Bulletin of the *Transilvania* University of Braşov
Series II: Forestry • Wood Industry • Agricultural Food Engineering • Vol. 4 (53) No. 2 - 2011

TECHNOLOGICAL ASPECTS REGARDING TIMBER EXPLOITATION USING MOUNTY 4100 CABLE YARDER

S.A. BORZ[1] M. BIRDA[1] Gh. IGNEA[1] I. OPREA[1]

Abstract: *In the last period, as a result of bot, the European projects funding and own funds, the logging companies from Romania have begun to improve their own machinery stock by acquiring last generation equipment - cable yarders, specialized for short and medium distances as a response to the technical, economic, silvicultural and ecological requirements. Due the fact that these machines are relatively recent in timber exploitation from Romania, technological studies are necessary in order to optimize the exploitation processes in such cases.*

Key words: *Mounty 4100, cable yarders, productivity, technology.*

1. Introduction

As a response to the technical-economic and silvicultural-ecologic requirements, in the last period, the logging companies from Romania have manifested an increased interest for modern exploitation technologies recently released on the domain market. Although these technologies present, most of the time, prohibitive acquisition costs for many Romanian logging companies some companies have succeed to acquire new, high-performing machinery through European projects and their own funds.

Having superior ecological outputs in comparison with those presented by tractors, as well as due the fact that they are utilizable in steep terrain, cable yarders represent an important option for Romanian logging companies, as a result of the overall specific conditions generated by applied silvicultural systems, geomorphology, physical and geographical elements.

Cable yarders [3], developed in the last decades, posses mobile control groups (mounted on tractors, trucks, wheeled platforms, and excavators) and a swinging span (sometimes telescopic) which provides the necessary height for the cable system in the initial line point. The cable system of such installations consists of the main cable (mainline) anchored to the opposite end, hauling cable, as well as other cables (winching cable, guying cables, auxiliary cable, hauling back cable).

2. MOUNTY 4100 Machine Description

MOUNTY 4100 [4], is a skyline from cable yarders group, which consists of an artificial swinging span, mounted on a MAN TGA 33430 truck (Figure 1). The machine main endowments, both, in the standard release as well as in customisable releases (like the studied one), are presented in Table 1.

[1] Forest Engineering Dept., *Transilvania* University of Braşov.

Fig. 1. *MOUNTY 4100 Cable Yarder*

Table 1
MOUNTY 4100 Technical characteristics

Technical characteristic	Standard variant	Custom variant
Base machine	MAN TGA 33430	MAN TGA 33430
Artificial span	Swinging (13100 mm)	Swinging (13100 mm)
Boom	Woody 50	Woody 60
Main line	800 m length and 22 mm diameter	800 m length and 22 mm diameter
Hauling line	900 m length and 11 mm diameter	900 m length and 13 mm diameter
Carriage	LIFTLINER 4000 with IVECO engine	LIFTLINER 4000 with IVECO engine
Auxiliary devices and materials	- shoes; - bands; - safety devices; - anchorage devices;	- shoes; - bands; - safety devices; - anchorage devices;

3. Study Location

Observations regarding both, the applied exploitation technology as well as chronometry regarding realized productivities (logging process) and installing - uninstalling processes in the case of MOUNTY 4100 cable yarder (Figure 2) have been realized in the administrative area of Codrii Verzi ai Argeşului Forest District, Management Unit VII Bădeanca, compartments 87B and 88B.

Fig. 2. *Study Location*

The main silvicultural characteristics for the observed compartments are presented in Table 2.

Table 2
Silvicultural characteristics for *compartments 87B and 88B*

Characteristic	87B	88B
Area, [ha]	15.4	13.5
Composition, [%]	100 Spruce	100 Spruce
Density, [tenths]	0.8	0.7
Age, [years]	50	50
Average breast diameter, [cm]	21	15
Average height, [m]	20	17
Average tree volume, [m^3/piece]	0.224	0.128
Silvicultural system	thinning	thinning

4. Applied Exploitation Technology

The applied exploitation technology [3] represents the sum of technological applied procedures for timber exploitation from a site.

Usually, timber exploitation, with machines from MOUNTY series (2500, 4000, 4100) can be realized independently or in association with other machines (for example Highlander - combination machine specialized in harvesting and logging).

When the timber yarding is independently realized (studied case), the machine installation can be done in order to transport the timber uphill (studied case) or downhill [4].

Being a machine which combines logging operations with timber processing specific operations [2], [4], the development of the timber exploitation process is realized as follows:

- Timber harvesting is semi-mechanically realized, usually by 1-2 workers, in accordance with removed trees dimensions and terrain specific difficulties;
- Timber logging (yarding): is mechanically realized, by the winching worker deployed in the stand. After one charge (load) realization, the machine's controls are transferred to the base machine operator. The operations are radio-controlled, the command transfer being realized through acoustic signals. Timber yarding is executed, mainly, by the base machine operator, and is realized in a series of phases: taking of the command, hauling cable activation, charge landing (generally on the base machine platform), charge choker detaching and carriage returning;
- the operations from the upper deposit (landing site) are realized entirely by the base machine operator, which, after charge detaching occupies the boom's cab and executes operations such as branching, limbing, cutting (to final length), timber and limbs movement, stack sorting and arranging.

The work formation recommended by producer [4] is composed from:

- Main operator which has attributions in timber yarding and processing;
- Winch worker with attributions in timber lateral yarding and (partially) in yarding, sometimes in timber harvesting as well;
- Felling worker with attributions in harvesting, sometimes in timber yarding.

5. Corridor Opening

In order to install the cable yarder, sometimes there is necessary to open some corridors. The corridors opening consists both, in trees felling and cleaning from any obstacles, being a complex decision which has to follow the production process optimization both on short and long term periods.

Short term optimization refers to optimal premises creation for timber exploitation in conditions generated by a specific situation, in the studied case thinning in spruce stands.

Long term optimization refers to the conditions which will exist in the future in the studied stands. Thus, for the studied stands, in the future there will be executed thinnings, and eventually clear cuttings. Corridor opening refers both, to the spatial location, as well as to the intervals between two successive corridors.

From an organizational point of view, there can be formulated some recommendations regarding corridor opening, as follows:

- If possible, the corridors should follow convex terrain forms, because through timber hauling (operation frequently executed semi-suspended), there result gullies on the corridor center. If this problem is not significant in the case of small trees yarding (full tree system), these gullies are deeper in the high trees yarding case (other systems), offering premises for soil erosion. If located on secondary streams or concave relief shapes, in case of high intensity rains, these gullies will accumulate water from the lateral slopes. Also, in case of lateral yarding, the charges are better controlled when the yarding sense is uphill, fact with a high importance especially in the very dense stands.

- Direction of felling deployment in case of corridor opening depends on the base machine position and yarding direction. Thus, if the yarding is realized uphill, felling direction deployment should be from downhill to uphill, with downhill directions for tree felling (parallel to the corridor center). In this way, trees mishmash is avoided and quality yarding premises are created for the timber situated on corridor. In the reduced density stands case, felling can begin from uphill if the tree mishmash is avoided.

- Although in practice the corridors width varies between 4 and 10 m, their widths should be limited to 4-6 m [3], especially in spruce stands, in order to avoid their vulnerability to wind falls. In younger stands, by corridor opening, there is extracted an important volume, reason for which the opening intervals should consider the overall extraction intensity, keeping in this way the selective character of the thinning.

- Because this machine type is used in our country only recently, the optimization of distance between two successive corridors represents a complex problem, which could be solved only through technical, economic, silvicultural and ecological studies. However, in other countries, the interval between two successive corridors is of 40…50 m [2], which ensures a lateral yarding distances of 20…25 m. Also, in first thinning conditions, reduced spaces between trees create difficulties in lateral yarding.

6. Installing - Uninstalling the Cable Yarder MOUNTY 4100

Maybe one of the greatest technical advantages offered by this machine is represented by short installing - uninstalling times. An installing - uninstalling cycle can be complete or shorted [2], as the cable yarder is positioned for the first time in order to execute yarding operations, respectively, is moved from one corridor to another. In Slovakia, for example [2], a shorted cycle (for MOUNTY 4000 cable yarder) takes an average time of 78 minutes. Preliminary results for our country conditions, in spruce stands in which thinnings were executed show that the specific operations for a complete installing - uninstalling present the following succession:

- For installing:

1. Recognition in terrain of the designed corridor;
2. Corridor opening by trees felling with mechanical chainsaw;
3. Preparation of both, end spar support-tree, and intermediary spars (tree branching, through operator climbing and operations with chainsaw, shoes preparing, auxiliary materials preparing);
4. Base machine preparing (tower extension, tilt angle adjustment, boom cab adjustment, platform adjustment, machine stability adjustment, tower anchorage, carriage preparing);
5. Mainline deployment (usually manual);
6. Mainline anchorage to the end of the installation;
7. Shoes mounting and mainline positioning on the shoes;
7. Carriage mounting on the mainline and hauling line attaching;
8. Mainline tensioning;
9. Working test.

- For uninstalling:

1. Mainline loosening;
2. Carriage uninstalling from the mainline, hauling line detaching, carriage moving with boom;
3. Intermediary spars uninstalling;
4. End spar uninstalling;
5. Mainline and auxiliary materials recovery (the auxiliary materials can be attached to the end of the mainline when the last one is recovered on the drum);
6. Tower anchorages detaching;
7. Tower mounting on the truck.

Preliminary results obtained in our country show that in conditions of a distance of 300 m, an average slope of 26°, by uninstalling two intermediary spans, and using a work formation of 3 men, the total uninstalling time was of 127 minutes. Also, for a line installing, in the conditions of a real length of 150 m, an average slope of 35°, without intermediary spans, the total consumed time was of 182 minutes (in execution conditions of all mentioned operations for installing).

7. Productivity

A very important aspect is represented by the productivities realized with these cable yarders, as well as their comparison with productivities realized by other applicable means in similar conditions.

Thus, if referred to a global productivity of the felling site, which includes all the time consumed for installing - uninstalling, workers breaks, technological breaks and other time categories, and by taking in consideration the commercial realized volume of timber (omitting of exploitation residuals - limbs, branches, small non utilisable pieces resulted from stem sorting and cutting), in conditions of an average 8 hours working day, for an observation period of 20 labour days, the obtained results are presented in Table 3. In this table by pieces number refers to the total number of obtained commercial pieces, by volume refers to the the commercial volume obtained per day, and by productivity refers to the amount of commercial volume obtained per one hour.

Regarding the cable yarder outputs in yarding operations, there were realized determinations for time consumption in case of both lateral yarding and hauling. Preliminary results, obtained on a basis of a sample consisting in 100 work cycles (by considering of operative times) are presented in Table 4 [1], [3].

Table 3

MOUNTY 4100 Productivity in Thinning (*Spruce Stands*)

Day	Pieces obtained by processing	Volume [m^3/day]	Prod. [m^3/h]
1	531	24.264	3.033
2	172	6.436	0.805
3	70	2.812	0.352
4	55	3.431	0.429
5	234	16.320	2.04
6	551	24.256	3.032
7	489	27.543	3.443
8	428	18.506	2.313
9	24	1.242	0.155
10	259	12.800	1.600
11	583	29.758	3.720
12	456	27.266	3.408
13	319	13.039	1.630
14	203	7.557	0.945
15	93	8.316	1.040
16	163	11.952	1.494
17	318	19.018	2.377
18	400	23.447	2.931
19	458	34.519	4.315
20	240	14.202	1.775
Average	***302.3***	***16.334***	***2.042***

Table 4

MOUNTY 4100 outputs for yarding operations in thinning conditions

Characteristic	Value
Average hauling distance, [m]	190.13
Average lateral yarding distance, [m]	21.58
Average slope of the hauling track, [°]	22.09
Average slope of the lateral yarding track, [°]	26.30
Average tree volume, [m^3/piece]	0.308
Average time per work cycle, [s/cycle]	473
Hourly output, [m^3/h]	5.880

For the operations executed in order to process the timber, work productivity depends on a series of factors such as: species, exploitation system, obtained assortments, pruned height, total number

of pieces per one charge etc. For the studied conditions (thinning), on a sample of 85 work cycles, the cable yarder outputs are presented in Table 5. The operations executed in the base machine range are the following: boom manoeuvres, stem grabbing, branching, limbing, cut to length, piece sorting, stack arranging, limbs and branches arranging in bunches.

Table 5

MOUNTY 4100 outputs for processing operations in thinning

Characteristic	Value
Maximum number of pieces per load (charge), [pieces]	5
Minimum number of pieces per load (charge), [pieces]	1
Average number of pieces per load (charge), [pieces]	2.624
Species	Spruce
Average tree volume, [m^3/piece]	0.300
Exploitation system	Full tree system
Average time per work cycle, [s/cycle]	216
Hourly output, [m^3/h]	13.158

8. Conclusions

The usage of MOUNTY 4100 machine in forest exploitations in our country is for the moment at the beginnings. There are necessary more comprehensive determinations regarding work productivity with machines such this one, as well as determinations regarding fuel consumptions and time consumptions for installing - uninstalling in order to optimize the work with these machines in diverse conditions/ aspects which will be treated in future papers, as the new data becomes available.

Also, there appears as being necessary the realization of some technical and organizational coordinates regarding timber exploitation with this machine, problems which will be presented also in future papers.

Aknowledgements

We would like to thank Mr. Albert Şerban, engineer, director of S.C. ALSER FOREST S.R.L. and Mr. Pal Vilmoş, director of S.C. RAPID FOREST S.R.L., for technical and logistic support.

References

1. Hidoş, C., Isac, P.: *Studiul muncii. Vol. III. Măsurarea muncii* (*Work Study. Vol. III. Work Measurement*). Bucharest. Technical Publishing House, 1971.
2. Messingerová, V., et al.: *Technological Planning in Cableway Terrains in Slovakia.* In: Proceedings of 42nd International Symposium on Forestry Mechanization - FORMEC 2009, Praga, Czech Republic, 21-24 June, 2009, p. 307-315.
3. Oprea, I.: *Tehnologia exploatării lemnului* (*Wood Exploitation Technology*). Braşov. *Transilvania* University Press, 2008.
4. *** *MOUNTY in Operation - Application Methods Uphill and Downhill.* Available at: *http://www.forsttechnik.at/mounty-in-operation.* Accessed 25.08. 2011.