

## THE IMPORTANCE OF NON-WOOD FOREST PRODUCTS WITHIN TESTING THE ANALYTIC HIERARCHY PROCESS, IN SATU MARE COUNTY, ROMANIA

Ciprian Tudor, Cristinel Constandache, Lucian Dincă

**Key words:** analysis, analytic hierarchy process (AHP), decision making, non-wood forest products (NWFPs)

### INTRODUCTION

In 1999, the new definition of NWFPs has been adopted, into an FAO Congress: "Non-wood forest products consist of goods of biological origin other than wood, derived from forests, other wooded land and trees outside forests" (FAO, 1999).

A lot of specific conglomerates were discovered during the innovations carried out in the different types of institutions, which involved critical impacts in the segment of non-wood forest products (Ludvig *et al.*, 2016). In many countries it was elaborated a lot of nutritional and medical researches for discovering the most important chemical substances of forest fruits.

In Romania, some economic objectives were accomplished well in terms of selling and commercializing forest fruits, such as: sea buckthorn, raspberries, blueberries, blackberries and rosehips (Vasile *et al.*, 2016).

Non-wood forest products (NWFPs) bring a lot of contributions in the bioeconomy, having an important role for increasing the economic potential and widening the borders of the market segmentation (Prokofieva *et al.*, 2017). In Romania, the definition of the non-wood forest products is presented well in the Forestry Code (Law 46/2008) article 58, paragraph (3) which includes flora, fauna, forest fruits, mushrooms, medicinal plants and so on (Blaga *et al.*, 2018; Tiwary *et al.*, 2020). A well sustained management is improved by their potential to climb up in the economic sector, especially in rural communities, where the wood is not so demanded by the as forest product (Huber *et al.*, 2019).

Non-wood forest products (NWFP) is an important resource provided by the forests, being an integral share of goods. Also, these are usually utilised in human's diet, recreation activities and social outputs, being an good opportunity to generate income. The derived products offer an good entrance in the market field (Vacik *et al.*, 2019).

This paper brings clearly informations about the processes involved in evaluation of the non-wood forest products qualities and the ways of obtaining pure consequences about them, by using the analytic hierarchy process (AHP), based on multicriterial sequences. The aim of the paper is to highlight the

most important and demanded categories of non-wood forest products (NWFPs) from Satu Mare County, Romania, surprising their actual contribution in technical, social and economic segmentation in the market zone.

From a geographical point of view, Satu Mare County is situated in North-Western Romania (figure 1. A, B).

In 1968, it was founded by the territorial restructuring of the former Maramures Region. The estimated surface reaches 4.418 km<sup>2</sup> (1,9% from national territory). The categories of land uses includes: 72% agricultural land, 18% forests, 3% rivers, 7% another surfaces (www.wikipedia.org).

In 2014, according to the data processed within the National Institute of Statistics (INSSE), the surface of forests and forest vegetation from the outside the forest fund, occupies approximatively 73.444 ha (www.insse.ro). In 2015, the Satu Mare County Forest Administration reported a total area of the state-owned forest fund, managed by National Forest Administration Romsilva, of approximately 28.356 ha representing approximately 43% of the national forest fund in Satu Mare County (www.rosilva.ro).

Thus, the following non-wood forest products can be found in Satu Mare County in the next branches: edible mushrooms, seeds production, fauna of hunting interest and medicinal plants.

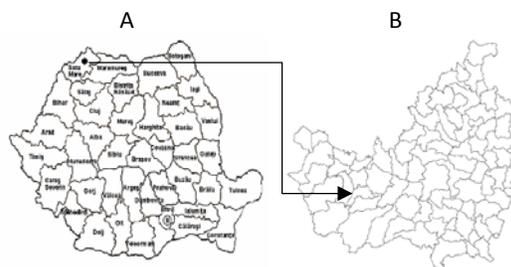


Figure 1. Geographical position of Cluj County on Romania physical map: A; B

### MATERIAL AND METHOD

As materials, it were used the databases from the reports and documents carried out by forest districts,

within Satu Mare County Forest Administration, as well as informations which were given by speciality ministries. In the content of the paper it were analyzed 4 categories of NWFPs such as: 1. Mushrooms, 2. Tree products, 3. Understory plants, 4. Animal origin.

These four categories were included in the European project COST Action FP1203 and were studied in similar reseaches in county's such as: Bihor (Timiș-Gânsac *et al.*, 2018), Dâmbovița (Cântar *et al.*, 2020), Vrancea (Tudor *et al.*, 2019), Bacău (Blaga *et al.*, 2019), Buzău (Tudor *et al.*, 2020), Arad (Pleșca *et al.*, 2019), Brăila (Vechiu *et al.*, 2019).

As methods, for describing benefits the non-wood forest products and their importance, it was used made an multicriteria analysis, being integrated in the Analytical Hierarchy Process (AHP). Developed in 2008, by the expert Thomas Saaty, this kind of analysis is based on multicriteria sequences, being an important step in decision making process (Saaty, 2008). In the vision of Saaty, the Analytic Hierarchy Process (AHP) is a theory which is based on the complex comparisons and derive priority scales from the reasons of the experts. It is these scales that measure intangibles in relative terms. This theory is a well structured technique, based on the connection between mathematics and psychology.

The scales contains an absolute set of numbers situated into the interval (1...8), which represents the the comparisons values. It's all about how one element can dominates another one, to a given attribute. The AHP, help the decision makers and the stakeholders to find which goal fits best the alternatives from the decision making process. The procees is made up by 19-well established criteria (table 1, 2) and for each of them, the absolute numbers from the scale, are attributed. After Saaty, 2008, the absolute numbers shows the intensity of importance as shown below:

1 Equal Importance

2 Weak/ slight

3 Moderate importance

4 Moderate plus

5 Strong importance

6 Strong plus

7 Very strong/ demonstrated importance

8 Very, very strong/ Extreme importance.

So, when the number in 1, two kind of activities will contribute equally for accomplish an fixed objective. As we move towards to number 8, those 2 activities differ as intensity, one being more or less above the other.

Those 19 criteria capture essential aspects related to the method of harvesting, processing, marketing and transportation of non-timber forest products:

1 → harvesting period

2 → harvested quantity/ worker/8 hours

3 → harvesting cost

4 → knowledge for harvesting

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

19 → transport process.

Also, the Expert Choice Desktop (v. 11.5.1683) software package was used for making the diagram of sensivity of every species analyzed. This program was designed to see the gaps and the difference between the attributes distributed for each criteria as well as the degree of importance.

## RESULTS AND DISCUSSIONS

From the set of data mentioned above, the pairwise comparisons by using the judgements of the experts were made for the selected non-wood forests such as: *Cantharellus cibarius* (chanterelle), *Armillaria mellea* (honey fungus), sessile oak seeds, *Corylus avellana* (hazelnut), *Fragaria vesca* (raspberry-bush), *Urtica dioica* (nettle), *Alium ursinum* (wild garlic) and *Lepus europaeus* (european hare). The analytic hierachy process (AHP) has worked independent for every criterion, being realised through the experts opinion. From the diagram of sensivity designed in the program Expert Choice Desktop (figure 2), it was identified that the most important and demanded non-wood forest products (NWFPs), with an high rate of alternatives participation are making apart from the categories of Animal origin (*Lepus europaeus*- European hare), Mushrooms (*Armillaria mellea*- Honey fungus) and Tree products (*Corylus avellana*- hazelnut).

Similar studies using AHP were conducted by Enescu *et al.*, 2018, in Timiș county, where the European hare counting a largest population with a very strong importance (8) for the criterion 9 (distribution range). Also it brings a lot of derived products, being an important segment of gastronomic tourism (Cîrnu and Nichiforel, 2014). Furthermore, according to the analysis of European hare in Dolj County (Cântar *et al.*, 2018), it has proved that is brings a long harvesting period, an various portfolio of derived products, a high distribution range as well as an high demand on market. For this study (table 2), the European hare takes moderate importance (3) for the portofolio of derived products (criterion 18) and strong importance for the distribution range (criterion 9) and market demand (criterion 14). In 2017, according to the data provided by the Ministry of Waters and Forests, in Satu Mare County, Romania, the population of European hare

accounting a number of individuals situated in interval 37000-45000 (Enescu and Drăgoi, 2019). From the mushrooms category (table 1), Honey fungus represents an important source for gastronomic tourism, culinary recipes, being an important part of the local cuisine. The AHP has proved an good complex of alternatives with demonstrated importance (7) and extreme importance (8) in the case of activities adjusted to the criteria (5, 14, 16, 18). The mean of the intensity importance structured by the number of alternatives was 7.5, which is very close to the maximum potential (extreme importance). Beside of these strongly points, honey fungus communities have a lot of abiotic threats. For Satu Mare county, at the same criteria, the Honey fungus has register lower mean of the alternatives (mean=5.6). In terms of abiotic threats and the portofolio of derived products, the number of alternatives for each criterion is the same. For the cycle of harvesting period, the costs of harvesting and the distribution range were attributed moderate to strong importance (4,5).

In the category of understory plants, *Corylus avellana* (hazelnut) registered 8 criteria with strong importance (7), for the activities related to the harvesting period, cost, complexity and knowlegde. The trend is in growth, due to the high mean of alternatives and subproblems selected to satisfy well the objectives of each criteria (mean=6.26).

As disadvantages, most of the alternatives have extreme importance (8) in the case of criteria 10, 12 and 16, hazelnut being affected by the harmful effects of the biotic threats, perishability and the expensive price of the derived products. Weak importance was recorded in the market segment (market demand), which involves majore capital looses.

Table 1. The results recorded for the categories of Mushrooms, Tree products and those of Animal origin

Criterion	Mushrooms		Tree products	Animal origin
	<i>Cantharellus cibarius</i>	<i>Armillaria mellea</i>	Oak seeds	<i>Lepus europeus</i>
1.Harvesting period	4	5	8	7
2.Harvested quantity / worker / 8 hours	5	6	1	8
3.Harvesting cost	4	5	8	1
4.Knowledge for harvesting	4	5	6	8
5.Tools needed for harvesting	8	7	6	3
6.Complexity of harvesting process	4	6	5	8
7.Development of harvesting process	4	5	6	8

8.Knowledge for recognition	5	4	7	8
9.Distribution range	2	4	6	5
10.Biotic threats	7	6	1	4
11.Abiotic threats	5	4	3	8
12.Perishability	4	5	2	6
13.Market potential	5	3	6	8
14.Market demand	7	8	1	5
15.“Celebrity” of the product on market	8	6	1	3
16.The price of raw product	6	7	1	5
17.The price of the derived products	6	5	7	8
18.Portfolio of derived products	7	8	4	3
19.Transport (harvesting - storage center)	4	5	6	8

Table 2.The results recorded for the category of Understory plants

Criterion	Understory plants			
	<i>Corylus avellana</i>	<i>Fragaria vesca</i>	<i>Urtica dioica</i>	<i>Alium ursinum</i>
1.Harvesting period	6	2	3	1
2.Harvested quantity / worker / 8 hours	7	4	3	2
3.Harvesting cost	7	2	3	6
4.Knowledge for harvesting	7	3	2	1
5.Tools needed for harvesting	5	4	2	1
6.Complexity of harvesting process	7	3	1	2
7.Development of harvesting process	7	3	2	1
8.Knowledge for recognition	6	2	3	1
9.Distribution range	7	1	8	3
10.Biotic threats	8	5	3	2
11.Abiotic threats	6	7	1	2
12.Perishability	8	7	1	3
13.Market potentia	7	4	1	2
14.Market demand	2	6	3	4
15.“Celebrity” of the product on market	5	7	4	2
16.The price of raw product	8	3	4	2
17.The price of the derived products	4	3	1	2
18.Portfolio of derived products	5	6	1	2
19.Transport (harvesting - storage center)	7	1	3	2

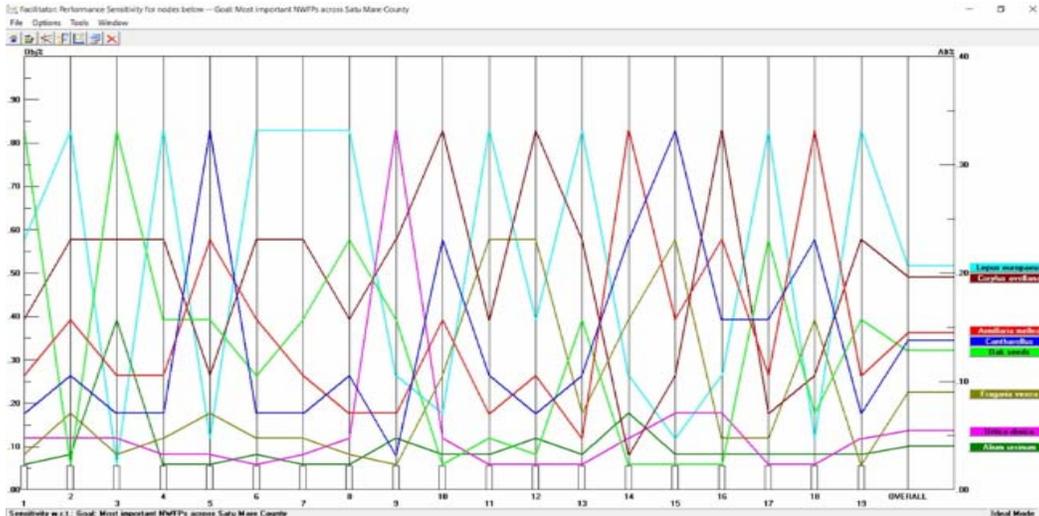


Figure 2. The ranking of the intensity importance for each analyzed species (the diagram of sensitivity)

Due to its importance for hunting, the European hare was widely distributed to many countries outside its original range. Its ability to expand the natural area is strictly influenced by the presence of a large number of natural enemies. However, the European hare population is maintained due to its large breeding capacity. In 2009, in 65 Giera Area Forest District Lunca Timisului, Timiș County, the European hare species, has registered an effective of 670 individuals. In 2010, there is an increase with 60 individuals (8.95%), reaching 730 individuals, showing the high rate of breeding (Dronca *et al.*, 2014). Into an study carried out by Enescu *et al.*, 2018, it is shown that in 2017, an high rate of population growth of European hare has been recorded in Timiș County, Romania, summing 73.962 individuals (7.1% from total population recorded in Romania).

*Armillaria mellea* (Honey fungus) is a mushroom with a high culinary appreciation in Romania being considered an “traditional food”. Honey fungus (*Armillaria mellea*(Vahl) P.Kumm.) can be well conserved after the harvesting period, being used during winter as aperitifs or garnish such as “zacuscă”, stew and holopchi (Dincă and Gânsac, 2020). Since the oldest time, their usage was applied by the local populations in numerous rural or urban communities from the entire territory of Romania as an important source of food and for rise up the capital incomes especially in rural zones (Birkinshaw *et al.*, 1948).

Some significant quantities of Honey fungus are harvested in many counties across Romania, but mainly in Bacău, Maramureș, Suceava, Mureș, Neamț. Their distribution range is amplified in beech forests, where the fructification can be strong in hilly and mountain regions, but weaker in plain areas (Vasile *et al.*, 2017). In general, the nutritional value of edible fungi (Honey fungus, penny bun) is

due by their high content of fiber, protein, minerals, vitamins and insignificant quantities of fats (Mattila *et al.*, 2001; Barros *et al.*, 2008). Respecting their chemical composition, edible mushrooms could contain an alternative source of new antimicrobial compounds, in principal secondary metabolites (Valverde *et al.*, 2014).

*Corylus avellana* or hazelnut, is a shrub which produce the fruits called “hazelnuts”. These achenes stores a major amount of triacylglycerols, accounting for up to 60% from the dry weight of seeds (Savage *et al.*, 1997). Due to the fact that the hazelnuts have an significant amount of fats, protein, vitamins, dietary fibers, minerals and phenolic antioxidants in their, has occupied an place in the category of dried nuts which are essential in terms of nutrition and health (Cosmulescu *et al.*, 2013).

## CONCLUSIONS

The diversity of non-wood forest products in Satu Mare County is represented well by the species from the spontaneous flora situated at the different altitudinal plant belt and the regional fauna. The actions like harvesting and marketing of non-wood forest products could be an important source of income, especially where the wood product cannot be obtained and processed. The NWFPs have an important socio-economic role, being a renewable resource from the forest. The results of this paper work, bring essential information about the actual state of the non-wood forest products, their contribution on market segment and their potential to generate income. By using the pairwise comparisons within analytic hierarchy process (AHP) and the Expert Choice Desktop, it was found that the most important and demanded NWFPs belongs to the categories of mushrooms, Tree products, Animal origin and Understory plants. Based on the analysis

made, the first place is occupied by the hazelnut, which register eight criteria with strong importance, including period, costs, complexity and knowledge of harvesting. The second place belongs to the European hare, having good results in the terms of distribution range and market demand. The third place is taken by the honey fungus which has proved an good complex of alternatives with demonstrated importance and extreme importance for the activities adjusted to the criteria which reffers the tools needed for harvesting, marked demand, the price of raw product and the portofolio of derived products. In the binary sense, the analysis provided by Analytic Hierarchy Process and Expert Choice Desktop proved to be an essential tool to choose the alternatives which suits best the objectives of the decision making process. For representative results, the researches purposed for the future must be focused on the additional criteria which creates more financial problems, involving managers and stakeholders.

#### ABSTRACT

Due to the fact that Romania has many relief forms, an temperate climate and an varied hydrological regime, it hosts a whole series of forest habitats that have a great tendency to expand and that include a rich flora distributed on various altitudinal plant belt, as well as a complex fauna. The updated Forestry Code (Law 46/2008 calls into question certain features and definitions of wood products, but also of non-wood forest products, both sources being renewable and of great economic interest. The present article highlights the importance of non-wood forest products from Satu Mare County, Romania, and their actual contribution in the socio-economic segment of the market. By using the analytic hierarcy process (AHP) designed by Thomas Saaty, it was established a hierarchy of each non-wood forest products, using a scale of eight absolute numbers from 1 to 8 which showed the intensity of the importance, divided on 19 criteria. The intensity is established by the number of alternatives attributed to the product, based on judgements made by 3 experts. For this study, it was analyzed 4 categories of NWFPs distributed in the Satu Mare county, such as: mushrooms, tree products, understorey plants and animal origin.

Statistical data was analyzed by using the Expert Choice Desktop software, which brings the sensivity of each species described and their actual importance for each criterion. The main categories of non-wood forest products analysed were: mushrooms, tree products, understorey plants and animal origin. Most of the good alternatives with strong or extreme importance were attributed for the criteria containing the activities such as harvesting, distribution range, market demand and the portofolio of derived products. As weak points, it can be mentioned that

some of the products are exposed to the harmful factors or perishability manifested in the time of collecting or transport. NWFPs have an important contribution in human wellbeing and healthy. According to FAO, several million households from worldwide are depending on NWFPs. The AHP brings good results in the decision making process and could help the managers/stakeholders, to find the best way for producing the income and benefits for the new companies. Based on the pairwise comparison made by the experts, the managers can focus on the strong points and also to put them into balance with weak points.

#### REFERENCES

1. BARROS L., CORREIA D.M., FERREIRA I.C.F.R., BAPTISTA P., SANTOS-BUELGA C., 2008 - Optimization of the determination of tocopherols in *Agaricus sp.* Edible mushrooms by a normal phase liquid chromatographic method, *Food Chemistry*, 110(4), pp. 1046–1050.
2. BIRKINSHAW J.H., STICKINGS C.E., TESSIER P., 1948- Biochemistry of the wood-rotting fungi: 5. The production of d-threitol (l-erythritol) by *Armillaria mellea* (Vahl) Quélet. *Biochemical Journal*, 42(3).
3. BLAGA T., DINCĂ L., ENESCU M.C., 2018- Using the analytic hierarchy process to select the most important non-wood forest products for Iasi county. *Lucrări Științifice, Seria Horticultură*, 61(2), pp. 306-316.
4. BLAGA T., PLEȘCA I.M., DINCĂ L., 2019- Selecting the most promising non-wood forests products for Bacau County using the analytic hierarchy process. *Studii și Cercetări Științifice-Biologie*, 28(1), pp. 29-33.
5. CÂNTAR I.C., ENESCU C. M., DINCĂ L., 2018-Application of the analytic hierachy process in selection of the most important non-wood forest products for Dolj county, *Analns of Craiova University, Agriculture Montanology, Cadastre Series*, Vol. 48(2), pp. 50-57.
6. CÂNTAR I. C., DINCĂ L., 2020- The most important NWFPs from Dambovita County identified through the analytical hierarchy process. *Annals of the University of Craiova – Agriculture, Montanology, Cadastre Series*, 49(2), pp. 70-73.
7. COSMULESCU., BOTU M., TRANDAFIR I., 2013- The Mineral Source for Human Nutrition of Nuts in Different Hazelnut (*Corylus avellana* L.) Cultivars, *Not Bot Horti Agrobo*, 41(1), pp.250-254.
8. CÎRNU M., NICHIFOREL L., 2014 - Analiza rolului serviciilor ecosistemice ale pădurii în strategia de marketing turistic a regiunii Bucovina. *Bucovina Forestieră* 14(1), pp. 40-50.

9. DINCĂ L., TIMIȘ-GÂNSAC V., 2020- The Usage of Non-Wood Forest Products - Culinary and Artisanal Traditions in Romania, Sustainable Development Research (2)1, pp.50-57.
10. DRONCA D., PĂCALĂ N., BENCSIK I., DUMITRESCU G., MARCU A., CEAN A., CIOCHINA-PETCULESCU L., POPA R., MARIȘ C., DRONCA A., 2014- Dynamics of Game from 65 Giera Aria Forest District Lunca Timisului in 2009-2013 Period, Animal Science and Biotechnologies, 2014, 47 (2). pp. 60-62.
11. ENESCU C.M, DRĂGOI M., 2019 – Overlapping between the hunting seasons of the main game species and the picking intervals of truffles in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 19(3), pp. 207-212.
12. FAO, 1999 - Towards a harmonized definition of non-wood forest products, Unasylva, 50(3).
13. HUBER P., HUJALA T., KURTTILA M., WOLFOLEHNER B., VACKI H., 2019 - Application of multi criteria analysis methods for a participatory assessment of non-wood forest products in two European case studies, Forest Policy and Economics, 103, pp. 103-111.
14. LUDVIG A., CORRADINI G., ASAMERHANDLER M., PETTENELLA D., VERDEJO V., MARTÍNEZ S., WEISS G., 2016 - The practice of innovation: The role of institutions in support of Non-Wood Forest Products, BioProducts Business, 1(6), pp. 73-84.
15. MATTILA P., KÖNKÖ K., EUROLA M., PIHLAVA J.M., ASTOLA J., VAHTERISTO L., HIETANIEMI V., KUMPULAINEN J., VALTONEN M., PIIRONEN V., 2001 - Contents of vitamins, mineral elements, and some phenolic compounds in cultivated mushrooms, Journal of Agriculture And Food Chemistry 49(5), pp. 2343-2348.
16. PLEȘCA I. M., BLAGA T., DINCĂ L., BREABĂN I. G., 2019- Prioritizing the potential of non-wood forest products from Arad county by using the analytical hierarchy process. Present Environment and Sustainable Development, 13(2), pp. 225-233.
17. PROKOFIEVA I., LOVRIC M., PETTENELLA D., WEIB G., WOLFSLEHNER B., WONG J., - 2017 - What is the potential contribution of non-wood forest products to the European forest-based bioeconomy?, Towards a sustainable European forest-based bioeconomy, 132.
18. VACIK H., HALF M., SPIECKER H., PETTENELLA D., TOMÉ M., 2019 - Non-Wood Forest Products in Europe: Ecology and management of mushrooms, tree products, understory plants and animal products, BoD – Books on Demand, Norderstedt, Germany.
19. SAVAGEA G.P., MCNEILA D.L., DUTTAB P.C., 1997 - Lipid Composition and Oxidative Stability of Oils in Hazelnuts (*Corylus avellana* L.) Grown in New Zealand, JAOCS, 74 (6), pp. 755-759.
20. SAATY T.L., 2008 - Decision making with the analytic hierarchy process, International Journal of Services Sciences 1(1), pp. 83-98.
21. TIMIȘ-GÂNSAC V., ENESCU C.M., DINCĂ L., ONET A. 2018- The management of non-wood forest products in Bihor county", Natural Resources and Sustainable Development, 8(1), pp.27-34.
22. TIWARY A., VILHAR U., ZHIYANSKI M., STOJANOVSKI V., DINCA L., 2020- Management of nature-based goods and services provisioning from the urban common: a pan-European perspective. Urban Ecosystems, 23(3), pp. 645-657.
23. TUDOR C., DINCĂ L., 2019- The main categories of non-wood forest products from Vrancea County, Research Journal of Agricultural Science, 51 (4), pp. 211-217.
24. TUDOR C., CONSTANDACHE C., DINCĂ L., 2020- The social and economic contribution of the main categories of non-wood forest products from Buzau County, Romania, Scientific Papers, Series A. Agronomy, 63 (2), pp. 319-323.
25. VALVERDE M.A., HERNÁNDEZ-PÉREZ T., PAREDES-LÓPEZ O., 2014 - Edible Mushrooms: Improving Human Health and Promoting Quality Life, Hindawi Publishing Corporation International Journal of Microbiology Volume 2015, Article ID 376387, 14 p.
26. VASILE D., DINCĂ L., VOICULESCU I., 2016 – Wild berries collected in 2016 from national forest fund managed by RNP Romsilva. Revista Silvicultura și Cinegetică, 21(38), pp. 72-76.
27. VASILE D., DINCĂ L., ENESCU C.M., 2017- Impact of collecting mushrooms from the spontaneous flora on forest ecosystems in Romania, AgroLife Scientific Journal, 6(1), pp. 268-275.
28. VECHIU E., DINCĂ M., DINCĂ L., 2019- The diversity of non-wood forest products from Braila County. *Annales of West University of Timisoara. Series of Biology*, 22(1), pp. 57-62.  
www.wikipedia.org  
www.insse.ro  
www.rosilva.ro

#### AUTHORS' ADDRESS

TUDOR CIPRIAN, CONSTANDACHE CRISTINEL, DINCĂ LUCIAN - "Marin Drăcea" National Institute for Research and Development in Forestry, \*Corresponding author, e-mail: [cipriantudor210@gmail.com](mailto:cipriantudor210@gmail.com)