

## IMPLEMENTATION OF CATERPILLAR TRACTORS IN BULGARIA

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**Abstract :** *The caterpillar tractors are very common in Russia and moreover unknown as a logging engine in the European Union. Bulgaria is one of the rare places where they could be seen to work on steep slopes. In the early 90s their use in forestry was object to ecological restrictions but they are used in Bulgaria nevertheless, although far not so massively as in Russia. On the other hand, some modern machinery with caterpillars like the heavy harvesters of Valmet and John Deer already operate in mountainous grounds which would be traditionally classified as “Seilgelände” or “cable ground”. That led us to the conclusion that a consideration of the caterpillar skidding tractors might be useful. Our investigations showed that the caterpillar skidders are quite productive and the ecological damage they cause is exaggerated.*

### 1. Background

The mechanization of logging started in Bulgaria in the early 50s: in 1948, the use of chain saws and the Swiss-made cable systems „Wyssen” began, in 1950, the first tractors were acquired and, in 1952, the Faculty of Logging Engineering was founded. Initially, the cable systems dominated in logging operations. The first acquired tractors were agricultural caterpillar tractors – Russian tractors KT-12 supplied with winches and appeared to be unsuitable for Bulgaria’s slopes. Since 1958, Russian caterpillar forestry tractors TDT-40 have been used, suitable both for plain and mountain forests. The caterpillar tractor „Sauer-Mulli” was also tested but it was found unsuitable because of its insufficient tractive force /4/.

The apogee of cable systems was around 1970, when their number achieved about 360 and their annual output achieved 1.8 mil m<sup>3</sup>, which was unprecedented for that time in Europe. In the same year, the large-scale use of wheeled tractors started, which later on brought the decline of both cable systems and animal force /5/. The discussions about cable systems and tractors have never ended, but the All-European trend was towards tractors. In Bulgaria, the summit of the tractor logging was about 1990, when their number achieved 900, and the hauled mass achieved 2.0 mil m<sup>3</sup> or 94% from the mass hauled by machines. Most of the hauled 2.0 mil m<sup>3</sup> were done by wheeled tractors (92%) and only 8% by caterpillar ones. Romanian wheeled agricultural tractors „Universal-651M” proved to be the most suitable for the conditions of Bulgaria. According to the Ministry of Agriculture and Forests, nowadays there are 640 such tractors used for logging, 80 wheeled forestry tractors, most of them TAF-650, and 70 forestry caterpillar tractors, most of them TDT-55 Onezhets, a later modification of TDT-40. Nevertheless, Bulgarian forest workers are quite accustomed to caterpillar tractors – they were the only ones used in Komi Republic in Northern Russia, where Bulgaria exploited a huge logging concession for some 30 years.

A decrease of tractor hauling began with the beginning of political changes in 1990. Since 1990, as a consequence of economical crisis and some circumstances of privatization, Bulgarian forestry sector has acquired almost no new tractors /2/. According to the data of “Gorska Tehnika” company, the only important acquisition was the reconstruction of 50 used old agricultural tractors for forest logging. Meanwhile some 30% of all tractors became unusable and were disjoined to spare parts or sold for scrap.

The cable systems also decreased, the use of animal force increased and achieved an average of 68%, in some regions up to 100% /1/.

The main reason for the increasing usage of animal force was its low acquisition costs. A second reason was the ecological policy. Since 1990 the clear cuts, which are favourable for the use of machinery, have been severely restricted in favour of shelterwood system and the femel system. Another consequence was the prohibition of caterpillar tractors implementation because of the damages they cause to soil, undergrowth and residual stand /6/.

In reality, the prohibition did not restrict the use of caterpillar tractors. On the opposite, it increased in some sense. We are speaking about the private forestry contractors who acquired military traction-engines at the price of scrap and reshaped them for logging. According to the Ministry of Defence the sold traction-engines were about 400. Thus, the caterpillar tractors almost prevail in the logging operations in Bulgaria for the time being.

## **2. Aim**

The aim of our investigation was to determine the advantages and disadvantages of caterpillar tractors as they are to be observed in Bulgarian forests.

## **3. Materials and results**

The precise object of the investigation was the caterpillar forestry tractor TDT-55 Onezhets manufactured in Arkhangelsk in Russia /3/. TDT-55 is designed for skidding of logs or whole trees. Its tractive force is 45.6 kW. The centre of gravity of the tractor is displaced 570 mm ahead with regard to the centre of caterpillars, which enables it to transport heavy loads. On level ground, we have recorded a maximum load of 11.7 m<sup>3</sup>, whereas while moving on short steep slopes up to 30° (58%), a maximum load of 6.2 m<sup>3</sup> was recorded when ascending and 16.7 when descending. The performance was especially high – up to 32.1 m<sup>3</sup>/d – for hauling of concentrated large timber (e.g. clear cuts or blowdown areas) on short distances up to 500-700 m. For other cutting systems, a very good organization is required; otherwise the daily performance is low (9 to 12 m<sup>3</sup>). The low performance was due to the manual operations with the chokers, which took 30 to 40% of the operation time. The caterpillar tractor is also quite suitable for transportation of piled wood or cut to 2-m-pieces industrial wood. An average load of 6 m<sup>3</sup> of piled wood was recorded. Our observations were performed in the spring of 2007 in the State Forestry (SF) Satovcha in the SW of Bulgaria, touching the border of Greece. The wood cutting areas were on the southern slopes of Rhodopes, in the zone of the beech, fir, spruce and pine forests. The terrain configuration is marked by pronounced ridges, vast valleys, steep slopes and stone formations.

Based on our observations and the known references, following advantages and disadvantages of the caterpillar tractor TDT-55 Onezhets as compared to a wheeled tractor of the same class (e.g. TAF-650) it can be stated.

Advantages:

- a higher tractive force on steep slopes,
- a lower slipping percent (5% compared to 15% for wheeled tractor) which reduces the fuel consumption, especially on light or wet soils,
- a better contact to soil which enables the overcoming of steep slopes with inclinations 20°-25° (36%-47%) close to dynamic stability of the tractor whereas the wheeled one overcome no more than 18 °-20° (30%-36%),
- the ability to work as a bulldozer in building and repairing of forest roads whereas the wheeled tractors are usable for transport operations only and
- the reliability on difficult ground (marshlands, swamps, mud, snow, stones or high stumps).

Disadvantages:

- low transportation speed up to 2.5 or 3.5 km/h, which is 2 to 3 times lower than the transportation speed of a wheeled tractor,
- more difficult driving, maintenance and repairing and
- lower transportability (caterpillar engines may not access asphalt-covered roads).

In order to establish the real technical, economical and exploitation characteristics of caterpillar tractors, we have analyzed the statistics of Bulgarian Ministry of Agriculture and Forests for the period 1997-2007. The data refer only to the state-owned enterprises. The caterpillar tractor is compared to the most common wheeled ones, which for Bulgaria are the agricultural tractor Universal-651M and the forestry tractor TAF-650 (Table 1). The Table 1 cites the number of reported tractors, their annual production, workdays and demurrages, the use of time percent and the transportations costs for a cubic metre of hauled timber. The Table also shows that the daily performance of TDT-55 and TAF-650 is almost the same. So are the average transportation costs - fuel, lubricants, etc., without amortization and wages. The not included drivers' wages (3.70-4.50 BGN/m<sup>3</sup>) should not differ for the investigated tractors. It is obvious that in general the disadvantages of TDT-55 are balanced by its advantages.

The statistics of the Ministry does not consider the private contractors who have a better daily performance but less working days in a year (only about 70%) because of lack of contracts.

**Table 1: Technical and economical characteristics of different tractors for the period 1997-2007**

Tractor	Number of tractors	Annual production	Work days per year	Daily performance	Demurrages	Demurrages because of repairs	Use of time percent	Costs (write-off not included)
		m <sup>3</sup>	days	m <sup>3</sup> /day	days	days	%	BGN/m <sup>3</sup>
Universal-651M	519	3200	210	15,2	53	22	87,5	3,26
TAF-650	36	3405	196	17,3	67	37	81,6	3,85
TDT-55	59	3610	205	17,6	56	37	85,4	3,88

In order to establish the ecological aspect of caterpillar tractors usage, 12 former cutting areas in different forest districts were investigated where logging was conducted in 2001 using such tractors. The year 2001 was a seed year for both conifers (pine, fir and spruce) and beech. The mature conifer forests of the investigated region are marked with a dense grass or blueberry cover that hinders their natural regeneration. The caterpillars scarify that cover and enable the seed to reach the soil and thus enables the natural regeneration. Thus, we could observe a very good natural regeneration exactly on the places where the old skidding roads and the traces of caterpillars could still be seen. In order to prove that we measured 6 x 6 m sample plots on the skidding roads. For each sample plot, the number of seedlings, the diameter and the height were recorded (Table 2).

**Table 2: Natural regeneration of skidding roads**

Tree species	Number of seedlings	Average diametre, mm	Average height, mm
Pine	9.6	11.8	762
Spruce	11.5	9.8	485

No sample plots in fir stands were established but their condition was not different.

The good natural regeneration means that there was no significant erosion caused by the use of caterpillar tractors. Of course, some erosion could be observed here and there in the cutting areas, especially on steeper plots but it was obviously due to heavy loads and not to caterpillars.

#### **4. Conclusions**

Based on the cited data and observations following conclusions might be drawn:

- Caterpillar tractors are suitable for steep slopes where their only alternative would be a cable system.
- They can work all over the year regardless of snow and mud.
- The ecological damages they cause are rather exaggerated.

#### **5. References**

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