THE STUDY OF WOOD COLLECTION OPTIONS AND THE NEED FOR ACCESSIBILITY OF THE FOREST IN CRISANULUI VALLEY FROM PRODUCTION UNIT III GALBENA, SUDRIGIU FOREST DISTRICT, BIHOR FOREST ADMINISTRATION

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RESEARCH ARTICLE

Abstract
This paper presents the need to build new forest roads in basins that are not accessible from the point of view of wood exploitation, within the Production Unit (P.U.) III Galbena, within the Bihor Romania Forestry Administration. Currently, 705.11 hectares of the area of the P.U. III Galbena are inaccessible. Accessibility is only 82%, while the possibility of access reaches 90%.
For seven felling areas with stands reaching the age of exploitation, postponed from exploitation in the period 2021-2023, five variants of wood collection were made, with solutions that include the construction of tractor road sections (variants V1-V5) and forest road (V3-V5) so that timber exploitation is easier. The operating costs were determined in the five variants. It has been demonstrated that by applying V3 collection variant, only by reducing the wood extraction costs, 30.3% of the proposed forest road (724m) would be amortized. In variant V5, 13.4% of the forest road required according to the forestry arrangement FN001=2.4km would be amortized only from the reduction of the wood exploitation costs.

INTRODUCTION

As stipulated in the Forest Code – Law 46/2008 updated, at Art. 83 (1) "Increasing the accessibility of the national forest fund is a basic condition for sustainable forest management..." (**, 2008).

The production unit III Galbena has access through a public road and four forest roads. According to the forest planning plan (AS, 2014) developed for the period 2014-2023, it was proposed to implement three new forest roads, as detailed in the following table:

Table 1
Necessary forest roads with forest destination (AS, 2014)

Road name	Length -km-	Served area -ha-	Served volume -m³-
FN 001 Târnicioara	2.4	174.48	11781
FN 002 Păuleasa	1.5	219.74	3854
FN 003 Budeasa	1.4	97.75	774
Total	**5.3**	**491.97**	**16409**

Thus, the existing road network has a total length of 31.4 km, of which forest roads 27.3 km and accessibility is ensured in the proportion of only 82%, and the possibility of 90%.705.11 ha (18%) of the surface of UP 3 Yellow is thus inaccessible at this time.

Current accessibility and accessability at the end of the decade (AS, 2014) are also featured in the work published by Irimie, 2021.

Of the three forest roads proposed for the decade ending this year, no road has been made. It is also the reason why in 3 plots was postponed wood exploitation, in the area where the road FN 001 Tarnicioara was supposed to be built.

The documents of value for seven felling have been drawn up and it is desired in this paper to perform a simulation on how to collect and exploit the wood mass in year/future years.

The collection network represents all the ways to remove the wood mass.

According to the Silvic Code – Law 46/2008 updated to Art. 85 (1) "The design and construction of forest roads shall be carried out on the basis of principles which respect landscape framing and do not affect the quality of water, soil and habitats". (***, 2008)

The exploitation technology is given by

the sum of the operations through which the wood exploitation is carried out from a parquet, in chronological order (Horodnic, 2003; Timofte, 2007). The way of realization of the exploitation, the equipment used, the means to be drawn close are closely related to the existence of collection routes. In the case of this study, in the pool from the plots 42-49 these collection routes are missing. Moreover, the collection distances are large and very large, the degree of accessibility being G ≥ 4, respectively the average collection distances are frequently over 1000-1500m.

There is a question of urgency of extracting wood from exploitable forests and it is desired in this study to show the need to make the road as urgent as possible proposed in forest managent plan (FN 001 Tarnicioara) since the year 2014, at least partially in a first phase.

MATERIAL AND METHOD

The study was carried out at the Sudrigiu Forest District, P.U. III Galbena (fig. 1), and included the analysis of seven plots proposed for exploitation in the period 2021-2023. Even if the documents required for valorisation have been drawn up (**,2021, a; ***,2022; ***,2023), the exploitation of these plots has been postponed due to reduced accessibility, in the absence of an adequate collection network. There is even a lack of roads for tractors.

The plots are provided with progressive cuts and are aged between 117 years (coupe no.1832) and 128 years (Coupe no. 1887, 1911). Other data, such as: volumes, degree of accessibility, age, slope are presented in Table no. 2.
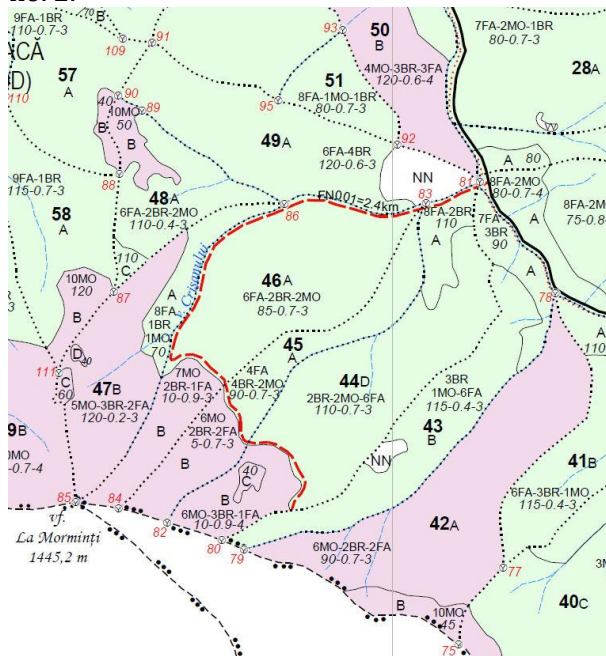

Figure 1 **Study Localization – Arboretum map UPIII%, Sudrigiu Forest District, Bihor Forest Administration (AS, 2014)**
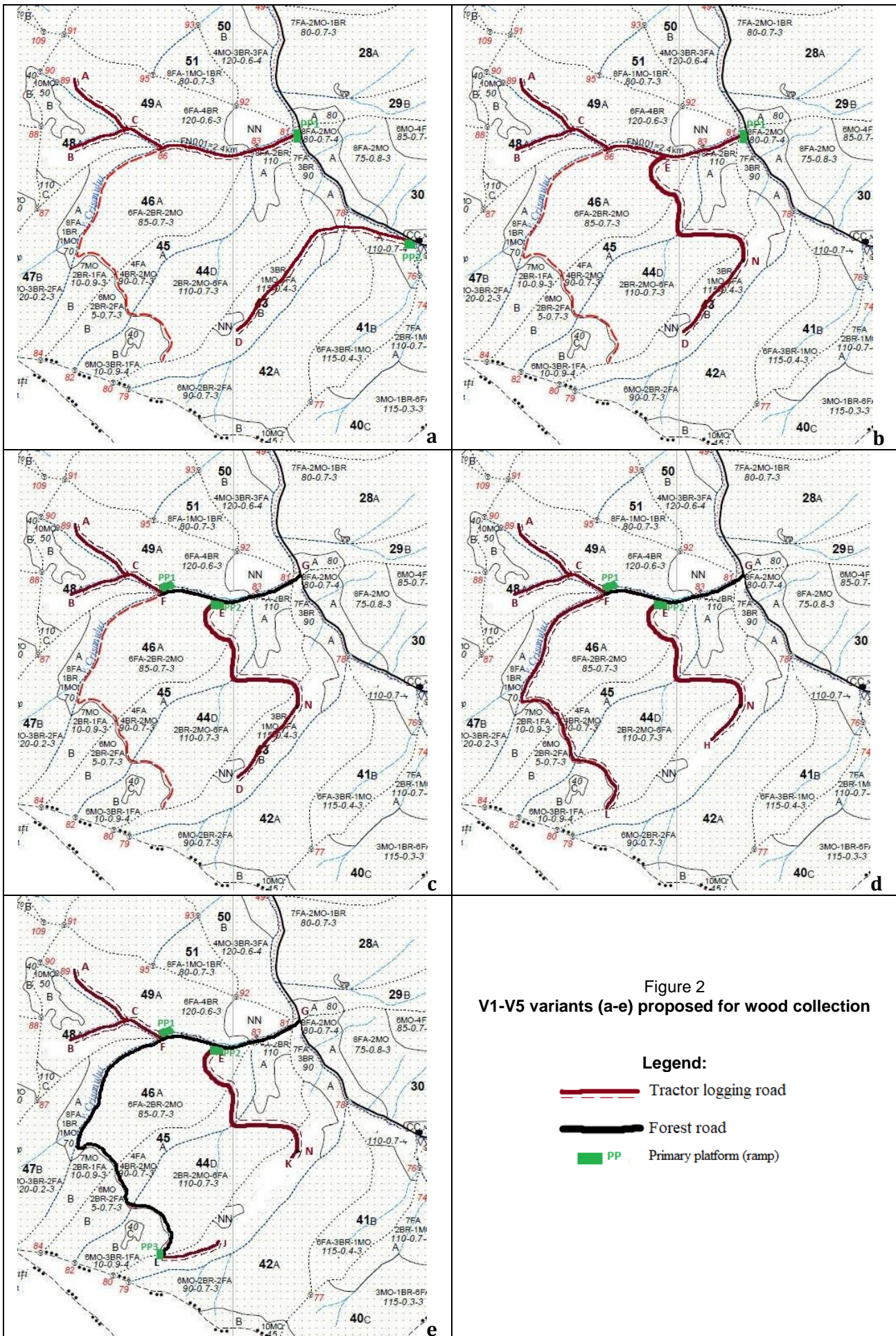
Table 2

Presentation of data from the felling areas in which the study was conducted

No. crt.	Coupe no./ year of inventory	Plots	Volume of the average tree, in m³/tree	Age, years	Area, ha	Volume, m³	Accessibility grade	Slope, degrees
1	742/2021	43B%	1.02	122	10.00	1964.0	3	30
2	1798/2021	43B%	1.15	122	5.00	1254.58	4	30
3	1802/2021	43B%	1.25	122	5.11	1507.27	4	30
4	1832/2021	48A%	1.25	117	5.50	926.25	4	25
5	1884/2022	48A%	1,11	118	9,29	1708,26	5	25
6	1887/2022	49A%	1,64	128	14,0	1652,11	3	34
7	1911/2022	49A%	2,10	128	10,0	1312,05	4	34
Total	-	-	-	-	58.9	10324.52	-	-

Thus, five variants of wood collection were proposed, by making tractor roads and sections of the road proposed in forest managent plan. In variant V5, it is planned to complete the forest road of 2.4 km originally proposed in 2014 (Figure 2). The proposed collection variants (Vi) are:
  - V1 – NEW TRACTOR ROADS: A-PP1, B-C, D-PP2 (Figure 2a);
  - V2 – NEW TRACTOR ROADS: A-PP1, B-C, D-E (Figure 2b);
  - V3 –NEW TRACTOR ROADS: A-F, B-C, D-E AND DRUM AUTOFORESTIER G-F (Figure 2c);
  - V4 – NEW TRACTOR ROADS: A-F, B-C, H-E, F-L AND DRUM AUTOFORESTIER G-F (Figure 2d);
  - V5 – NEW TRACTOR ROADS: A-F, B-C, K-E, L-J AND DRUM AUTOFORESTIER G-L (Figure 2e).

Figure 2
V1-V5 variants (a-e) proposed for wood collection

Legend:

Tractor logging road
Forest road
PP	Primary platform (ramp)

An optimal collection network should be carried out from the first cuts (progressive, successive I), even thinning. Trails shall comply with the appropriate environmental, technical and economic requirements. After approval, the route is picketed with white paint and square hammer.

In order to estimate the costs for the arrangement of the proposed roads, the length (L), the average cross slope (i_t), the number of stumps to be removed must be determined.

Professor Ciubotaru A. (1996) proposes a simplified calculation relationship for estimating the necessary expenses (CM) when arranging the tractor road with bulldozer is:

$$CM = 0{,}784 \cdot i_t \cdot L \cdot TOB,$$

Where: i_t is the average transverse inclination of the land along the tractor road, expressed in subunit values;

TOB - the working time tariff with the bulldozer of 81-160CP, depending on the slope and nature of the land, (110-160 lei/hour, increased by 50% for land with rock).

L - the length of the proposed route, in meters;

$$L = L_{0i} \cdot c_s / \cos \alpha,$$

Where: L_{0i} is the horizontal distance, measured on the map or determined analytically, on which the wood is to move;

c_s - route sinuosity coefficient, ($cs = 1{,}29$ for tractor roads);

α - longitudinal inclination of the route, in degrees.

For each variant, the cost of the proposed tractor roads was determined. In Table 3, the calculation is shown:

Table 3

Determination of the necessary elements and costs for the construction of tractor roads in variant no. 1

No. crt.	Plots	Proposed route	Longitudinal inclination i_l, in degrees	Length road L, in meters	Transverse inclination i_t, in %	TOB, lei/hour	CM, in lei
1	43B	D-PP2	22	1613.92	40	210	105066
2	49A	A-86	22	779.13	50	225	67931
3	49A	86-PP1	6	933.92	30	180	39084
4	48A	B-C	20	466.75	30	195	21161
Total		-	17.81	3793.72	38.36	203.85	233242

Similarly, the other 4 variants have been done, and the final results are represented below:

Table 4

Centralization of the costs necessary for the realization of tractor roads for the five proposed variants

Variant no.	i_l, in degrees	L, in meters	i_t, in %	TOB, in lei/hour	CM, in lei
V1	17.82	3793.72	38.36	203.85	233242
V2	17.51	3489.70	46.51	246.85	260549
V3	16.92	3279.26	29.75	211.43	221465
V4	10.61	5167.19	21.90	217.36	354701
V5	14.67	3082.48	36.10	209.30	199620

To these costs are also added the costs of road construction, where appropriate (Table 5).

The design of forest roads is extensively carried out in specialized works (Bereziuc, 2006; Bereziuc, Olteanu, Ene, 1996; Bereziuc, Oprita, Olteanu, 1987; Olteanu, Olteanu, 2006) And has a special role to play in the optimal accessibility of forests.

In order to estimate the costs of construction of these forest roads, it was taken

into account the recommendations of Order no. 560 of 21.06.1999 issued by M.A.P.P.M. (art. 2.9, 2.10) updating the PD 67/80 Regulation on the design of forest roads for the movement of motor vehicles, thus, by transforming the tractor roads into auto roads "se relieves the investment value of the road by about 45%, this being found in: preparatory works, earth embankments and derogations". Thus, it can be said that the autoforestier road made in optimal

conditions is 2,222 more than the tractor road, from a financial point of view (**, 1999).

Determining the costs necessary for the realization of the self-forestry roads in the five proposed variants

Variant no	Proposed route	i_l, in degrees	L, in meters	Costs, In lei
V1	is not the case			
V2	is not the case			
V3	G-F	6	723.97	86845.51
V4	G-F	6	723.97	86845.51
V5	G-L	3.89	2446.33	431197.04

For these felling areas, the estimate of the harvesting works was prepared, with the estimation of the exploitation costs for the entire technological process. The estimates were determined by using a program made in Microsoft Excel^M 2021 for Windows (Timofte, Irimie, 2023). As an operating period, the period of 5.5 months was chosen (***, 2011; **, 2021,b), being progressive works. The adopted exploitation technology was in length wood system. The wood collection will be done entirely with tractors equipped with forest winch. Tractor roads and forest roads required in each variant were determined separately, so that there is no overlap in determining operating costs.

If these seven felling areas were exploited this year (2023), the operating costs would be:

Centralization of the operating costs, without tractor roads or forest roads, with the change of the degree of accessibility given by the proposed collection variant

PARTIDA/ an	Exploitation costs of wood in variant no. ..., in lei/m³														
	V1			V2			V3			V4			V5		
	G*	lei	lei/m³	G	lei	lei/m³	G	lei	lei/m³	G	lei	lei/m³	G	lei	lei/m³
742/2021	3	223990	124	5	243474	134	4	233412	129	4	233412	129	4	233412	129
1798/2021	4	167149	143	5	175478	150	4	168339	144	4	168339	144	3	161025	138
1802/2021	4	185095	132	5	198459	142	5	194101	139	5	196437	140	2	169927	121
1832/2021	4	118540	140	4	118540	140	2	110548	130	2	110548	130	2	110548	130
1884/2022	5	221791	139	5	221791	139	3	204946	128	3	204946	128	3	204946	128
1887/2022	3	194757	126	3	194757	126	1	183196	118	1	183196	118	1	183196	118
1911/2022	4	164729	136	4	164729	136	3	155193	128	3	155193	128	3	155193	128

* G – grade of accesibility

RESULTS AND DISCUSSIONS

The choice of the collection variant has always been a concern and a necessity within the framework of a documented design of an operating site (**,1997; ***,1998). The five proposed variants try to cover the possible solutions for the exploitation of the rerspective basin, and the purpose of this analysis is to find the optimal solution. In this study, the analysis is more complex because the collection roads and the roads ensuring the technological transport are missing, and the achievement of the EF001 section (GL in Figure 2e) has been postponed.

From an economic point of view, the costs in the proposed 5 variants:

Table 7

Centralization of the operating costs with tractor roads and forest roads where appropriate, with the change in the accessibility given by the proposed collection variant

Specs	Exploitation costs in variant no. ..., in lei				
	V1	V2	V3	V4	V5
Costs of wood exploitation (CE)	1276051	1317227	1249736	1252071	1218248
Costs for the arrangement of tractor roads (TAF)	233242	260549	221465	354701	199620
Costs for road construction (DAF)	-	-	86846	86846	431197
Total costs (CE + TAF + DAF)	1509294	1577777	1558046	1693617	1849065

The cumulative representation of these costs is shown in Figure 3.

It is noted in Figure 3 that, by exploiting the seven feling area in variant V5, it could depreciate 13.4% of the proposed road GL = 2,446 km, according to figure 2e.

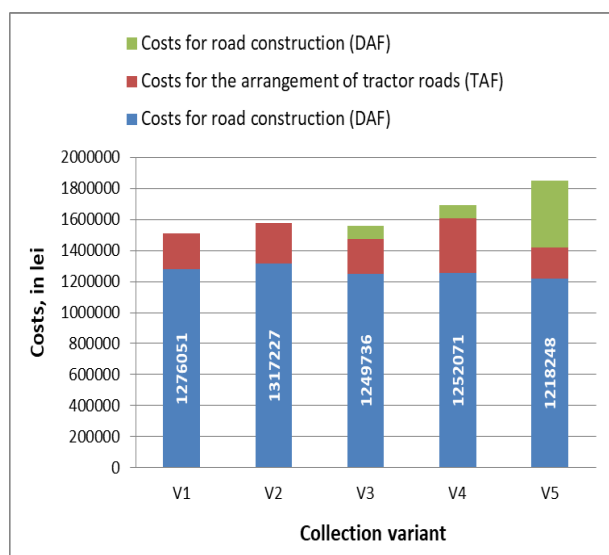By applying the 3 colection variant, 30.3% of the proposed GF section of 724m (fig. 2c) is amortized.

Figure 3 **Cumulative representation of the costs of operation and realization of the necessary roads in the five variants**

Figure 4 shows the total costs for the exploitation of timber from the seven felling areas, in the five proposed variants:
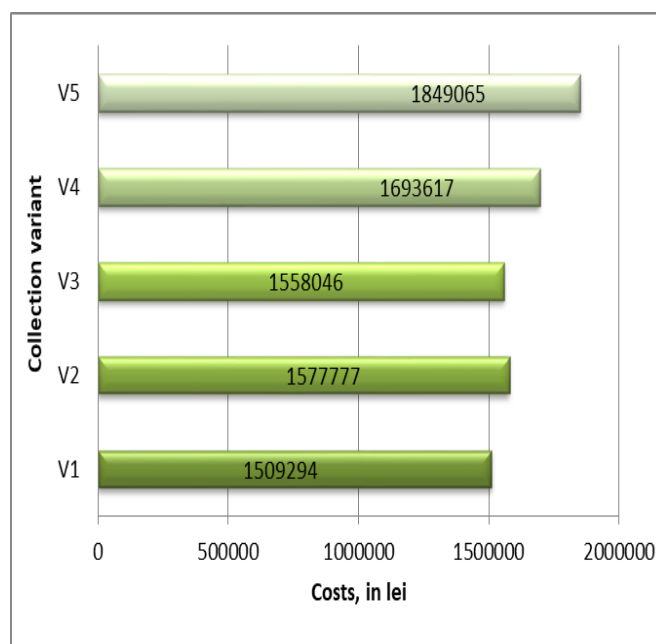

Figure 4 **Representing the total costs for extracting wood from the seven felling areas in five collection variants**
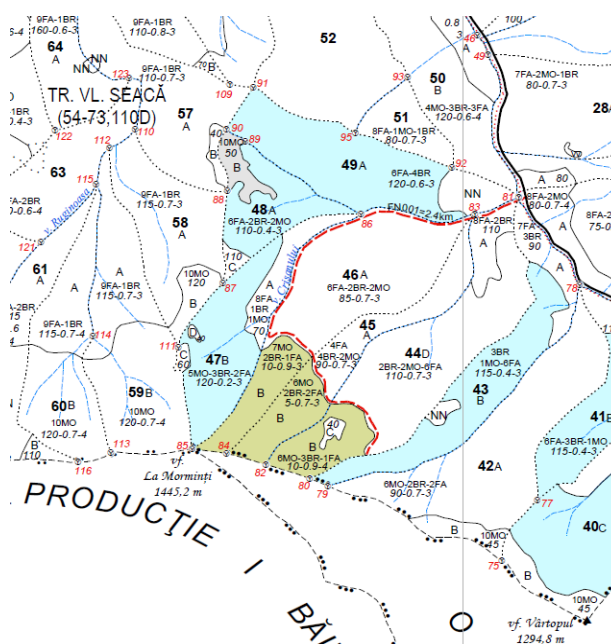

Figure 5 **Map UP III % - Forestry works proposed in the decade 2014-2023 (AS, 2014)**

CONCLUSIONS

Although variant 1 is 3.1% cheaper than variant 3 with that proposed section of forest road 724m and 18.4% cheaper than variant V5 which includes the entire proposed forest road (2,446 km) in forest managent plan, it should be emphasized that these roads will serve in the future all the forestry and exploitation works in plots 42-49. Analyzing the map of forestry works (Figure 5), the investment will be amortized in maximum 3 years, as no less than five plots will have to be exploited in the coming years, the stands reaching the exploitative age, and in another 3 plots must be carried out care work.

Also, this necessary road FN001 of 2.4 km proposed will increase by at least 2 degrees the accessibility of future stands/pots, and the value of wood will increase. The ecological aspects are not to be neglected. This road will reduce the damage (Horodnic, 2014) by reducing the collection distances, will protect the roadside trees having an increased width compared to the tractor road, it will allow the evacuation of rainwater and snow melting in a controlled manner through drainage ditches and culverts (Kastridis, 2020), will ensure controlled access to this area for all forestry and forest management, hunting and sport fishing activities, interventions in case of damage, calamities or disasters. (Giurgiu, 2006; Forestry Code - Law 46/2008, Art.83 (2), updated).

The full-tractor collection method applies to accessible land, especially in the case of total cuts, where all the trees are extracted and gathered with the tractor without obstacles. This method can also be used in selective pruning, provided that the thickness of the remaining shafts provides enough space for the use of the winch. In the case of thinning, this collection line is not preferred because of the high shaft thickness, low volume on the wire, and other aspects, except where 2 m colour is created by means of specific marking of the trees using the „ciochinare" process (devices for tying logs) (Ciubotaru, 1996; Ciubotaru, 1998; Ionaşcu, 2002).

The fragmented tractor collection method is used in situations where the tractor-mounted winch is not feasible from a forestry point of view, either due to too high stand density, or, or because of slopes with inclination greater than 40-45%. This method is also preferred when land conditions or economic issues limit the deployment of tractor roads in the depth of the parquet (Oprea, 2004; Timofte, Budau 2008).

A greener variant of the collection would be: nearby tractors, funiculars, splints and grafting. They are especially used in selective cuts.

In conclusion, it is recommended to urgently carry out the FG section of 724 m, part of the necessary road FN001 of 2.4 km.

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