

LOGGING EQUIPMENT IN BULGARIA – CURRENT STATE AND FUTURE PROSPECTIVE

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Abstract

The results from survey of forestry equipment in 2019 show 1371 units in Bulgarian logging industry. Expectedly, the largest share is in the farm tractors adapted for timber skidding. The rate of cable skidders is more than three times lower. Cable skidders and yarders should prevail, given that most of the forests in Bulgaria are situated on steep terrains with complex forms. A fundamental problem in logging industry in Bulgaria is the huge predominance of old equipment (in operation over 10 years), and their lower production rates and higher maintenance and repair costs. A major renewal of the logging machinery is expected, due to its physical wear and lack of manpower in the logging industry as well as in the industry as a whole, which is becoming increasingly tangible. The retrofit must be done with new high-performance equipment that, while more expensive, will ensure efficiency and lower unit costs. Facilitating access to EU programs will encourage the purchase of modern logging equipment. The density of the forest road network is insufficient and investment is needed to build new forest roads to reduce the average skidding distance and unit costs, and to rise the productivity of primary transport. Increasing the maximum allowable felling intensity will lead to the possibility of mechanized logging. The increasing the intensity of cutting will expand the use of harvesters and forwarders in coniferous forests. Another driver for the rapid introduction of new logging equipment are the long-term contracts of companies for better predictability and sustainability of investments. Barriers are the oncoming recession in the demand for timber and the supply of large volumes of cheap timber damaged by natural disasters from other European countries.

Key words: forwarders, harvesters, mechanization improvement, skidders, yarders, years in operation.

Introduction

In Bulgaria forests account for about 4.5 million hectares, corresponding to 37 % of the land area and are mainly located in hilly and mountainous areas (EFA 2020). Over the last 5 years, an average of about 8.0–8.3 million cubic meters timber (over bark) per year has been produced, and

about 6.6–7.0 million cubic meters timber (under bark) per year (EFA 2019). The mentioned volumes are significantly under annual increment of Bulgarian forests of 16.7 million cubic meters (over bark). Deciduous tree species predominate – 70.5 % from forest territory, but their share from total growing stock is lower – 55.5 %.

Bulgarian forest territories are characterized by steep terrains, small dimensions of most cutting areas, and predominance of deciduous timber. The traditional harvesting system in Bulgaria is motor-manual tree felling and processing and extraction mostly by skidder, yarder, and animal force, which corresponding to an early stage of mechanization. Traditional extraction methods are based mainly on adapted agricultural tractors with related logging equipment such as winches, as well as wheel cable skidders.

In the 20th century large areas with coniferous plantations were created at very low altitudes. While coniferous plantations have usually served their primary purpose of helping to control erosion, numerous waves of mortality have been observed in recent decades due to the combined negative effects of drought, aging and lack of opportunities for regular thinnings (Milev et al. 2017, MoEW 2019).

From an economic point of view, the total output at basic prices of forestry and logging in 2017 in Bulgaria is approximately EUR 707 million, which is an increase of 2.7 times compared to EUR 266 million in 2005. However, persons employed of forestry and logging in 2017 are approximately 12000 and have decreased by 1300 employees (9.8 %) compared to 2005 (Eurostat statistics explained 2020).

The beginning of the development of the mechanized timber extraction is considered to be the operation of the first two Wyssen sledge yarders in 1949. During the period 1958–1961 between 85 and 97 % of the mechanized timber extraction is carried out by cable yarders and their number reaches 248 units (Vasilev 2013). Several models of cable yarders have been developed and produced in Bulgaria. Currently, only about 5 % of the timber extraction in Bulgaria is carried out by ca-

ble yarders, although 60 % of the forests are located on terrains with large slopes.

In the second half of the 1960s, the use of cable yarders gradually narrowed with the introduction of rubber-tired tractors. They have higher mobility, a simpler technological process and can transport timber over longer distances. In the middle of the 70s of the XX century the production of the Shipka ShT-80 four-wheel-drive articulated cable skidders began in Bulgaria (Manolov et al. 2009).

In the early 80's of the twentieth century, environmentally friendly logging was realized by foresters and loggers, and tractor-mounted tower yarders began to be imported. Later tractor-mounted tower yarders began to be produced in Bulgaria. During the same period in Bulgaria the MSI-100 4WD forwarder and MBI-100 4WD clambunk skidder were developed. Later, production of the Shipka TG-50G tractor log trailer began (Manolov et al. 2009). Forwarders manufactured by leading world companies, gradually began to enter the forestry in Bulgaria at the beginning of the new millennium. Hundreds of 4WD and 6WD old high-mobility military trucks have been used in logging in Bulgaria as low-cost substitutes of forwarders since the early 1990s.

Motor-manual tree felling and processing is among the most used options in timber harvesting operations and it is formally known to be a heavy job exposing the workers to safety hazards and harmful factors (Cheța et al. 2018).

Adapted agricultural tractors are the most widely used means of timber extraction in Bulgaria, as well as the Balkans, the Carpathians, Italy, etc. (Borz et al. 2013, 2015; Moskalik et al. 2017; Proto et al. 2018a; Cataldo et al. 2020).

Wheel cable skidders are used in many harvesting systems due to their better lon-

gitudinal and lateral stability, mobility and long winch cable (60–100 m) giving a better opportunity to access to marked trees and enhanced productivity (Georgiev and Stoilov 2007).

Forwarders are a mechanized alternative to agricultural tractors and horse logging (Proto et al. 2017, Borz et al. 2019). Modern forwarders are an effective extraction option for timber harvesting operations that provide the opportunity for higher levels of mechanization. With their ability to carry logs from the forest to the roadside or processing areas, they have an established lower environmental impact in comparison to tree-length skidding options (Proto et al. 2018b). In Austria, whose forests are predominantly on mountainous terrain, the distribution of timber extraction machines from stand to landing in 2009 is as follows: cable yarders – 20 %, skidders – 49 %, forwarders – 26 %, and other means – 5 % (Holzleitner et al. 2011). Ten years later, in 2019, this ratio has changed in favour of forwarders: cable yarders – 19 %, skidders – 37 %, forwarders – 43 %, and other means – 5 % (Prem and Bauer 2020).

Fully mechanized timber harvesting systems are generally characterized by a high operational performance being widespread and used across many regions. Such systems are adaptable to different levels of operational integration, enabling also the recovery of energy wood, but given integration configurations affect their performance (Apăfăian et al. 2017). In a survey in neighbouring Romania evaluated the perception of state forest managers, contrary to expectations, the mechanized harvesting systems were rated as highly preferred. In particular, cable systems were among the first preferences of the respondents, being followed by those

systems involving forwarding operations (Munteanu and Borz 2018).

About 65 % of the timber extraction in Bulgaria in the 90s of the last century were mechanized, and in loading operation the degree of mechanization is about 85 %. There has been significant regression in this regard in recent decades. About 550 units of adapted tractors and no more than 60 others worked in logging. The tractor skidding has very obsolete equipment with expired depreciation period. The cable yarders were about 40 sledge yarders and 20 tower yarders, of which a little more than half worked constantly. The most common are Pirin and Koller (Dinev 2009).

It should be noted that in recent years new modern logging machines have started to enter the Bulgarian forests – forwarders and cable skidders, cable yarders, as well as second-hand ones. So far, this update is not enough. Mechanization may change this situation, by offering fewer, better jobs, which may prove attractive to the new and more educated generations. Mechanization allows multiplying operator productivity and for this reason achieves an overwhelming superiority over traditional technology, which makes it a better choice even when utilization rates and labour cost are comparatively low (Spinelli and Magagnotti 2011).

Currently, there are no reliable data on the number and state of logging equipment in Bulgaria, and various sources indicate contradictory data. All this makes the study of logging equipment in Bulgaria actual, relevant and necessary.

The aims of the present study are: i) to establish the number and years in operation of available logging equipment; ii) to analyse the current state, influencing factors and future prospects for development.

Materials and Methods

The study of logging equipment in Bulgaria was conducted in the spring of 2019. A questionnaire (see Table 1) was sent to the six state forest enterprises, two training and experimental forest ranges of University of Forestry, municipal forest enterprises, forestry production cooperatives. The questionnaire was accompanied by detailed instructions and an example to be completed. The six state forest enter-

prises sent the questionnaire to their territorial divisions. To avoid duplication, as one machine is reported to neighbouring territorial divisions, the number and type of equipment are determined on a specific date, 3rd of May 2019.

Data were collected from 160 territorial divisions of state forest enterprises, two training and experimental forest ranges of University of Forestry, municipal and private structures in which mechanized logging was currently carried out.

Table 1. Questionnaire used for the survey.

Questionnaire						
for logging equipment, working on the territory of state forest/hunting range, municipal forest enterprise, forestry production cooperatives as of May 3rd 2019						
No	Brand and model of the machine	Age classes				Owner
		new	1–5 years	5–10 years	over 10 years	
1.	Ground-based extraction					
1.1.	Adapted agricultural tractors for skidding					
1.2.	Purpose-built machine					
1.2.1.	Skidders					
1.2.2.	Forwarders					
1.2.3.	Tractor log trailers					
2.	Cable-based extraction					
2.1.	Sledge yarders					
2.2.	Tower yarders					
3.	Harvesters					
4.	Timber loading machines					
4.1.	Tractor mounted knuckle-boom					
4.2.	Front loaders					
5.	Mobile chippers					

The data were processed and classified by type of machine, type of running gear and age.

Results

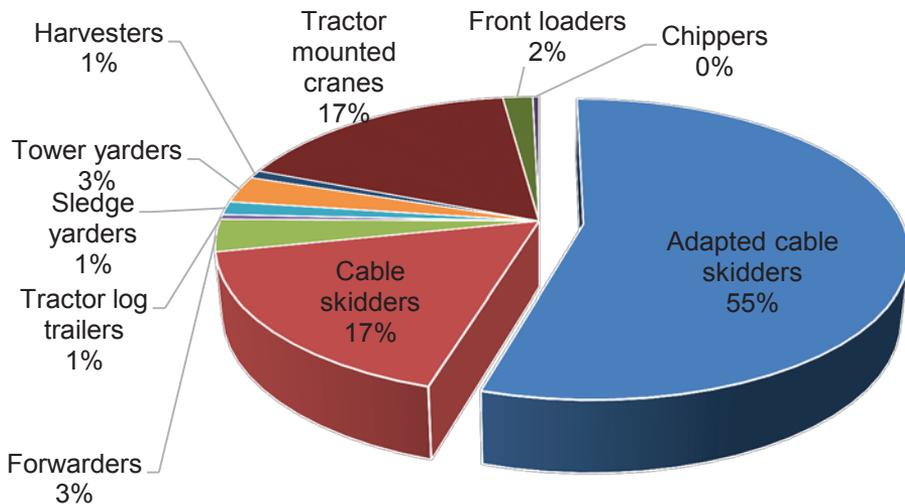
The data of logging equipment by number, type, age classes, and percentage is

shown in Table 2 and Figure 1.

From the Figure 1 it can be seen that in Bulgarian forestry timber extraction equipment (80 %) is widespread. Skidding operations with the adapted agricultural tractors, numbering 750 (55 % of all logging equipment), predominate. Followed by cable skidders – 233 units (17 %), tower yarders (3 %), and sledge yarders (1 %).

Table 2. Data of logging equipment in Bulgaria.

Type of machine	Age classes				Total
	new	1–5 years	5–10 years	over 10 years	
Adapted cable skidders	2	19	22	707	750
Cable skidders	7	17	18	191	233
Forwarders	2	9	9	28	48
Tractor log trailers	0	4	1	2	7
Sledge yarders	1	0	0	19	20
Tower yarders	1	1	0	38	40
Harvesters	1	2	0	9	12
Tractor mounted cranes	3	13	6	210	232
Front loaders	2	7	2	13	24
Chippers	1	1	0	4	5
Logging equipment total	20	73	58	1221	1371

**Fig. 1. Percentage of logging equipment by type.**

The forwarders are 48 units (5 %) of timber extraction equipment (Fig. 2). In general, ground-based equipment for transport of assortments has a relatively small share – as mentioned, 48 forwarders and 7 tractor log trailers, i.e. 6 %.

As expected, among the timber extraction machines the largest share of 68 % belongs to adapted agricultural tractors for skidding in a semi-suspended position, as 750 units were reported. Adapted trac-

tors widely used in Bulgaria do not fully meet the operating conditions in forestry, but they have a relatively low cost as mass-produced 4WD agricultural tractors (Fig. 2).

The purpose-built cable skidders – 233 units (21 %) are less than adapted ones. The ratio between adapted agricultural tractors and cable skidders is about 3:1. However, cable skidders should prevail, given that most of the forest areas of Bul-

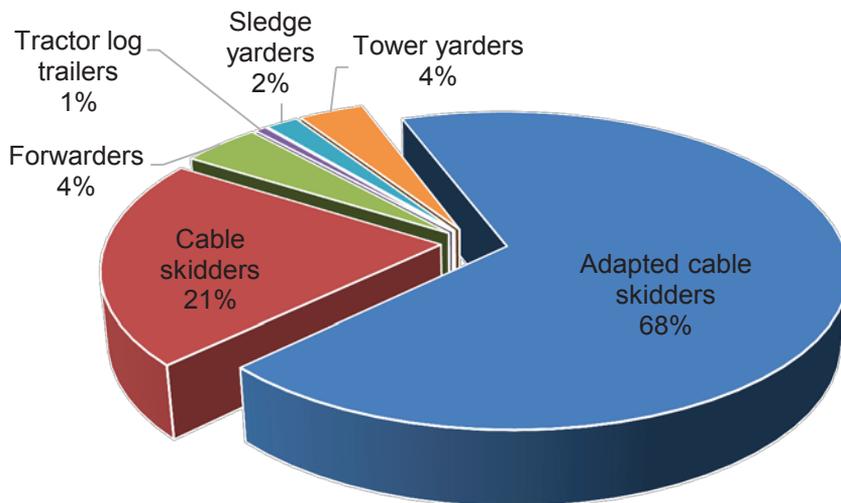


Fig. 2. Percentage of timber extraction equipment by type.

garia are located on steep terrain with complex shapes. The most common cable skidders used in Bulgaria are middle – sized from brands LKT-80/81T/82 (100 units) and TAF-658/690/2010 (44 units).

It is noteworthy that in general the forwarders work independently, not only with harvesters, which are 12 units, i.e. ratio of 4:1. The most common forwarders used in Bulgaria are heavy – sized from brands John Deere (25 units) and Komatsu Forest (6 units). Two of harvesters, John Deere 1170E and 1270E, two John Deere 1510E and one 1510G forwarders operate mainly in poplar plantations (Novakov 2020).

Ground-based timber extraction vehicles (adapted cable skidders, cable skidders, forwarders, tractor log trailers) are a total of 1038, versus 60 cable-based machines, i.e. ratio of 17:1. It is important to note that there are 3 mountain harvesters among the forty tower yarders.

A very serious problem is obsolete and depreciated equipment (Fig. 3). The largest share of machines over 10 years

belongs to the group of sledge and tower yarders (95 %), followed by adapted agricultural tractors (94 %), tractor mounted cranes (91 %), and cable skidders (82 %).

The share of machines over 10 years of age is relatively lower among harvesters (75 %), forwarders (58 %) and front loaders (54 %). Only tractor log trailers up to 5 years (57 %) predominate, while those over 10 years are 29 %.

In ground-based extraction the more environmentally friendly wheel skidders predominate (91 %), while the tracked ones are 9 % in total.

Discussion

A fundamental problem in logging industry in Bulgaria is the huge predominance of equipment in operation over 10 years (89 %), and hence, their lower production rates and higher maintenance and repair costs. Bulgarian forestry needs for new modern logging equipment, which is a prerequisite for increasing productivity

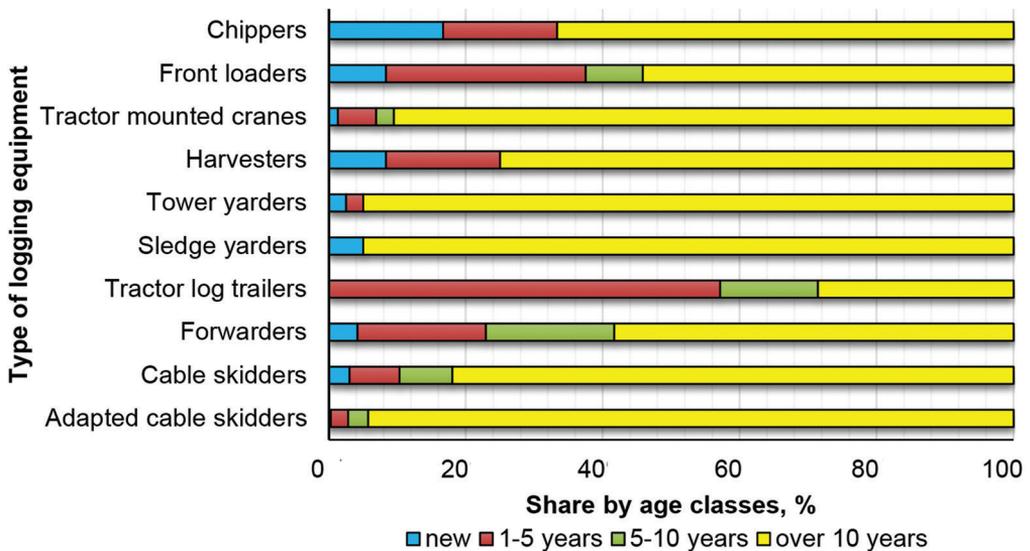


Fig. 3. Share of logging equipment by age classes.

and improving working conditions. Given that the backbone of logging equipment in Bulgaria are cable skidders and adapted agricultural tractors, which are a total of 783, there is a significant aging (average 91 %). For example, the most common adapted agricultural tractors used in logging in Bulgaria are Universal-651M (331 units) and Bolgar TK-82N (93 units), both are no longer produced by over 20 years and factories no longer work.

The drivers toward renewal of logging equipment are several.

A major renewal of the logging machinery is expected, due to its physical wear and lack of manpower in the logging industry as well as in the industry as a whole, which is becoming increasingly tangible. Modernization must be done with new high-performance equipment that, while more expensive, will ensure efficiency and lower unit costs.

There is a sustainable demand for wood, both for heating and from wood-working and pulp and paper mills. Tem-

porary barriers are the oncoming recession crisis in the demand for timber due to COVID-19 and the supply of large volumes of cheap timber damaged by natural disasters from Central-European countries. The effective use of forest biomass is set as a priority objective in the European Union Forest Strategy and is a key part of the strategy of the European Commission for Sustainable Energy Union with a future-oriented policy on climate change. In recent years limiting the dependency on imported fossil fuels and their replacement by renewable energy sources has gained strategic importance. In Bulgaria the majority of forest biomass is used locally, making it a major factor in ensuring the energy independence and stability in rural and mountainous areas (EFA 2019).

Increasing the maximum allowable felling intensity over 30 % will lead to the possibility of mechanized logging. Coniferous species are preferred for timber harvesting in Bulgaria because they are better suited for the pulp and paper

mills. Only 29 % of the forests by area are coniferous, but they provide 45 % from growing stock. Increasing the intensity of logging will expand the use of harvesters and forwarders, which now work mainly in clearcutting in coniferous plantations affected by natural disturbances. At higher cutting intensity harvesters and forwarders will be able to operate effectively on moderate slopes and their numbers and production rates will increase. It can be expected that forwarders, based on their advantages, will gradually replace military off-road trucks and have the greatest potential to increase their number and share. This is prompted by the increasingly noticeable lack of skilled and even unskilled labor force. An important advantage of new equipment is the comfortable working environment in the cab of the machine and the ergonomic control devices. Such a machine can retain more skilled workers in the forestry industry.

Facilitating access to European Union programs will encourage the purchase of modern logging equipment.

Variation in slope reflects the difficulty, and thus costs, of accessing forest stands. Road density has a positive effect and has the largest impact of all factors. The magnitude of this effect reflects the fact that forest road network in Bulgaria is a limiting factor for the forestry and in particular logging industry. The density of the forest road network ($7.9 \text{ m}\cdot\text{ha}^{-1}$) (MoAF 2014) is insufficient and investment is needed to build new forest roads to reduce the average skidding distance and unit costs, and to rise the productivity of primary transport.

Another driver for the rapid introduction of new logging equipment are the long-term contracts of companies (5–7 years) for better predictability and sustainability of investments.

Conclusions

The predominance of adapted agricultural tractors in Bulgarian forestry does not correspond to the fact that most of the forest areas are located on steep terrains with complex shapes, despite this feature requires the use of purpose-built skidders and cable yarders. Therefore, the use of harvesters is limited, as well as by the predominance of deciduous forests. The number of forwarders which otherwise work in conjunction with harvesters is 4 times greater than that of harvesters, and it can be expected that forwarders will gradually replace military off-road trucks and have the greatest potential to increase their number and share.

Both physical wear and lack of manpower in the logging industry leads to renewal of the logging machinery, which while more expensive, will ensure efficiency, higher productivity and lower unit costs. Facilitating access to European programs will encourage the purchase of modern logging equipment. Increasing the maximum allowable felling intensity will improved the possibility of mechanized logging. Another driver for the rapid introduction of new logging equipment are the long-term contracts of companies for better predictability and sustainability of investments.

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