Opportunity to use small forest tractors at skidding in thinned stands in Romania

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Abstract:
Currently some thinned stands in Romania remain un-harvested because of difficult skidding conditions and of lower returns resulting in important quantities of wood being left in the forest. Presently the harvesting of thinned stands is done using largely non mechanical equipment, typically animals. The use of animals at landings makes a fragmentation of technological lines, a fact that reduces the productivity and increases the time taken in tending operations (thinnings).This paper analyses the opportunity to use the small forest tractor FORESTER TD, which is currently in the prototype stage, in yarding operations.

Keywords: thinning, skidding, small forest tractor

1 Introduction

FORESTER TD small tractor (Fig.1) is an adapted Romanian model based on technical features taken from models FORCAT 2000 and FORCAT 36D. In the present conditions it is in prototype stage and has been tested in logging works in different variety of the skidding process, in stands where the predominant species group is represented by deciduous, coniferous or mixtures of these. After cuttings, secondary products (thinnings), main products or incidental products could result. To work as forwarder, FORESTER TD can be equipped with different types of trailers, with different overall characteristics (Fig.2)

2 Place of researches

Experiments regarding the productivity of the small tractor FORESTER TD were made by Rus, A., in 2009, in 10 compartments from Forest District Beclean, Forest County Bistriţa – Năsăud of the Directorate of Forestry Forest Beclean Bistrita-Nasaud, thinnings being the cuts that were carried out .

3 Working method

Timing – recording works and also for determining the harvested volume were made on operations (yarding and "first skidding" – forwarding) and global (whole gatering with Forester TD). Operative times and regulated interruption times were measured.

Figure 1: FORESTER TD small tractor

Figure 2: BERFOR Trailers for using the tractor as forwarder

Table 1: Factors of influences - quantification

Studied factors	Measurement unit	Observation – determination method	Comments
Group of Species	-	Observation	Beech
Movement Distance	m	Determining the length of the winch cable. Determining the real movement distance during "first skidding – forwarding"	The winch cable was marked in meter. Distances for "first skidding" – forwarding were determined by positioning technique
Volume	m^3	Volume determination	Using records cards with dimensional characteristics of logs
Time	Hours	Timing	Timing with electronic timer with possibility to interrupt the countdown
Volume of the average tree	m^3/tree	Forest management register	For thinnings, the volume was established during forest inventory

Regarding the data acquisition, for yarding these were recorded for volume categories of average tree and categories of yarding distances. Were took into account the following categories for volume of average tree: <0,1 m^3/tree, 0.1 – 0.3 m^3/tree and 0.3 – 0.5 m^3/tree, respectively <20m and 20 – 40 m for yarding. For "first skidding" and forwarding, were took into account the same categories for average tree and for movement distances were studied intervals between 100 and 500m with 100m step.

For "first skidding" and forwarding, was followed primarily to load the tractor at capacity in correlation with the number of logs that it can carry. In case of small volume (<0.1 m^3/tree) the loads were around de 1 m^3/ carriage (10 … 20 pieces). In case of volume for average tree between 0.1...0.3 m^3/tree the load were around de 2 m^3/ carriage (7 … 20 pieces and in case of volume between 0.3...0.5 m^3/tree the loads were around 3 m^3 (6...10 pieces).

The times realized during operations and also the global times for yarding – "first skidding" and yarding – forwarding were recorded for a working groups made up of three people, respectively a machine operator, a mechanic and a wooden. For assembling the loads were use mainly the chokers.

4 Results regarding the work productivity at yarding with FORESTER TD

Yarding operation comprises the following phases:

- Positioning the tractor with the back to the yarding direction;
- Ensuring the tractor stability;
- Roll off the cable from the winch and bring the hook to the pieces that will be transport:
- Binding the load;
- Mechanical pulling the load;
- Untie the load

To establish the efficiency for wood yarding with FORESTER TD the time for each operation was recorded taking into account the characteristics of the wood mass (volume of the average tree), of the moved pieces, of the loads, of the skidding distances and also the slope conditions. The results regarding the times recorded for wood mass yarding with FORESTER TD are presented in Table 1.

Table 2:Average recorded times for yarding operation in relation with distances, declivity and volume of average tree

Operation	Declivity [%]	Yarding distance [m]	Volume of average tree		
			<0.1 m^3/tree	0.1...0,3 m^3	0.3...0.5 m^3
Yarding	< 10%	< 20	0.15	0.08	0.07
		20 - 40	0.19	0.10	0.09
	10 – 20%	< 20	0.16	0.09	0.08
		20 - 40	0.20	0.11	0.10
	20 -40%	< 20	0.17	0.10	0.09
		20 - 40	0.21	0.12	0.11
	Average	**< 20**	**0.16**	**0.09**	**0.08**
		20 - 40	**0.20**	**0.11**	**0.10**

Data from table 1 shows that the times recorded per m^3 have wide limits in accordance with the factors took into account. Generally, declivity has an important influence, increasing the working time, together with the time in which is realised the pulling. Regarding the volume of the average tree size, the time increased as the number of pieces increased. Generally, the number of pieces decreased as the volume of pieces increased. The realized time at yarding in accordance with the distance and declivity varies in large limits, because there is an extra time for guiding the loads between the trees.

Taking into account the average values on declivity and on volume of average tree, in figure 3 is presented a distribution of times recorded for these factors. Factors declivity (p) and yarding distance (d) are placed on curves in accordance with the average time recorded for categories fo the volume of the average tree.

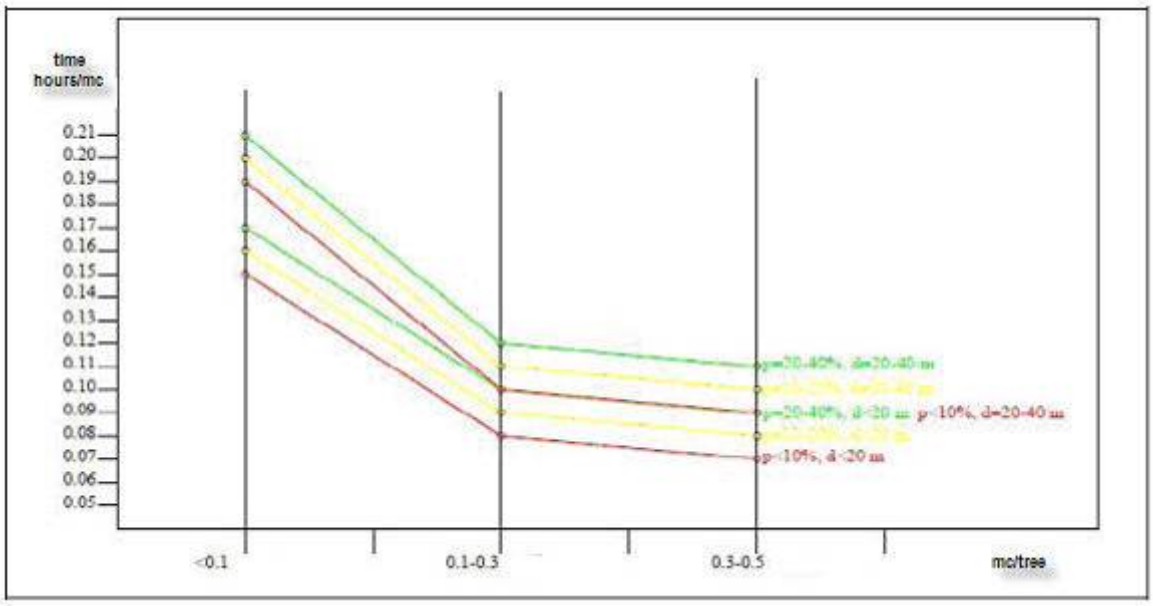

Figure 3: Distribution of average of recorded times for yarding in relation with the influence factors

If are taken into account the average condition for declivity and yarding distance, could result distributions of the recorded times in accordance with those two factors for categories of volume of the average tree. In figure 4 is presented the experimental and the theoretical curve for volume of average tree in rapport with the time necessary for yarding. R^2 is the determination coefficient, which represents how nearby is the experimental curve by the theoretical curve. Values near to 0.9 indicate that the experimental curves can be assimilated approximately in 90% with the theoretical curves.

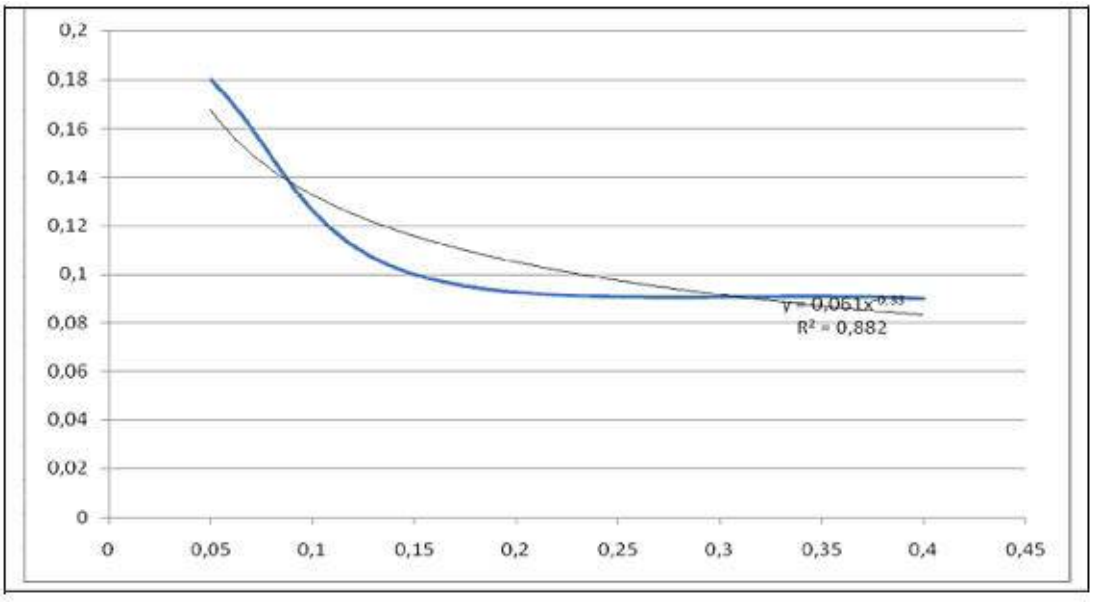

Figure 4: Average times for yarding distances (blue – experimental curve; black – theoretical curve)

In accordance with the presented data, some new information regarding the productivity for yarding operation with this tractor could be gathered (tab. 2)

Table 3: Productivities at yarding for FORESTER TD

Productivities and times for average conditions										
Volume of average tree [m^3/tree]	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50
Times [hours/m^3]	0.16	0.13	0.11	0.10	0.10	0.09	0.09	0.08	0.08	0.08
Efficiency [m^3/hour]	6.10	7.67	8.77	9.64	10.38	11.02	11.59	12.12	12.60	13.04
Productivity [m^3/8 hours – mean]	48.80	61.34	70.12	77.11	83.00	88.15	92.75	96.63	100.77	104.33
Productivity per workers [m^3/8 hours – worker]	16.27	20.45	23.37	25.70	27.67	29.38	30.92	32.31	33.59	34.78

5 Conclusions

Due to its small size, FORESTER TD can penetrate easily through corridors that exist between trees and do not require specially designed tracks (made by earthmoving works). Only in special cases, when the declivities are very high are required some summary embankment works to achieve a relative horizontal platforms to keep the tractor stability. Tractor manoeuvrability is very high because of the possibility for full turning in place by handling in reverse order the tracks. Fuel consumption in a thinning stand for 100 – 120m for forwarding, in 5.5 effective working hours, 26 m^3 harvested, was 17 litres, approximately 3.1 l/hour and 0.65 l/m^3. The number of collected trees is different in rapport with their position on stand and with the volume of each piece. During the research, sometimes till 10 pieces compose a load (0,05 – 0,07 m^3/tree). The tractor has good results for distances for "first skidding" and forwarding till 500m. Productivity decreased as the forwarding distance increased. The slope declivity for FORESTER TD should be as small as possible. Even if this tractor could rich more than 35^0, the declivities should be as small is possible. For the roadside lending, FORESTER TD is very useful because it can do very easy the wood handling and loading.

6 References

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