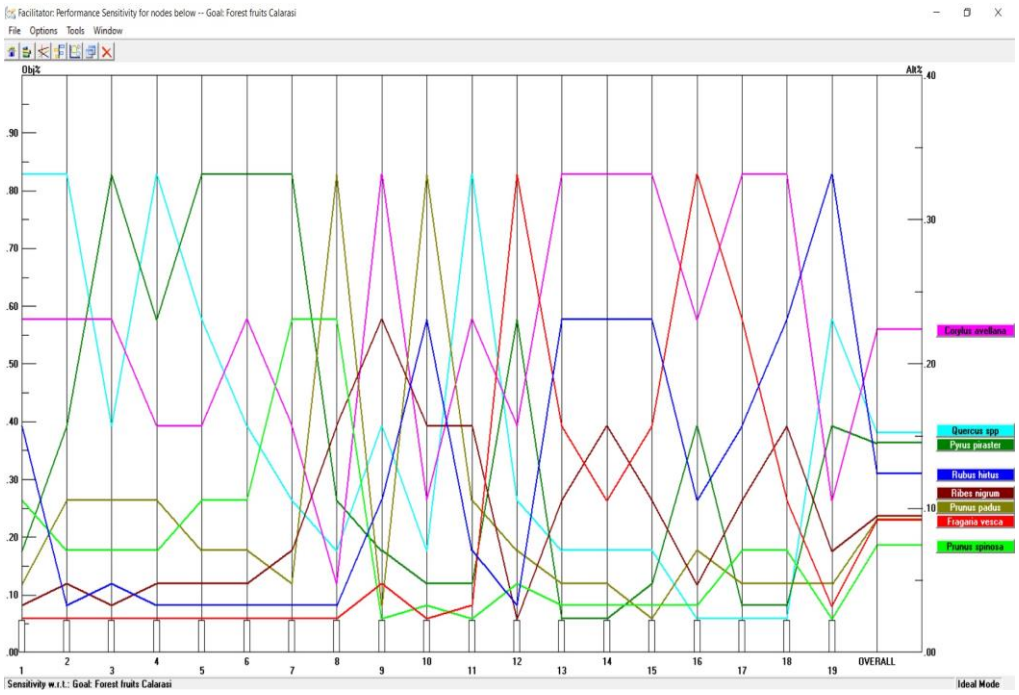

Figure 4. The diagram of sensivity obtained through the Expert Choice Desktop software

***Corylus avellana* (hazelnut).** Numerous studies have showed the importance of hazelnuts, as well as of *Corylus avelanna* plantations on the Romanian territory. Based on this species, truffles plantations can be made with the help of potions inoculated with *Tuber aestivum* mycelium (DINCĂ AND DINCĂ, 2014). The importance of these plantations is represented by 2 advantages: the production of truffles and hazelnuts. It is estimated that the annual production of truffles can reach 140 tons (DINCĂ AND DINCĂ, 2012). Hazelnut shells contain high number of polyphenols and according to the biological assays, these compounds can be particularly useful in food technology or pharmaceutical industry (MENCHERINI *ET AL*., 2017). Almost 90% of shelled hazelnuts are used as an important compound in food (bakery, chocolate, confectionary industry) industries (CIARMIELLO *ET AL*., 2014; MADESIS *ET AL*., 2013).

***Pyrus pyraster* (wild pears).** *Pyrus pyraster*, named as European wild pear, is a species from Rosaceae family. It is considered that species of *Pyrus pyraster* and *Pyrus caucasica* are the ancestors of domesticated form *Pyrus communis* (European pear). The genus *Pyrus* L. have almost 38 species and numerous interspecific hybrids. The wild species are spreaded in Europe, temperate zones of Asia, north-west of Africa (BROWICZ, 1993). In Poland, the studies carried by DOLATOWSKI *ET AL.*, 2004, showed that the genetic parts of *Pyrus pyraster* communities it may be highly genetically eroded. In Romania, the European wild pear is distributed on the edges of hardwood forests, pure or mixed with deciduous species, grouped or isolated. In Satu Mare county, Romania, it can be found the Reservation of European wild pears which is unique in Europe. Here, some of the exemplars reached almost 150 years and they still growing (https://www.presasm.ro/fotogalerie-tezaurul-din-satu-mare-cea-mai-mare-rezervatie-de-par-salbatic-din-europa/).

The fruits are edible, with 1-4 centimetres in diameter, hard pulp and astringent taste. A sweet taste is reached when they are riped (https://en.wikipedia.org/wiki/Pyrus_pyraster/). The wild pears bring potential economic contribution in alimentary industry, with a large area of capitalizing modalities. The fruits can be consumed whole, raw or in compote, juice, marmalade, paste or puree mixed with other fruits. Through fermentation you can get various drinks such as: vinegar, cider, liqueur, brandy (www.mybusiness.honlapom.com).

***Quercus* sp. (acorns).** The achenes are called acorns, being the fruits of oak species. The acorns can be bitter (*Quercus ilex subsp. ilex*) or sweet (*Quercus ilex subsp. ballota*). Since the old times, the acorn was an important resource for both feeding pigs and goats (https://ro.wikipedia.org/wiki/Ghind%C4%83). In the early century, acorns have played an important role in human wellbeing, being an important source of food for many crops around the world (BAINBRIDGE, 1986).

For wildlife species, acorns represent an important source of food, being highly digestible, with strongly energetical compounds such as fats, low proteins and so on (KIRPATRICK AND PEKINS, 2002). Since the ancient times, the acorns were usually characterised as a famine food, based on the evidence which was partially described by undetailed ethnographic record (MASON, 1992).

CONCLUSIONS

Călărași County offers a great variability of forest fruits, from various species of plants, trees and shrubs. Their pronounced distribution is rendered by the relief with the flat configuration, warm climate, as well as the ecological conditions of growth and development of the species with pronounced temperament of light and with high amplitude towards the summer heat. The forest management plans have established the estimated quantities of forest fruits harvested over a decade, but these values do not provide the necessary accuracy, requiring in-depth studies conducted by forestry specialists in the field. With the help of the hierarchical-analytical process (AHP), the most important forest fruits proved to be hazelnuts (*Corylus avellana*), wild pears (*Pyrus pyraster*) and acorns (*Quercus* sp.), in terms of the 19th criteria that lead to their appreciation in social, economic and cultural plan. The use of this process allows the expression of the importance of forest fruits based on the assigned alternatives, being an efficient mean of prioritizing them that provides the necessary information to develop the best decisions on capitalization and marketing of new products, based on constructive strategies.

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