RESEARCH ON THE CHOICE OF ECOPRODUCTIVE TECHNOLOGIES OF FOREST HARVESTING IN THE NATIONAL PARK OF SEMENIC - CHEILE CARAŞULUI

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ABSTRACT

The current paper addresses the issue of choosing ecoproductive technologies of forest harvesting in the National Park of Semenic - Cheile Carasului, both through the optimal choice of the method of operation and through the system of machines used for forest harvesting from the economic, ecological and ergonomic point of view. Subsequent to the presentation of the materials and methods used, different methods of harvesting are compared in the context of ecoproductive exploitation. The selected optimal method was examined by means of a SWOT analysis through highlighting its advantages and disadvantages. After choosing the method of harvesting, the effective application of technologies of reduced environmental impact took place by choosing the optimal machine systems.

INTRODUCTION

The modern approach in which forest planting and harvesting is a unitary system where the two activities are interrelated suggests that they are inseparable and that forest harvesting is a forestry regeneration method which determines the planting of a new stand.

Harvesting technological systems which are widely used nowadays prove to be inadequate for reduced impact forest harvesting and, therefore, we are witnessing a globally-oriented implementation of organization solutions to ensure the protection of skidtrails, soil, seedlings, wood stands and water stretches.

Reduced Impact Forest Harvesting is a working system based on the controlled implementation of specific operations of harvesting and collecting wood with a low level of soil disturbance, and the subsequent growth of trees, which ensures the perpetuation of forest functions and its economic viability after harvesting.

A fit-for-purpose specific technological process is not a prerequisite, differing in point of structure from the conventional one; however, those ways of harvesting that reduce the consequences of present actions on the future value of the forest should be carefully chosen. In this context, any damage is an additional cost for the manager of the harvested area, the counterpart of the amount representing the decreased economic and ecological value of the future stand.

The aim of this research is to identify the method and machine systems for eco-productive forest harvesting in areas of integral protection and in the sustainable conservation areas of the National Park Semenic - Cheile Caraşului. The aim was achieved by addressing the following objectives: comparison of different methods of harvesting, the SWOT analysis of the selected optimal method, the choice of the related machine system.

MATERIALS AND RESEARCH METHODS

The materials used to achieve the intended goals and objectives consist of mainstream literature (books, journals and papers) addressing the topic of eco-productive technologies for forest harvesting. To collect specific data about the targeted area, forest planning and landscape planning maps were examined.

The following research methods were used:

- *review of mainstream literature* to support the working hypothesis and achieve all the three intended objectives, as well as to collect data about the National Park Semenic - Cheile Caraşului;

- *reasoning*, which was based on the data collected from mainstream literature and on the data with specific reference to the targeted area of forest planning.

- *analysis and synthesis*, used to process data collected from mainstream literature, related to those of the targeted area and collected in forest plots.

At the same time, *reasoning* and *analysis* and *synthesis* were used in drawing up the conclusions of the research.

With regard to the methods used to achieve the objectives, they are presented for each objective such as follows:

- *comparison of different methods of harvesting*: in relation to the eco-productivity of each method, resulting in the choice of an optimal methods of harvesting;

- *the SWOT analysis* of *the selected optimal method*: as presented in the table by analyzing the advantages and disadvantages of the selected optimal method with a view to raising awareness and choosing the best machine system;

- *the choice of machines in relation to the method*: the terrain characteristics, existing access roads and their availability in the targeted area determine the choice of the optimal machine systems to be used in eco-productive technologies of forest harvesting in the National Park Semenic - Cheile Caraşului.

RESEARCH FINDINGS AND INTERPRETATION

RECOMMENDED HARVESTING METHODS AND TECHNOLOGIES

One of the challenges that forest harvesting engineering has to face is the dissemination and application of technologies with reduced environmental impact. We may identify a new field of interest, that of "ecology of forestry operations" that applies the principles of industrial ecology in forest harvesting to minimize the impact on the structure and functions of the biosphere, lithosphere, hydrosphere and atmosphere.

In this context, it is important to evaluate the performance of the forest harvesting systems in relation to environmental protection, and establish the quality standards that will be enforced and monitored in practice.

Ecotehnological models of forest harvesting are characterized by:

- rationalization of the use of tractors;
- extension of cable installations as basic equipment;
- development of optimal transportation networks to reduce distances to collection;

- use of harness in tandem with high performance machines carrying out the harvesting of young trees;
- use of the harvesting method in the assortments with reduced length, and of "Forwarding" technology.

Implementation of "Reduced Impact Logging" - RIL has gained importance in the area of interference of the challenges caused by changes in environmental conditions and concerns for achieving economic and social benefits.

The comparison of different methods of logging was done using them against the eco-productivity of each method and their application according to the type of intervention, as described in (Table 1), resulting in the selection of the optimal logging method.

Applicability of methods according to the intervention type

Table 1

Intervention type	Logging method		
	Shortwood system	Trunks and poles	Full tree and tree parts
Cuttings	Good	Good	Good
Progressive and successive	Good	Moderate	Not recommended
Gardening (selective and dispersed harvesting)	Good	Not recommended	Not recommended
Selection of various age tree groups	Good	Moderate	Not recommended
Thinning	Good	Moderate	Not recommended

The cut-to-length method is preferred in the following cases:

- the harvesting areas are reduced and/or dispersed;
- partial cuts or thinning are at stake;
- interventions are carried out in sensitive areas requiring a high degree of protection;
- the road network is not dense and the storage space is relatively reduced;
- the high quality of assortments is targeted.

With a view to eco-technological harvesting with reduced impact and damage to the soil, seedlings and trees that remain in the forest, the cut-to-length method will be chosen as the most suitable to be used across the entire national park where they harvesting works will take place.

The current harvesting method applied to the National Park of Semenic – Cheile Caraşului is featured by the impact on the forest environment (Table 2), showing both advantages and disadvantages.

Advantages and disadvantages of the selected harvesting method

Table 2

Shortwood system	
Advantages	- reduced negative impact on stands that have a regular shape, thus being less likely to downgrade by breaking or cutting when harvested; - the debris contain, to a large extent, small branches, tops and other non-recoverable parts resulting from logging, thus protecting the soil, and the apparent tree roots require, to a lesser extent, maintenance equipment or auxiliaries, the storage area is less large, the length of parts allowing for highly winding trails and smaller connection radius;
Disadvantages	- relatively high initial investment and, sometimes, high operating costs, lower productivity, intensive character in terms of work organization, under-exploitation of the harvesting equipment, especially when the slope is steep;

DESCRIPTION OF THE MACHINE SYSTEM RECOMMENDED FOR FOREST HARVESTING AND COLLECTION

The eco-efficient forest exploitation should integrate harvesting, collection and transport through mapping the functional needs of forestry machinery to the requirements of environment and to the socio-economic ones so that work is carried out rhythmically and at reduced costs.

Even if environmental technologies of wood harvesting and collection are more and more emphasized, it does not mean giving up high performance equipment of high productivity, moving on the ground. Parallel to the increase in the proportion of the use of pull cable means of collection, there are concerns and trends of modernization of the equipment of the type of forestry tractors so as to be able to penetrate into areas that were not originally their area of use (steep slopes).

In this case, **harvesting** will be done by using mechanical saws, carrying out the felling and cutting operations as well as the partial cleaning of branches.

The entire park area will generate a volume of harvested timber of 703,336 m3 (70,333 m3 annually) resulting from:

- treatment: – 538,151 m^3 (53,815 m^3 annually)
- maintenance: – cutting 4 843 m^3 (484 m^3 annually)
  - thinning 52,505 m^3 (5,250 m^3 annually)
  - hygiene cuttting 42 527 m^3 (4,252 m^3 annually)
- conservation works – 65,310 m^3 (6,531 m^3 annually).

Timber harvesting is performed under specific conditions consisting, in fact, of a progressive concentration on the surface of the wood flooring. Transport, in this case, to the National Park of Semenic - Cheile Carașului is done only on the existing dedicated routes (collection trails) avoiding the creation of new routes.

The machine system will be chosen according to each type of work performed, the conditions on the ground, the existing roads network, in each forest district (Table 3).

The machine system recommended for timber harvesting

Table 3

Forest district	Production unit	Works/Treatment	Intended Works/Treatment	Machine system for timber harvesting
Reşiţa	VII Reşiţa IX Caraşova X Comarnic	Maintenance	Cutting, thinning, hygiene cutting	harnessing felling and bucking by miniforwarder
		Regeneration cuts	Flush cutting	miniforwarder
			Progressive cutting	In the production units of VII Reşiţa and IX Caraşova – Taf- ul In the production unit of X Comarnic - cable yarder
			Topping in the case of simple groove	miniforwarder
		Conservation works	Conservation works	miniforwarder
Anina	V Celnic VI Anina VII Mărghitaş VIII Cireşnaia IX Buhui X Izvoarele Caraşului	Maintenance	Cutting, thinning, hygiene cutting	harnessing felling and bucking by reduced capacity cable yarder
		Regeneration cuts	Progressive cutting	harnessing felling by independent winches bucking by forwarder
			Gardening cutting	Cable car
		Conservation works	Conservation works	harnessing bucking by forwarder
Nera	II Nergana III Nergăniţa	Maintenance	Cutting, thinning, hygiene cutting	bucking by independent winches felling and bucking by miniforwarder
		Regeneration cuts	Progressive cutting	bucking by independent winches felling and bucking by forwarder
		Conservation works	Conservation works	harnessing felling and bucking by forwarder
Bozovici	III Ponеasca	Maintenance	Hygiene cuts	felling and bucking by cable car network
		Regeneration cuts	Progressive cutting	
Văliug	ICuca-Gozna II Bolnovăţ VI Crivaia IX Trei Ape XI Semenic XII Molidu	Maintenance	Cutting, thinning, hygiene cutting	harnessing felling and bucking by cable car network
		Regeneration cuts	Gardening cutting	cable car network
		Conservation works	Conservation works	harnessing felling and bucking by cable car network

Technological advancement enhances forest activity with less loss of timber, with a low level of pollution, with reduced impact on the environment and lower consumption of raw materials; as long as the most adequate logging technological systems are used. The

main objectives of the design and planning work for logging are: optimization of technological processes and operations to minimize the environmental impact.

CONCLUSIONS

The volume of timber in areas with full protection and sustainable conservation areas amounts to 703,336 cubic meters per decade, so annual figures are of 70,333 cubic meters, which, compared to the area covered by forest, represents 3.2 cm/year ha. Timber is a source of revenue for the forest, therefore much of the income from the sale of the timber must return to the forest.

Logging must be understood as "forest operations" or "forest technological operations" and its individualized study points to the scientific field that covers design, implementation, control and steady improvement of logging systems.

The use of the methods in relation to individual productivity and applicability depending on the type of intervention resulted in the choice of the optimal logging method.

Thus, the timber must be operated by means of the shortwood system, being the best choice, because it must take into account and comply with the norms of eco-protection and treatment of forest. Besides an optimum method, the machine systems used for timber harvesting in an economic, ecological and ergonomic way is also important. Another important principle, having in mind that the operations are carried out in a national park, is landscaping, even if works are performed, they should take into account the flooring aspect, both during harvesting and after its reinstatement.

Regarding the shortwood method, the main advantages are reduced negative impact on the stand, lower soil and apparent roots disturbance as debris can remain on the collection routes.

The main disadvantages are the relatively high initial investment and sometimes high operating costs, lower productivity.

The integrated work involves the optimal association with machinery and equipment for operation on the specific terrain where timber is harvested.

In areas where timber harvesting is lower (maintenance, conservation works) reduced capacity cable yarders, miniforwarders and harness will be used.

The machine systems used for treatment consists of cablecars, carterpillars, forwarders and independent winches. Therefore, a revamping of the machinery used and an orientation towards the implementation of organization solutions to protect sloping land, soil, seedlings, standing trees and water stretches.

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