Austro2007/FORMEC´07: Meeting the Needs of Tomorrows´ Forests – New Developments in Forest Engineering, October 7 – 11, 2007, Vienna and Heiligenkreuz – Austria

FULL-MECHANIZED HARVESTING IN BULGARIA – THE OUTLINES OF AN UPCOMING MARKET

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Keywords: harvesters, forwarders, processors, market

Abstract: *The full-mechanized forest harvesting with harvesters and forwarders has not yet been employed in Bulgaria, mainly because of financial reasons. However, the EU membership results in an improvement of the investment climate that is already sensed also in forestry. In the present study, a first prognosis of the up-coming market of heavy forest harvesting machines in Bulgaria is made, based on data about the Bulgarian forests and of Central European experience.*

1. Introduction

According to a World Bank report, Bulgaria is "the most south-easterly country in Europe with substantial forest resource" (World Bank, 1995).

With its territory of 110 square km Bulgaria is approximately as large as Austria or Bavaria or the Czech Republic. 30% of this territory (4 000 000 ha) are forests, most in the mountains (70%). The yearly timber production is about 5 500 000 cubic m, which is less than the half of the yearly production of the Czech Republic. Because of the predominance of young forests, only 1/2 of the annual increment is harvested. And as the post-war conifer plantations (1 000 000 ha) grow older, the intermediate cuts started predominating (50.2% of the total harvest in 2005) – indeed, for the first time in history (NFB, 2005).

In the 50s of XX century, Bulgaria was one of the first countries that employed widely the cableways (350 cableways, 25% of the hauled timber in 1965). Later, the use of tractors prevailed. Since 1960, 900 tractors have been acquired and employed for hauling. They were preferred to the cable cranes because of easy operating and the cheap fuel of those times. Harvesters and forwarders have not been employed because of the mountainous ground of Bulgaria.

In the 90s, instead of promoting the heavy machines, the economical crisis of the transition years reduced the use of machinery to 2/3 of its level in 1990 and restored the predominance of animal force (Table 1). Which is more, most of the employed machinery is outdated and worn out (Gluschkov et al., 2004; Dinev et al., 2006).

Table 1: Share of the hauling means in Bulgaria in percents of the total timber production

years	tractors	cable cranes and ways	horses
1990	57%	6%	37%
2005	37%	4%	59%

Besides of the cheap human power (the esteemed monthly income of a forestry worker was 250 EUR in early 2006) the main cause of the decline of forestry mechanisation was and still is the lack of investments. A proof of this statement are the over 400 military trucks and tracked machines that were sold by the Army according to Army reports and employed for hauling, thus revealing a latent demand of hauling machinery (Gluschkov, S.et al. 2007). The only reason of employing them were their very low acquisition costs since their other parametres, e.g. the fuel consumption, are not comparable with normal skidders.

For the coming decennium, a revival of forestry investments in Bulgaria can be foreseen. Joining the European Union will probably have similar consequences for Bulgaria as it had 15 years ago for the new *Bundesländer* in Germany: it will improve the investment climate but raise the labour costs. Logging contractors already complain that they lose their workers who find better salaries in the construction business.

Therefore, the **aim** of the present study is to find out the technical limits of the up-coming market of logging machinery in Bulgaria.

2. Materials and methods

It is well known that wheeled forestry machines (skidders, forwarders, harvesters) can be operated on slopes up to 35%, called passable ground. Skidders can be operated on steeper slopes on special machine tracks (Maschinenwege). Slopes with inclinations from 50% up to 100% and even 140% are undisputable cable ground (Seilgelände) that requires cable cranes. Cable cranes are also operated on lower inclinations to avoid soil damage. Tracked machines (tractors and harvesters) are operated without machine tracks on steeper slopes than wheeled ones – up to inclinations of 65% and even more, depending on the soil and the machine itself (Stampfer et al., 2004; Heinimann, 1995).

Recently, the company ThüringenForst that manages the state-owned forests of the state of Thuringia issued a "Compendium of Forest Works" that states the most appropriate logging technology for different conditions (Findeisen, 2006). A more detailed version of the same is used for a project dealing with timber hauling on medium steep slopes (Findeisen, 2007). This version is presented here in Table 2 and was further used to calculate the possible number of forestry machines for Bulgaria.

Table 2: Recommended logging technology after the Thuringian "Compendium of Forest Works"

slope inclination, %	BHD 10–50 cm for conifer sp. BHD 10 – 35 for broadleaved sp.	other BHDs
0 – 35	wheeled harvester + forwarder	chain saw + skidder
36 – 50	tracked harvester + forwarder^{W}	chain saw + skidder^{MT}
51 – 65	tracked harvester + cable crane	chain saw + cable crane

65 – 140	chain saw + cable crane	chain saw + cable crane

In Table 2, "BHD" denotes the average breast-height diametre of the trees to be harvested. The index "W" denotes that the use of forwarders requires an auxiliary winch to keep traction at the trail. The index "MT" denotes that the operating of skidders requires the existence of a net of machine tracks. After the calculations of ThüringenForst, the construction of machine tracks is cheaper than the use of cable cranes for slope inclinations up to 50%. Generally, the recommendations of the "Compendium" in Table 2 follow the above definitions of "passable ground" and "cable ground" putting an "interim ground" (Übergangsgelände) between them that corresponds to inclinafions from 35 to 50%". The "Compendium" recommends the use of chain saws for extreme tree diametres and extreme slopes only.

More conservative recommendations gives a "Memorandum" of the Bavarian State Forestry Office (Table 3, see also LWF, 2004). It applies almost the same definitions of "passable ground" and "cable ground". Unlike the "Compendium" it relates the priority of harvester logging not from average diameter but from concentration of cutting volume (Holzanfall).

Table 3: Recommended logging technology after the Bavarian "Memorandum 13/04.2004"

slope inclination, %	common technologies
0 – 35	wheeled harvester + forwarder, or chain saw + skidder
36 – 50	tracked harvester + cable crane, or chain saw + skidder^{MT}
51 – 140	chain saw + cable crane

The requirement of high concentration is traditional but it becomes nowadays outdated, since harvesters are widely used for thinning even in the new EU-countries (Moskalik, 2004; Dvořak, 2006). Therefore, we have used for this study mainly the Thuringian classification in Table 2.

Our information about the distribution of cutting volumes according to the parametres inclination, tree diametre and concentration originates from the forest management plans of 15 State Forestry Districts made in the period 2000-2007 all over Bulgaria. They are representative for the near future since the rules of sustainable forestry management do not permit dramatic changes in timber harvest. Our information about the annual harvest originates from the annual reports of the Bulgarian National Forestry Board (NFB, 2005, 2006).

3. Results

According to the cited data sources, only 20% of the timber to be harvested in Bulgaria is on undisputable cable ground, 48% is on undisputable passable ground and 32% is in the interim zone of inclinations between 36 and 50% (Figure 1). In the following calculations we prefer to treat the interim zone as special passable ground, since in Bulgaria as well as in Thuringia the use of cable cranes is expensive (Gluschkov et al., 2006).

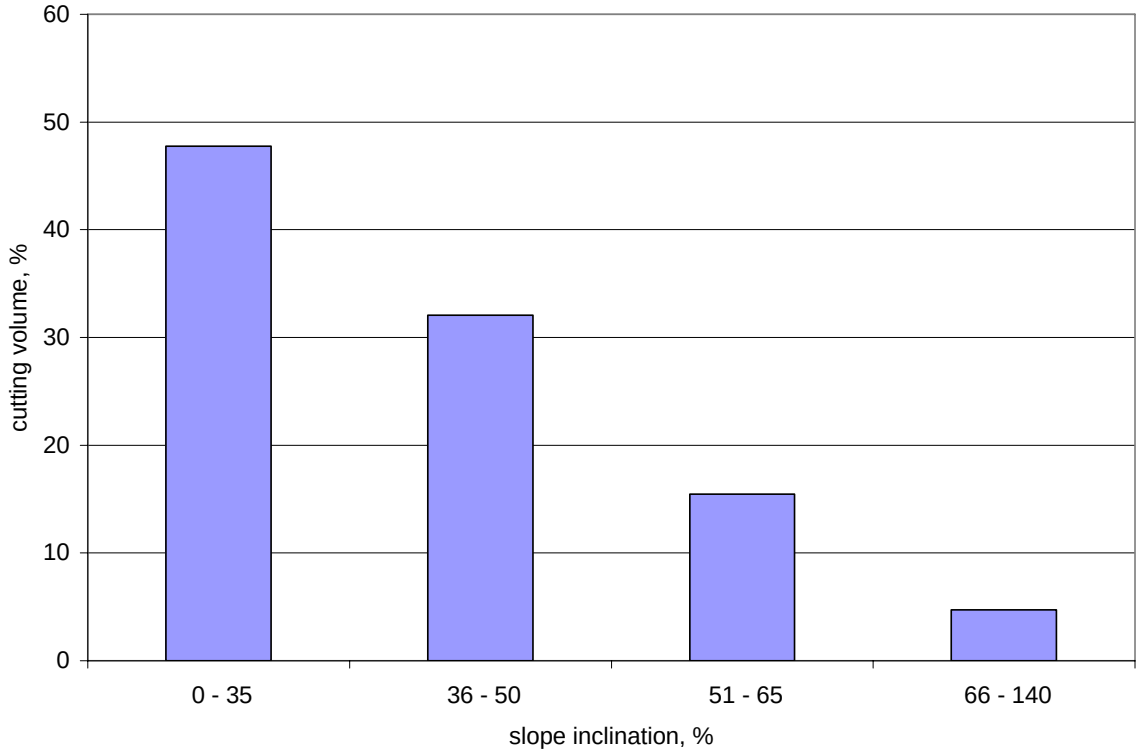

Figure 1: Distribution of the annual cut in Bulgaria according to slope inclination

Considering the inclination together with the diametre, we obtained following classification of the annual cut volume according to the criteria of the "Compendium" of ThüringenForst (Table 4).

Table 4: Percent distribution of the annual cut in Bulgaria after the classification of the Thuringian "Compendium of Forest Works"

slope inclination, %	BHD 10–50 cm for conifer sp. BHD 10 – 35 for broadleaved sp.	other BHDs
0 – 35	42 %	6 %
36 – 50	27 %	5 %
51 – 65	12 %	3 %
65 – 140	4 %	1 %

Together with the technology recommendations of Table 2, the percents of Table 4 determine the maximum market share of each machine, i.e. the percent of the annual cutting volume that is available and that can be processed or transported by this machine (Table 5). For example,

- The market share of the forwarders is the sum 69 % = 42 % + 27 % that corresponds to inclinations from 0 to 50% and suitable diametres from 10 to 35 cm (for the broadleaved species) or 50 cm (for the conifers).
- The market share of tracked harvesters is the sum 39 % = 27 % + 12 % that corresponds to inclinations from 36 to 65% and the above suitable diametres.
- The market share of cable cranes is the sum 20 % = 12 % + 4 % + 3 % + 1 % that corresponds to inclinations from 65 to 140% regardless of the diametre. We assign the same percent also to the processors since cable cranes transport whole trees, pruned or not, that are then cut to length at the truck road where a processor can be operated.

We do not consider here the "mountain harvester" which is a combination of a cable crane with a processor. We do not consider either the possibility to have a harvester on the truck road instead of a processor.

The maximum annual volume for each machine type was calculated by multiplying its market share to the total annual volume of 5 500 000 m^3 cited in the introduction part. Then, the maximum number of machines was calculated for each machine type dividing the maximum annual volume by a rough appraisal of the annual production of one such machine. The figures of the annual production in Table 5 correspond to German experience. For forwarders and wheeled harvesters, similar figures of annual production can be calculated based on the Polish Standard (Lasy panstwowe, 2007) or the recent investigations of Dvořák (Dvořák et al., 2006), when assuming the operation times listed also in Table 5. The latter correspond again to German experience (Hofmann, 1994) and seem realistic to Bulgarian experts, too. Besides, the standard of 1991 and the earlier Bulgarian ones count with higher operation times (21.3 days per month × 8.5 hours per day = 2200 per year) which have never been realistic, neither before 1989 nor with the present-day system of selling logging operations by auction.

Table 5: Calculation of the maximum number of machines

Machinery	Market Share, %	Maximum annual volume, m^3	annual operation time, h	annual production, m^3	Appraised maximum number of machines
Wheeled harvesters	42	2 310 000	2 000	20 000	116
Forwarders	69	3 795 000	1 600	13 000	292
Tracked harvesters	39	2 145 000	1 600	13 000	165
Cable cranes	20	1 100 000	1 200	7 000	157
Processors	20	1 100 000	1 200	10 000	110
Skidders	11	605 000	1 200	7 000	86

Another important factor is the concentration. The average concentration in Bulgaria is not big (70 m^3/ha). For the final cuts it is higher, about 100 m^3/ha, but for the thinnings it is quite low – 20 m^3/ha (Figure 2).

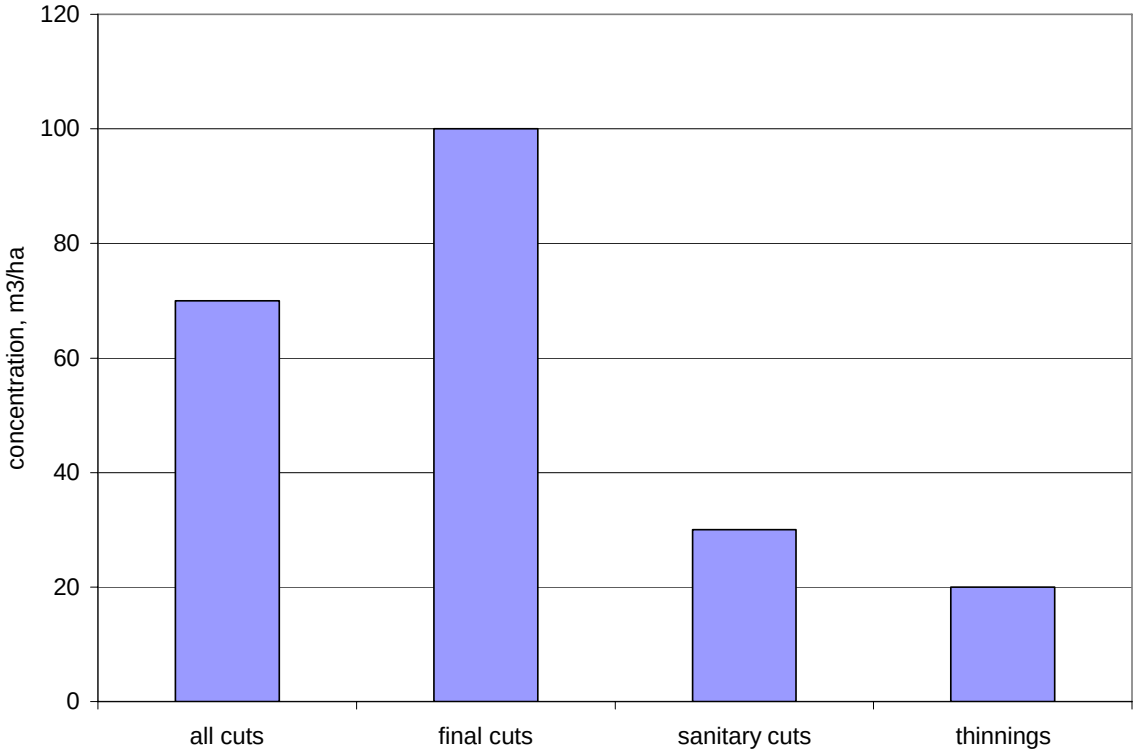

Figure 2: Average concentration of cutting volume in Bulgaria

Most of the cutting areas have a concentration of less than 100 m^3/ha, and only 30% of them have higher (Figure 3). The latter means that if concentration has to be a primary factor, the numbers for harvesters and forwarders in Table 5 have to be reduced to 30 % of their above values.

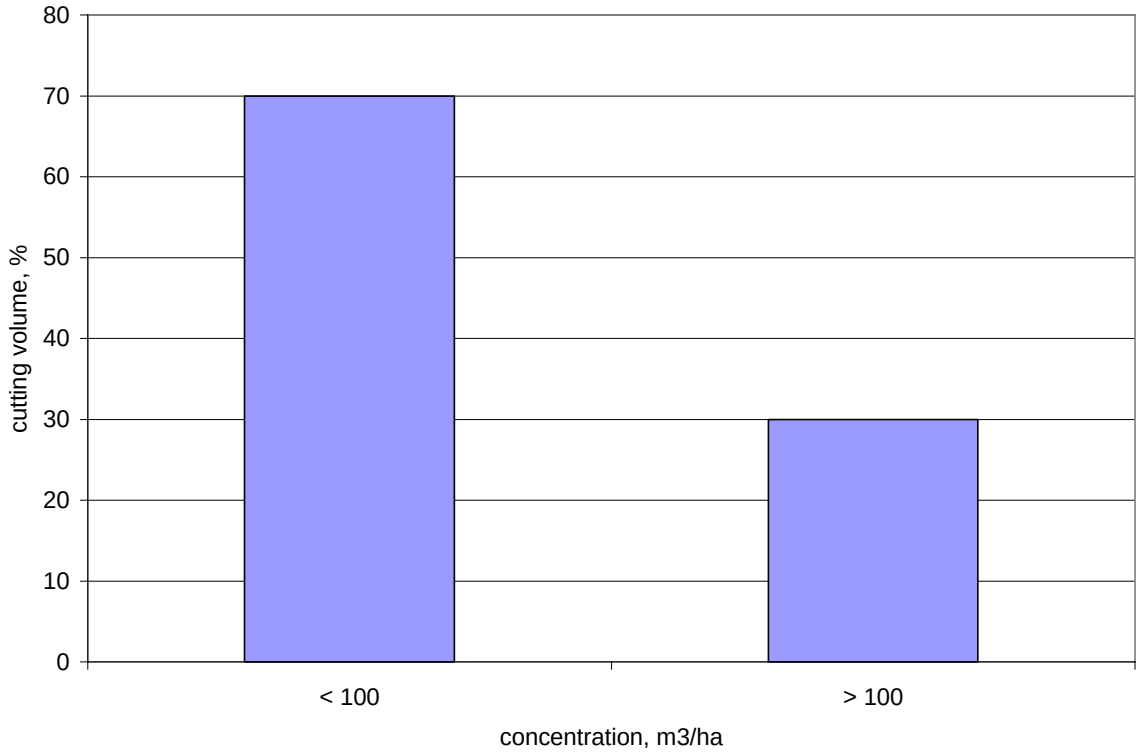

Figure 3: Distribution of the annual cut to its concentration

4. Discussion

In this study we have tried to determine the technical limits set to the employment of heavy logging machinery in Bulgaria by the parametres of Bulgaria's forests. The result is 926 machines.

We have not made any economic considerations to determine whether certain machine will pay back its costs or not. Of course, the acquisitions of heavy machinery will be made based on economic considerations and present day prices. It is indeed the speed of price change that will determine the dynamics of the market of forestry machinery.

To outline the real development, a comparison with the Czech Republic may be useful. In December 2005, 175 harvesters und 333 forwarders operated in the Czech forests, most of them belonging to the medium class (71–140 kW), for final cuts and thinnings starting from the age of about 40, on passable ground with inclinations up to 20% (Malík-Dvořák, 2007). There was a dramatic increase in the last years that was due to long-lasting activities in the past (Karásek, 2007).

Our conclusions are based on an evaluation of data originated from the Forest Management Plans, which have not been conceived to plan machinery. To have better information, an inventory of a suitable number of sample plots would be necessary.

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