Teamwork in thinning stands of the Požega mountains with special reference to tractor skidding

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TEAMWORK IN THINNING STANDS OF THE POŽEGA MOUNTAINS WITH SPECIAL REFERENCE TO TRACTOR SKIDDING

SKUPNI RAD PRI PROREDAMA U SASTOJINAMA POŽEŠKOGA GORJA S POSEBNIM OSVRTOM NA PRIVLAČENJE DRVA TRAKTORIMA

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This study presents the findings of an investigation on teamwork, which was defined as a group of people working on the same production task at the same time and in the same place. Work and time study served to establish the productivity of a group and to determine standard time and efficiency. The study also includes an investigation of the costs for every individual worker and for the entire group of workers in three different models applied on two work sites. These investigations were carried out in the mountainous region of the Forestry Management of Požega, in the forestry offices of Kutjevo and Pleternica.

The standard time of the Torpedo tractor ranges from 23.94 min/m^3 to 41.81 min/m^3 and that of the Ecotrac from 25.35 min/m^3 to 59.07 min/m^3. The daily performance of the Torpedo tractor ranges from 20.05 m^3/day to 11.48 m^3/day at distances of 50 m to 600 m and from 11.48 m^3/day to 8.43 m^3/day at distances of 50 m to 450 m. The performance of the Ecotrac ranges from 18.93 m^3/day to 11.71 m^3/day and from 14.60 to 8.13 m^3/day at distances of 50 m to 550 m.

At the Kutjevo work site, the total cost of the first pair (model 3 - cutters and tractors) amounted to 97.75 kn/m^3 and that of the second pair 103.28 kn/m^3. Compared to model 1, these costs were lower by 39.7% and 42.1% respectively and compared to model 2 by 23.4% and 29.7% respectively. The total costs incurred in model 1 at the Pleternica work site amounted to 163.35 kn/m^3 for the Torpedo tractor and to 226.43 kn/m^3, or 27.9% more, for the Ecotrac. The costs related to the Ecotrac were 28.1% higher in model 2 and 30.2% higher in model 3 compared to the costs related to the Torpedo.

Teamwork has been partially accepted as a practice in Croatian forestry and has helped to improve productivity. However, the results of the study point to an imperfect organisation of teams and to a need for them to be optimised.

Key words: teamwork, cutting and processing, skidding, timber inspection, standard time, daily output, costs.

INTRODUCTION
UVOD

According to Ugrenović and Benić (1957), the utilisation of forests is a production process encompassing the entire work invested for the purpose of producing and using the material goods of forests.

Human labour has been used extensively in forest exploitation, cutting, processing and transporting. In the past, transporting operations were first carried out by manpower and then by animal power. With the emergence of machines, manpower was replaced by mechanical power. This process of replacing power is almost complete in developed countries. Nevertheless, the developing and particularly the underdeveloped countries still use man and animal power and gravitation in addition to machines.

Most forestry workers work in the exploitation of forests and the resulting operational costs are very high. However, the entire costs of production, machines and roads must be regarded as a whole, as a single system. The exploitation of thinning stands accounts for a significant part of the entire activities of forestry exploitation in Croatia.

The choice of work technology for the exploitation of forests constitutes a significant problem and so does the choice of machines which partially determines the work technology. On the basis of an analysis of sustainability and of the ratio between the dominant and intermediate yields, an assessment is made of the machines to be applied and of the conditions in which they can be used.

Significant progress has been made in the exploitation of forests with the use of power saws for cutting and processing and tractors for skidding. In log skidding, the assortment method was abandoned and the shortwood, longwood and tree-length log methods of processing were introduced. Every method is adapted to the size, power and capacity of individual machines and to the conditions in the stands.

Apart from appraising the technical, productive and ergonomic characteristics of tractors, account must be taken of their environmental performance. Particular attention must be given to the possible damage to trees, to soil erosion, to an adequate level of training of the machine operators in issues relating to forestry, including technical and environmental issues.

Forest exploitation must be based on ecology, on an increased humanisation of labour and on minimising the costs of carefully selected optimal methods of work.

The use of tractors in forest exploitation reduces the role of human labour, allows for more accurate planning, aims at optimising production, leads to better performance, and reduces the cost of work.

THE PROBLEM AND THE AIM OF THE STUDY
PROBLEMATIKA I CILJ ISTRAŽIVANJA

Since the very beginning of his days, man has exploited forests in different ways and with different intensity. At first he used his own power and then began to rely on animal power. For timber logging, man also used the natural configuration of the terrain, gravitation and water flows.

In the 18th century, man started to apply different machinery for the exploitation of wood.The first mechanical skidding of wood was carried out by cableways of hemp cable in 1825 in Sorrento, Germany (Krpan 1995). The cutting and processing was done with axes and handsaws. Logs were predominantly hauled by animal power, using water flows (rivers) and narrow-gauge railway tracks.

According to Benić (1963), forest exploitation consists of two stages: the stage of cutting and processing and the stage of carrying the wood out of the forest after some initial processing. The latter stage consists of two sub-stages: skidding and hauling.

According to Bojanin (1983), forest exploitation encompasses stage 1 (cutting and processing) and stage 2 (transport of wood). The transport of wood is further divided into skidding and hauling.

Krpan (1992) divides forest exploitation into the cutting and processing stage and the transport stage. The transport stage consists of yarding, skidding and hauling. Yarding means moving parts of trees or logs by human, animal or mechanical power from stumps to the site where the load is best prepared for skidding, and this is predominantly done in openings. According to Krpan, skidding means moving parts of trees or logs from stumps or collection sites to an auxiliary landing. Hauling means moving parts of trees or logs from an auxiliary landing to the customers.

With the emergence of machines and their application in forest exploitation, the notion of technology appears, defined by Pampel as the "science of the natural and technical patterns of the material and technical aspects of the production process and its conscious application by people" (Krpan 1984).

According to Bojanin (1971), the introduction of mechanisation constitutes an attempt to increase efficiency, to reduce the labour force, to reduce workers' fatigue to the minimum and to reduce to the highest degree the costs per unit of product.

Bojanin (1983) studied the mechanisation of forest exploitation from two aspects: the working and technological aspect and the economic aspect. In his opinion, the best technical solution does not necessarily have to be the best economic solution. In making these choices, it is important to ensure the best technology and

machinery for the given circumstances, but with the most favourable economic aspect. However, it is the selling price and the technical characteristics of a rich variety of different forestry machines that ultimately determine the best choice of technology.

Skidder tractors, which first appeared in Croatia as early as 1951, were crawlers of the Caterpillar and Ansaldo type. The machines began to be introduced on a much larger scale in 1960, when the tractor factories called IMT, BNT and 14th October opened in what was then Yugoslavia. At the time, mass-produced agricultural tractors were used with some additional equipment which enabled them to work in forests.

The development of the third generation of machines (Sever 1980), which were specially designed to function in forests, originated from these agricultural tractors and their additional equipment was adapted for skidding operations.

Special forest tractors (skidders) were employed in Croatia for the first time in 1968, while in Norway they had been introduced as early as 1962. From 1979, an increasing number of articulated wheeler tractors and crawler tractors were introduced (Krpan 1984).

In Croatia in 1991 (Zečić 1996), logs were skidded by 353 adapted agricultural tractors, which accounted for 44.6% of the total skidding vehicles. Out of these, 212 tractors were equipped with winches. There were 13 articulated tractors of up to 35 kW, accounting for only 1.6% of the total number of skidding vehicles, 32 articulated tractors with more than 35 kW accounting for 27.8%, 32 forwarders or 4%, and 173 tractors with semi-trailers or 21.8%. In 1995, the situation changed drastically in favour of articulated wheeler tractors. Therefore, there were only 188 or 35.9% adapted agricultural tractors, 59 or 11.3% articulated tractors of up to 35 kW, 211 or 40.3% articulated tractors of more than 35 kW, 23 or 4.4% forwarders and 43 or 8.2% tractors with semi-trailers.

These machines cause some damage to the stand. The profundity of the compression or the break-up of the soil depends on the extent of the vehicle's pressure on the soil, on the condition of the soil, on the number of tracks and on the volume of the load. When moving over a felling site, an adapted agricultural tractor treads with its wheels on almost 2.5% of the soil, an articulated tractor on almost 5%, while their wheels sink 13.8 to 24.5 cm into the soil (Krpan 1993).

When moving from the trunks toward an auxiliary landing, a tractor damages the standing trees with its load, wheels and body. A tractor can cause more damage by moving in an uncontrolled way on the entire surface than by moving on previously planned tracks or built skid trails. With longwood or tree-length methods (Martinić 1990), there are 9.9% damaged trees in thinned stands. The damaged standing trees have a reduced diameter growth of up to 4.7% (Krpan 1993), they are vulnerable to fungi and their level of exploitation is lower.

The exploitation of thinning stands is affected by the law of production and the law of the diameter of a log, which were termed by Grammel in 1988 as the laws of mechanisation (Krpan 1996).

TEAMWORK IN FOREST EXPLOITATION
SKUPNI RAD U EKSPLOATACIJI ŠUMA

The traditional method of work in the exploitation of forests was too time consuming, since the stages of activity used to be done separately. Several months would pass from cutting and processing to the transportation of the product. In order to increase productivity, a solution had to be found in the improved organisation of work and in the better management of working time.

Depending on the number of workers involved in production, there is individual work and teamwork. Teamwork is defined as a group of people working at the same time and in the same place on the same production task. Such a form of work is carried out through simple or complex cooperation and is characteristic of all the developed forms of production (Krpan 1996).

Workers in a classical exploitation process - cutters, tractor drivers, foremen and district forestry officers - had been accustomed to work separately. With the introduction of the teamwork form of work organisation, they all began to be situated at one work site. A foreman spends the entire day with cutters and tractor drivers and directly manages the entire work, which has an effect on the quality of the work performance. Teamwork enables workers, foremen and district forestry officers to supervise each other. All members in the chain of the organisation have to do their part of the work responsibly.

The working process in teamwork can be adapted very quickly to changes in the cutting plan or to a re-adjusted plan, which ensures that the necessary task will be carried out.

The costs of cutting, processing, skidding and hauling were a decisive factor in favour of the introduction of this new and more rational form of work organisation.

The need for an improved work organisation was based on the high cost of exploitation brought about by the length of the production cycle. Therefore, the aim was to shorten the duration of production as far as possible. In fact, it is indeed possible to cut, cross-cut, buck and skid timber to the auxiliary landing and haul it to the main landing or to the customer in one working day. Such a model of work organisation has actually come very close to the industrial form of production. According to Benić (1971), working operations that take place simultaneously shorten the duration of a working stage or a working process.

Tractors were introduced in forest exploitation in the 1960s, both for skidding and hauling timber. As long as it was economically possible to exploit forests in separate working stages, tractors skidded forest products to the auxiliary landing only after the cutting and processing operations had been finished.

According to Winkler (1990), teamwork in forest production is carried out by crews of workers who separately perform cutting, skidding, hauling, construction work and so on, but they are only formally connected. The second type of crew in teamwork is the one that performs several stages of work, for instance, cutting and

skidding. These crews are permanent and the number of their members can vary. The third type is constituted by complex working groups doing all the major forestry management operations. They are permanent and closely connected. With the introduction of machinery in forest production, large groups have tended to become smaller and in this way individual work and all of its negative aspects are avoided.

Teamwork was introduced in Croatia for the first time in 1979 on the territory of the forestry management unit of Bjelovar. In the subsequent 2-3 years, teamwork came to be applied by all forestry offices in the Bjelovar region. In 1984, teamwork also started to be applied in the thinned stands, which gave rise to the need for an increased quantity of tractors.

In the territory of the forestry management of Požega, teamwork was applied for the first time in 1982 during the final cut of durmast oak, in compartment 69 of the Sjeverni Dilj I management unit. In the following years, teamwork was monitored and organised in order to achieve the best structure of the group. In 1995, almost the entire yield cut was felled and skidded by a working group of the then forestry management of Požega, on the basis of teamwork organisation. The remaining small part of the yield was cut by citizens themselves.

CHARACTERISTICS OF TEAMWORK
ZNAČAJKE SKUPNOGA RADA

A working group is a coordinated group of workers organised in such a way as to function as an autonomous unit equipped with necessary working tools and able to carry out a task. The essence of teamwork is to be well concerted in all operations, from the preparation of work to the transportation of forest products to the customer.

The main characteristics of teamwork include: a shared working assignment given to the entire group, collective work at the same work site, shared working tools and resources, the participation of several workers in the performance of a task, adapted work technology, a balanced distribution of the efficiency and of personal income according to the number of working days, collective responsibility for the fulfilment of an assignment, a collective journey to and from the workplace, a balanced distribution of the cost of fuel and lubricants, a balanced distribution of charges and allowances, and the daily presence of a foreman.

ADVANTAGES OF TEAMWORK
PREDNOSTI SKUPNOGA RADA

Apart from the internal co-ordination of activities aimed at a common goal, the advantages of teamwork also include: an increase in productivity without any additional energy input, working capital is tied up for a shorter period, the time required for timber logging is shortened, less bucking is required during processing,

losses in bucking and inspection are reduced (small residues, fewer pieces), teamwork can be practised throughout the year with a varying number of members, fresh and sound wood is delivered, improved protection from pests is ensured, the processing of wood is of better quality (with the processing taking place at the auxiliary landing), the work organisation on the site is better, absenteeism is reduced, the connection between cutters and tractor drivers is closer (they work in pairs), the cutting of trees is targeted, the group adapts itself to weather conditions, the cutter binds the load (no binder), the burden lying on the cutter working with a power saw is reduced, a vehicle ensuring timely emergency aid is always present at the work site, the work is humanised by switching workers within a group, the creativity of every group member can be expressed, an individual's personality can be freely developed, individuals are more interested in their work, a less efficient worker tries to catch up with the others and achieves a better output, the capacities of loading and transportation are fully exploited, the commercial effect is increased and the impact of group psychology is very significant.

DISADVANTAGES OF TEAMWORK
NEDOSTACI SKUPNOGA RADA

Disadvantages depend on the form and method according to which a group of workers is organised and on the choice of the technologies for the cutting and processing of wood (the longwood method, the shortwood method or the assortment method). If the group size is fixed and the distances of skidding are smaller, the cutter will do most of the work and the tractor driver will bind the load. In the opposite case, when the skidding distance is greater, the cutter will bind the load and will not have enough work to do. In groups whose size is not fixed, there are no extreme situations or excessive burdens on individual members, but when the group receives a new member there is a problem of adjustment.

THE AIM OF THE RESEARCH
CILJ ISTRAŽIVANJA

The aim of this study was to examine the application of teamwork in the cutting, processing, skidding and inspection of wood in the thinnings of the Požega mountains. The investigation analyses two groups of workers and their performance with regard to three different methods of work organisation.

A time and motion study will establish the productivity of the groups concerned and their time and piece quotas. In addition, the investigation will serve to establish the costs that the three different models that were applied at the two work sites entailed per member and per group.

THE SITE AND METHODS OF RESEARCH
MJESTO I METODE ISTRAŽIVANJA

The Forestry Management of Požega occupies an area of 49,486.11 ha with a total growing stock of 9,001,835 m^3, a mean annual increment of 310,072 m^3 and an average yield cut of 204,194 m^3. It is organised in six forestry offices: Čaglin, Kamenska, Kutjevo, Pleternica, Požega and Velika, with one Machinery and Civil Engineering business unit situated in Požega.

The average cut of the intermediate yield amounts to 58.62% and the best achievement ever was recorded in 1985 with 70.59%. The average dominant yield amounts to 41.38% of the yield cut.

Table 1 indicates that the third and the fourth age class occupy most of the area, namely: the third age class occupies 13,169 ha or 28.19% and the fourth age class 11,164 ha or 23.90%. The last, seventh age class occupies the smallest area, namely: 801 ha or 1.71%.

Table 1. An Overview of Age Classes in the area of the Forest Administration Požega, situation in 1990

Tablica 1. Pregled dobnih razreda na području Uprave šuma Požega, stanje 1990. godine

Age class *Dobni razred*		Growing stock *Drvna zaliha*			
Number *Broj*	Age (years) *Dob (god.)*	ha	%	m^3	%
I	1-20	7 240	15.50	-	-
II	21-40	5 593	11.97	454 100	5.75
III	41-60	13 169	28.19	2 509 300	31.76
IV	61-80	11 164	23.90	2 746 300	34.76
V	81-100	5 225	11.18	1 353 600	17.13
VI	101-120	3 526	7.55	708 900	8.97
VII	121<	801	1.71	128 100	1.62
Total / *Ukupno*		46 718	100.00	7 900 300	100.00

Obviously, most of the growing stock belongs to the fourth age class - 2,746,300 m^3 or 34.76% of the total growing stock. Next follows the third age class with a total growing stock of 2,509,300 m^3 or 31.76% and the seventh age class has the least growing stock - only 128,100 m^3 or 1.62%.

Compartments 46 b and 47 d (Pleternica) are located in the central eastern part of the management unit (Figure 1). The lowest point stands at 170 metres above sea level, where the auxiliary landing is situated and where the unit borders an agricultural plot. The highest point stands at 250 metres above sea level.

The soil in the area covering the lowest point of the compartment at some 250 m above sea level is composed of pseudogleic components on the hills and of pseudogleic loessial soil on clayey marl at a ratio of 0.50 : 0.50. In the upper part of the compartment there is typical loessial and pseudogleic soil, eutric brown soil and carbonate rendzina on clayey marls and sandy clay at a ratio of 0.70 : 0.15 : 0.15.

Figure 1. Pleternica Work site, a 3D Model
Slika 1. Radilište Pleternica, 3D model

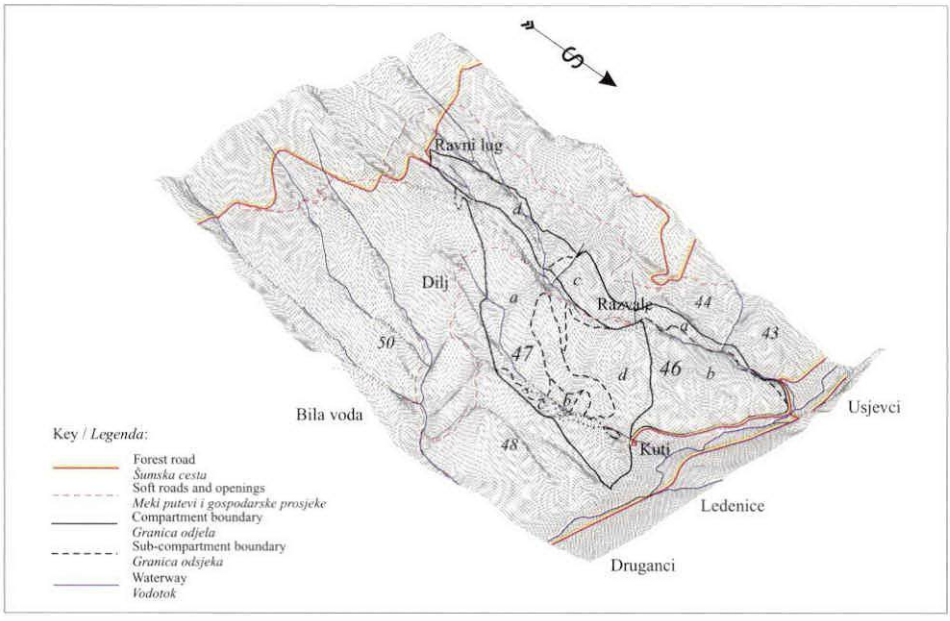
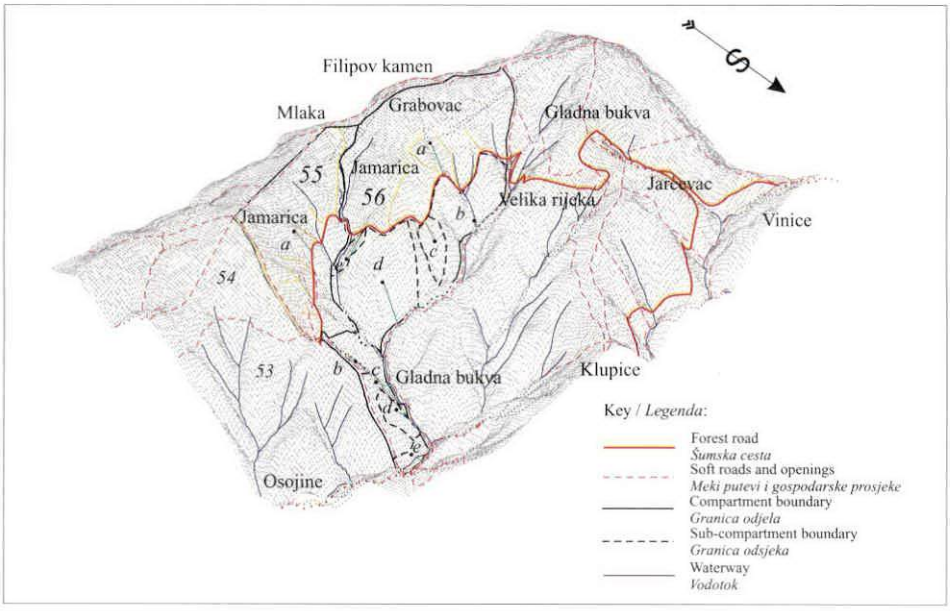


Figure 2. Kutjevo Work-site, a 3D Model
Slika 2. Radilište Kutjevo, 3D model



These two compartments belong to the Illyrian forest of durmast oak and common hornbeam with beech (*Epidemio - Carpinetum betuli* var. *Fagus sylvatica* /Ht. 1938/Borh. 1963).

The basic characteristics of the stand in compartments 55 a and 56 a (Kutjevo) are shown in Table 3. The lowest point of the compartment is situated at 550 m above sea level and the highest at 700 m. The compartments are situated (Figure 2) in the central part of the management unit. A forest road was constructed along the lower boundary of compartment 56 a and across the lower third of compartment 55 a.

FACTORS RELATING TO WORK SITES
ČIMBENICI RADILIŠTA

Factors relating to the habitat at the Kutjevo and Pleternica work sites are presented in Table 2. According to its configuration, the terrain is very even and the average and maximum longitudinal slopes hardly differ at all.

At the Kutjevo work site the air temperatures were very low and there were 2 to 4 cm of snow in the first working week. Throughout the working operation, the soil was predominantly humid.

The factors relating to the Pleternica work site differed considerably from the ones at Kutjevo, because work was carried out in the summer. The morning and daily temperatures were considerably higher than at the Kutjevo work site. The

Table 2. Factors Relating to the Work Site Habitat
Tablica 2. Stanišni čimbenici radilišta

Forest Office *Šumarija*		Kutjevo	Pleternica
Management unit *Gospodarska jedinica*		Južna Krndija I	Sjeverni Dilj II
Compartment, Sub-compartment *Odjel, odsjek*		55 a i 56 a	46 b i 47 d
Soil condition *Stanje tla*		Humid *Vlažno*	Dry *Suho*
Longitudinal terrain inclination *Uzdužni nagib terena*	maximal *maksimalni*	30 %	29 %
	average *prosječni*	12 %	10 %
Air temperature *Temperatura zraka*	morning *jutro*	0 - 11 °C	15 - 20 °C
	day *dnevna*	14 - 20 °C	24 - 33 °C
	average *prosječna*	16 °C	23 °C
Precipitation *Oborine*	rain *kiša*	Occasional, light *Povremeno, slaba*	Short shower, one day *Kratki pljusak, jedan dan*
	snow *snijeg*	2 - 4 cm, 1st week *2 - 4 cm, 1. tjedan*	
Working period *Razdoblje rada*		10. 04. - 12. 05. 1995.	03. - 13. 07. 1995.

soil was predominantly dry. The work was interrupted due to rain only on one occasion for 121 minutes.

FACTORS RELATING TO THE STAND
SASTOJINSKI ČIMBENICI

The factors relating to the stand are illustrated in Table 3. The analysed stand in Pleternica is 15 years older than the one in Kutjevo. The rotation amounts to

Table 3. Factors Relating to the Stands at the Work Sites
Tablica 3. Sastojinski čimbenici radilišta

Forest office *Šumarija*	Pleternica		Kutjevo	
Management Unit *Gospodarska jedinica*	Sjeverni Dilj II		Južna Krndija I	
Compartment, Sub-compartment *Odjel, odsjek*	46 b	47 d	55 a	56 a
Compartment area, ha *Površina odjela, ha*	18.24	18.40	37.92	37.32
Stand age, years *Starost sastojine, godina*	70	70	55	55
Ecological-economic type *Ekološko- gospodarski tip*	II - E - 11	II - E - 11	II - D - 10	II - D - 10
Management class *Uređajni razred*	Sessile oak from seed *Kitnjak iz sjemena*	Beach from seed *Bukva iz sjemena*	Beach from seed *Bukva iz sjemena*	Beach from seed *Bukva iz sjemena*
Rotation, years *Ophodnja, godina*	120	100	100	100
Cover, 0.1 - 1.0 *Obrast, 0,1 - 1,0*	1	1	0.9	0.9
Number of trees, items/ha *Broj stabala, kom/ha*	778	935	1 017	768
Mean tree diametar at breast height, cm *Srednji prsni promjer stabla, cm*	19	20	17	19
Mean stand height, m *Srednja sastojinska visina, m*	19	19	18	21
Mean tree volume, m^3 *Srednji obujam stabla, m^3*	0.538	0.597	0.408	0.595
Growing stock, m^3/ha *Drvna zaliha, m^3/ha*	284	299	200	233
Growing stock, m^3/compartment *Drvna zaliha, m^3/odsjeku*	5 172	5 525	7 596	8 710
Annual current increment, m^3/ha *Godišnji tečajni prirast, m^3/ha*	10.6	9.3	10.9	11.9
Annual current increment in the compartement, m^3/ha *Godišnji tečajni prirast u odsjeku, m^3*	194	172	413	445
Harvesting volume, 10-year, m^3/ha *Etat, 10-godišnji, m^3/ha*	38	40	37	43
Harvesting volume, 10-year, m^3/compartement *Etat, 10-godišnji, m^3/odsjeku*	694	736	1 403	1 605

100 years in all compartments except for 46 b where it is 120 years. The number of trees per hectare is much higher at Kutjevo. The characteristics of intermediate trees are slightly different.

The growing stock per hectare is 1/3 smaller at Kutjevo, but the annual increment at Kutjevo is 100% higher than at Pleternica. The yield cuts per hectare differ only slightly.

FACTORS RELATING TO EXPLOITATION
EKSPLOATACIJSKI ČIMBENICI

The applied method of cutting and the medium distance of skidding ranging from 350 m to 600 m are very important factors defining the work sites. In the structure of wood assortments, the technical roundwood ranges from 23.2% in compartment 55a to 35.5% in compartment 47d.

Table 4. Factors Relating to the Exploitation of Work Sites
Tablica 4. Eksploatacijski čimbenici radilišta

Forest office *Šumarija*		Pleternica				Kutjevo			
Management Unit *Gospodarska jedinica*		Sjeverni Dilj I				Južna Krndija I			
Compartement, Sub-compartement *Odjel, odsjek*		46 b		47 d		55 a		56 a	
Type of *Vrsta*	yield/*prihoda*	Intermediate *Prethodni*		Intermediate *Prethodni*		Intermediate *Prethodni*		Intermediate *Prethodni*	
	cut/*sijeka*	Thinning *Proreda*		Thinning *Proreda*		Thinning *Proreda*		Thinning *Proreda*	
Skidding distance (from OG), m *Udaljenost privlačenja (iz OG), m*		600		350		600		500	
Distance from tree to tree *Udaljenost od stabla do stabla, m*		15.4				10.3			
		m^3	%	m^3	%	m^3	%	m^3	%
Total cuttimber volume *Ukupno posječeni drvni obujam*	Gross *Bruto*	589		478		930		1 629	
	Total net *Ukupno neto*	473	100.0	383	100.0	856	100.0	1 493	100.0
	Technical roundwood *Tehnička oblovina*	154	32.6	136	35.5	199	23.2	389	26.1
	Long stackwood *Višemetar. pr. drvo*	319	67.4	247	64.5	657	76.8	1 104	73.9

ERGONOMIC FACTORS
ERGONOMSKI ČIMBENICI

The processes of cutting and processing are characterised by the noise and vibrations produced by a power saw. During the delimbing operation, the noise next to a worker's ear must not exceed 104 dB (A) (Lipoglavšek 1983). The average le-

vel of the daily exposure to noise should not exceed the permitted threshold of 90 dB (A) (Martinić 1990). According to Martinić, in teamwork the range of noise for a cutter working on a felling site is from 97.8 to 102.1 dB (A) and for cutters working at an auxiliary landing it is 101.9 dB (A).

"The vibrations on the handles must not exceed the maximum linear values of acceleration of 50 m/s^2 or the weighted average values (according to ISO) of 12 m/s^2, or the force of transmission to the hands of 20 N" (Lipoglavšek 1983).

Apart from the above-mentioned factors, the shape and the mass of tools are also relevant. The length of the handle and the total mass of an axe are adapted for cutting and driving wedges into wood. The length of the lever used for the rolling of logs is adapted to the average diameter of a log.

Lipoglavšek (1983) observed the noise and vibrations in skidding devices. The intensities of noise differ depending on individual working operations. The level of noise involved in work with a power saw imposes the obligatory use of occupational safety devices. The vibrations on a tractor seat differ significantly depending on individual working operations. An improved adaptation of machines to workers and a good positioning of handles in different types of tractors can help to reduce workers' daily fatigue.

ORGANISING WORK SITES FOR TEAMWORK
ORGANIZACIJA RADILIŠTA PRI PRIMJENI SKUPNOGA RADA

Several preparatory operations need to be carried out in order to successfully organise the cutting of a stand. An analysis of the terrain and the collection of the necessary data are done through teamwork. A district forestry officer, a forestry office manager and an expert on forest exploitation determine the appropriate method of work based on their experience. Next, an elaboration and a calculation are made with regard to the necessary quantities (of cutters and tractors) and it is on this basis that the final decisions with regard to the work technology are made.

When organising work sites, first the preparatory work (an analysis of the cutting plan) needs to be done in the office. On the basis of the determined quantities of tractors and cutters, the required numbers of workers and sizes of groups are defined. The remaining cutters are assigned to other areas to be felled and are given other silvicultural assignments. The next step is to categorise the terrain for tractors. The work order defined for every category of terrain and for the medium distance of skidding.

STRUCTURE OF A WORKING TEAM AND ITS INTERNAL ORGANISATION
STRUKTURA SKUPINE RADNIKA I UNUTARNJA ORGANIZIRANOST

A working team was composed of a certain number of cutters and tractor operators over whom a foreman was appointed. The selection of the team members (cutters and tractor drivers) was made by the foreman, the district officer, the offi-

cer for the exploitation of forests and the forestry manager. Several factors were considered when forming the team: the general ability of the cutters, their age, previous work results, their place of residence, knowledge of tractors, and/or certificates of occupational qualifications. The socialisation of the individuals within the team depended on the mutual relationship of the members and on the personality of each individual. In each crew at least one cutter also had to possess qualifications as a tractor driver, so that in the case of the absence of one of the tractor drivers, the cutter would be able to operate the tractor. The same condition applied to tractor drivers: at least one had to be trained to work as a cutter, in order to be able to substitute at felling.

When the team was at work, the workers did not alternate regularly in carrying out different operations, but an exchange took place only if one of the workers was absent.

Cutters changed places at regular intervals only at the auxiliary landing. Each month a different cutter would work at the auxiliary landing. The exchange was done to balance the burden imposed on each cutter and on the power saw, that is, on the saw chain, chain sprocket and chainsaw blade. The cutting mechanism of the power saw would wear out more easily when the cross-cutting was carried out at the auxiliary landing due to the mud or dust that would collect on the skidded timber.

THE FOREMAN
POSLOVOĐA

In teamwork, the presence and qualifications of the foreman are of great importance. The foreman of a team is proposed by the district officer, and the decision is confirmed by the forestry manager. Among the available forestry technicians, those who are relatively young, technically well trained, possess a driving licence, have more than five years of work experience, are appropriately creative, and have good managerial and communication skills are usually selected.

The foreman's tasks are: micro-organisation at the work site, the inspection of processed wood assortments, the quality control of felling, processing, skidding, sorting and the delivery of wood assortments, marking the tractor trails before they are constructed as well as the skid trails during work, being responsible for safety at the work site, taking control of the small cultivation operations carried out by the cutters during felling and processing, keeping records of work attendance, doing the monthly wage accounts, writing monthly reports for each worker and each working tool, ordering spare parts and operating supplies, fuel and lubricants, communicating regularly with the district officer, etc.

THE KUTJEVO WORK SITE
RADILIŠTE KUTJEVO

At the Kutjevo work site, there was a group of five workers: three cutters and two tractor operators. The workers assembled at the auxiliary landing. The cutters

and the foreman arrived by mini-bus, and the tractor operators drove the tractors every day from the parking place to the felling site, which took them about 30 minutes. At the end of their work, they would drive back to where the mini-bus was parked. The cutters would arrive earlier, attend to their tools and working equipment and wait for the tractors to arrive.

The cutters would ride on the tractors from the assembly point to the felling site; at lunchtime they would ride to the lunch site, and after lunch they would return to the felling site by tractor. With the last ride they would return from the felling site to the assembly point.

This team, according to the working order and the calculated workforce of 5.66 and 5.68 workers, was planned to consist of 5 members. The assumed efficiency was as much as 120%. Due to the expected frequent tractor failures, the transfer of workers from one team to another was arranged according to cutting priority.

With such an organisation of teams, two cutters were cutting in the forest, while a third cutter worked at the auxiliary landing. This was done as pair work, since each cutter worked with one tractor, prepared a sufficient quantity of wood for each load and almost for every cycle helped the tractor operator bind the load.

THE PLETERNICA WORK SITE
RADILIŠTE PLETERNICA

At this work site, a team made up of two cutters and two tractor operators, led by the foremen, arrived by mini-bus at the same time. The number of workers in this team was determined by the number of working tractors and by the number of cutters available. According to the working order and the efficiency per tractor without a choker, 3.71, or 3.83 workers were needed in the team.

In the morning, the tractor operators checked the tractors (fuel, oil, equipment), while the cutters prepared the power saws and other equipment. After this preparation, the tractors would drive to the felling site, taking the cutters and their working equipment.

At the felling site, one of the cutters selected and cut the trees. Meanwhile, the other selected a place to put the fuel, lubricants and other equipment, and then carried out the cross-cutting and inspection of wood assortments in the presence of the foreman. Both cutters from time to time bound the load with the tractor operator.

At the end of the working day, the trees were cut and processed for the first cycle on the following day. In this way, the tractor operators could start forming and skidding the load for the first cycle as soon as they arrived at the felling site, without having to wait for the load. At the felling site, the tractor drivers positioned themselves next to one another, consulted each other about the binding of the processed wood assortments, and agreed with one another not to leave any processed pieces. The loaded tractor would then head for the auxiliary landing. At the auxiliary landing the tractor operators separated and sorted the assortments by

species of wood and type of assortment, and when the last piece was unloaded, they would do the piling.

BUCKING AND INSPECTION OF WOOD ASSORTMENTS
PRIKRAJANJE I PREUZIMANJE DRVNIH SORTIMENATA

Depending on the method of cutting and processing, the wood assortments are generally bucked at the felling site or at the auxiliary landing. If the assortment method is used, the bucking and processing of wood assortments is done at the stump, and the measuring and inspection, depending on the number of workers in the team, are done at the log landing area or at the auxiliary landing.

In the shortwood and longwood harvesting method, the bucking and inspection of wood assortments are carried out by the foreman with one cutter at the auxiliary landing.

A team of 5 workers operated at the Kutjevo work site. Two cutters cut the trees and processed the wood assortments at the felling site, while a third cutter worked with the foreman at the auxiliary landing, bucking, cross-cutting, measuring and setting plastic boards on the technical roundwood.

Both the shortwood and the assortment method of processing were used. The foreman at the auxiliary landing would sometimes buck, but mostly only measure the volume and carry out inspection. The longwood method was applied only along the tractor skid trails or in the vicinity of the auxiliary landing.

At the auxiliary landing, the foreman generally approaches the loaded tractor that has just arrived and separates the long stackwood from the technical roundwood. A cutter uses the power saw to cross-cut, and the tractor continues skidding the technical roundwood through the auxiliary landing to the unloading area where the foreman bucks the assortments. In the unloading area, the tractor operator normally more down from the tractor and unfastens the load. The previous load is piled by the next tractor to arrive after the wood assortments have been inspected.

At the Pleternica work site, four workers formed the crew: two cutters and two tractor operators, with one foreman. The bucking, processing and inspection of wood assortments were carried out at the stump. The cutter, after cutting and delimbing the tree, separated the commercial timber from the stackwood by cross-cutting. After that, he measured and processed the long stackwood of 4 to 6 metres in length. After the cutter had cut, delimbed and cross-cut several trees, thus producing stackwood, the foreman would come with the timber-inspection book and the equipment for the measuring,bucking and numbering of commercial timber (calipers, measuring device and the complete equipment for plastic boards). The foreman measured and bucked the commercial timber, and the cutter immediately carried out the cross-cutting. After cross-cutting, the cutter would put down the power saw and take the callipers and the measuring device and measure each assortment, while the foreman would register the obtained data in the timber-inspection book. Based on the measurement data and also on the quality of the logs, the foreman then establi-

shes the assortment and quality class, and selects the colour of the marking board. After the inspection of all the pieces of commercial timber from one tree, the time comes for the stackwood to be inspected. Long stackwood lengths are predetermined, so only the diameters need to be measured. The foreman registers into the timber-inspection book the diameter of each piece. When one tree is completed, the second, and the third are processed, and as many trees are bucked as are needed so that the tractor does not have to wait for processing. At the end of the working day, the foreman prepares the necessary number of wood assortments, so that the next morning the tractors can start skidding without delay.

A MEASURING AND DATA PROCESSING METHOD
METODA SNIMANJA I OBRADA PODATAKA

During work and time study in the exploitation of forests, time consumption data are measured with a mechanical or digital chronometer. Common measuring methods are the continuous and repetitive timing methods. Both these methods have their advantages and disadvantages, but in practice, the repetitive chronometer method is used more frequently.

Taboršak (1987) recommends the repetitive method, but reveals the following disadvantages: the measurers need more training, the measurer needs more concentration, a specially constructed chronometer is needed, losses occur as a result of having to return the hands to the starting position, etc. The advantages are: irregularities in work as well as justified pauses are immediately spotted, there is no subsequent calculation of individual times, measuring can easily be continued if it is interrupted for any reason, and, finally, this method allows for the possibility of reading very short operations.

Barnes (1964) makes a preference for the repetitive method because each operation is seen on the observer's chart, so the measurer and the analyst can, during the measuring process, notice differences in each working operation.

For all these reasons, the repetitive timing method has been used in these studies.

DATA PROCESSING
OBRADA PODATAKA

The data were processed on a personal computer at the Institute for the Exploitation of Forests of the Faculty of Forestry in Zagreb. All the data on time measurement and on wood volume were transferred from the observer's charts into the computer. Using existing programs, Microsoft Word, Excel 5.0, Corel 7.0 and Autocad 13(R), these data were thoroughly processed. The map and photographs were printed on an HP DeskJet 560 C printer, and the text on an HP LaserJet IIIp printer.

The observation charts were processed twice. Each measurer at the end of the working day made a sum of the measured times and compared them with the time measured on a wristwatch, and established the difference in time and the validity of each observation chart, depending on whether it exceeded the allowed margin of error. The second time, the observation charts were processed after entering the data into the PC, and before the beginning of further data processing.

TIME STRUCTURE
RASPODJELA VREMENA

The time structure used in Croatia is similar to time structure applied in other European countries. In Germany, time and motion studies in forestry started in 1912, when the Max-Planck Institute (the former Kaiser-Wilhelm Institut für Arbeitspsyhologie) was founded. The Association for Work Studies (Verband für Arbeitsstudien REFA e. V.) was founded in 1924 (Krpan, 1984).

In 1956, Samset carried out a detailed time management working scheme in the exploitation of forests. In this work, time management was adapted to the forms of work organisation. By analysing working operations in the production process of the felling, processing and skidding of timber by tractor and by using teamwork, a time management scheme was devised in which the tractor drivers and the cutters cooperated with one another.

The total of measured times can be divided into effective time and delay time. Effective time consists of time spent directly in carrying out the work order (in producing a production unit).

Effective time spent at felling and processing is divided into tree and assortment time. The time that the cutter spends in binding the load was analysed as part of the effective time of the tractor working at the felling site. The effective time of the tractor cycle can be divided into fixed and variable times (Bojanin, 1980). All the times that are not functionally connected with the skidding distance are called fixed times. The time taken in driving a loaded and unloaded tractor is called variable time because it depends on the distance that has to be covered.

Delay time is all the time of rest and sporadic work which is not carried out in a cycle. Delay time, according to Bojanin (1977) and REFA (1976), consists of time for the interruption of work, time for rest and preparation-completion time. Interruption time can be both justified and unjustified. Justified interruptions are all those that are necessary to carry out the set task. Unjustified interruptions are all those that happen consciously or unconsciously, and which do not directly serve the purpose of completing the task. Sporadic work exists outside the regular cycle and is not considered as an interruption in the full sense of the word.

Preparation-completion time is part of delay time. The preparation time comprises the arrival of the tractor drivers from the transport vehicle to the tractor and the preparation of the tractor until its departure to the felling site. Completion

time consists of all the time spent in putting the tractor away, and for the driver to get ready and return to the transport vehicle.

A break is an interruption which serves to restore energy. Forestry workers take a break spontaneously when they feel tired. However, the time and duration of the break can be determined in advance. Interruption time for personal needs usually coincides with the break, so it is difficult to determine clearly the specific type of interruption. Therefore, in this work these times have been shown as one.

Respite is a short break which workers take after a very strenuous task. In this study it has not been dealt with separately, because after effective work, the workers always took longer breaks.

A lunch break is 30 minutes long and is established in advance (Taboršak, 1987). The time necessary to arrive at the lunch site and go back to work is calculated within this time.

Time that concerns technical interruptions can be accepted in two ways, as justified or unjustified. If the interruption occurs due to a minor fault of the tractor or working equipment, then we can regard it as a justified interruption. However, if the cause is a tractor breakdown that occurs due to bad and irresponsible handling, then we regard this as an unjustified interruption.

STATISTICAL ANALYSIS
STATISTIČKA OBRADA

Mathematical statistics programs usually applied in the study of time management were used for the statistical processing of the measurement data. For each work operation of fixed time, the required statistical measurements were calculated.

For fixed times:

1. Arithmetic mean

$$\bar{x} = \frac{\sum x_i}{n}$$

2. Standard deviation

$$s_x = \sqrt{\frac{(x_i - \bar{x})^2}{n-1}}$$

3. Standard error of the arithmetic mean

$$s_{\bar{x}} = \frac{s_x}{\sqrt{n}}$$

4. Percent error of the arithmetic mean

$$p = \pm \frac{s_{\bar{x}}}{\bar{x}} 100 \ (\%)$$

5. Required sample size for a 5% error of the arithmetic mean with a probability of 95%

$$N = \frac{1.962 s_x^2}{0.0 p^2 \bar{x}^2}$$

where in the expressions:

$\bar{x}$ - arithmetic mean (aritmetička sredina)
s_x - standard deviation
$s_{\bar{x}}$ - standard error of the arithmetic mean
p - percent error of the arithmetic mean, %
N - required sample size for a 5% error of the arithmetic mean with a probability of 95%
x_i - individual sample value
n - size of the measured sample

Variable times are equalised through regression equations of the line and the parabola, and, based on the strength of correlation, a regression line was chosen for the line: $y = a + bx$, and for the parabola: $y = a + bx + cx^2$.

RESEARCH RESULTS
REZULTATI ISTRAŽIVANJA

CUT, PROCESSED AND SKIDDED LOGS
POSJEČENO, IZRAĐENO I PRIVUČENO DRVO

The felling of trees at the Kutjevo work site is generally carried out in two periods. The first felling is carried out before the vegetation period, for the spring period, and the second from 1st to 15th July for the summer working period. The felled trees are processed by the cutters from the respective crew. The felling of trees is directed. A certain number of trees along the tractor trails are not felled in the first felling period, but later when the whole team is working. At the Pleternica work site the cutting and processing of trees is carried out simultaneously, followed by bucking and inspection at the stump, and immediately after that, tractor skidding takes place.

TIMBER VOLUME OF CUT TREES
DRVNI OBUJAM OBORENIH STABALA

The mean breast-height diameter of the felled trees amounted to 20.7 cm, the mean height of trees was 16.2 m, and the mean volume of trees 0.324 m³. The total volume of large wood at the felling site amounted to 987.85 m³. In the total number of felled trees (3047), 24.32% leant on the crowns of standing trees.

PROCESSED WOOD FROM PREVIOUSLY FELLED TREES – KUTJEVO WORK SITE
IZRAĐENO DRVO IZ UNAPRIJED OBORENIH STABALA – RADILIŠTE KUTJEVO

The processing of felled trees began six days after the felling had been completed. It was carried out by the cutters from the same team that had cut the trees. In

Table 5. Data on the trees processed by cutters working alongside Torpedo and Ecotrac tractors on the Kutjevo work site

Tablica 5. Podaci o stablima koja su izradili sjekači uz traktore Torpedo i Ecotrac na ra dilištu Kutjevo

Processed timber components *Sastavnice izrađenog drva*	Cutter with Torpedo tractor *Sjekač uz traktor Torpedo*	Cutter with Ecotrac tractor *Sjekač uz traktor Ecotrac*
	* - x - **	* - x - **
Processed trees, pieces *Izrađena stabala, kom*	240	246
Distance from tree to tree, m *Udaljenost od stabla do stabla, m*	7.65	8.75
	Technical roundwood *Tehnička oblovina*	
Number of pieces *Broj komada*	250	134
Processed volume, m^3 *Izrađeni obujam, m^3*	51.26	27.84
Diameter, cm *Promjer, cm*	17 - 25.5 - 51	15 - 26.8 - 45
Length, m *Duljina, m*	2 - 4.4 - 9	2 - 3.6 - 8
Piece volume, m^3 *Obujam komada, m^3*	0.076 - 0.205 - 0.817	0.045 - 0.208 - 0.610
	Long stackwood *Višemetarsko prostorno drvo*	
Number of pieces *Broj komada*	281	371
Processed volume, m^3 *Izrađeni obujam, m^3*	27.82	48.75
Diameter, cm *Promjer, cm*	8 - 15.2 - 42	9 - 17.6 - 38
Length, m *Duljina, m*	2 - 5.0 - 12.7	2 - 5.2 - 12
Piece volume, m^3 *Obujam komada, m^3*	0.016 - 0.099 - 0.554	0.031 - 0.131 - 0.482
Total volume, m^3 *Ukupan obujam, m^3*	79.08	76.59

* Minimal value — x Total or mean value — ** Maximal value
* *Najmanja vrijednost* — *x Ukupna ili srednja vrijednost* — ** *Najveća vrijednost*

Table 5 we can see that the cutter working alongside a Torpedo tractor (first cutter) processed 240 pieces, while the one working alongside an Ecotrac tractor (second cutter) processed 246 trees. The first cutter processed 250 pieces of commercial roundwood of a total volume of 51.26 m³, a mean diameter of 25.5 cm, a mean length of 4.4 m, and a mean volume of 0.205 m³. The second cutter processed 134 pieces of commercial roundwood of a total volume of 27.84 m³, a mean diameter of 26.8 cm, a mean length of 3.6 m, and a mean volume of 0.208 m³. The first cutter processed 281 pieces of long stackwood of a total volume of 27.82 m³, a mean diameter of 15.2 cm, a mean length of 5 m, and a mean volume of 0.099 m³. The second cutter processed 371 pieces of long stackwood of a total volume of 48.75 m³, a mean diameter of 17.6 cm, a mean length of 5.2 m and a mean volume of 0.131 m³. The first cutter processed a total of 79.08 m³, and the second one a total of 76.59 m³.

PROCESSED WOOD DURING THE SIMULTANEOUS CUTTING AND PROCESSING OF TREES – KUTJEVO WORK SITE
IZRAĐENO DRVO PRI ISTOVREMENOJ SJEČI I IZRADBI STABALA – RADILIŠTE KUTJEVO

Table 6 shows data on the processed wood on the Kutjevo work site during the simultaneous felling and processing of trees. The first cutter, working alongside a Torpedo tractor, cut and processed 280 trees of a total volume of 81.79 m³, a mean breast-height diameter of 20.2 cm, a mean height of 14.9 m and a mean volume of 0.292 m³. The second cutter cut and processed 289 trees, 109 trees more than the first one, of a total volume of 116.99 m³, a mean breast-height diameter of 21.1 cm, a mean height of 15.4 m and a mean volume of 0.301 m³. The mean walking distance of the first cutter from tree to tree was 10.1 m, and of the second cutter, 10.5 m.

The second cutter processed 12 pieces of commercial roundwood more than the first. The mean values differ marginally. When processing long stackwood, the second cutter processed 97 pieces more than the first, or 22.53 m³. The second cutter processed 27.02 m³ of the total processed wood, which was 30.5% more than the first cutter.

PROCESSED WOOD AT THE PLETERNICA WORK SITE
IZRAĐENO DRVO NA RADILIŠTU PLETERNICA

At the Pleternica work site (Table 7), one cutter both cut and processed the trees. He cut a total of 437 trees, of a total volume of 187.16 m³. The mean breast-height diameter was 26.2 cm, the mean height was 23 m, and the mean volume of a tree was 0.428 m³. The distance from tree to tree was 15.5 m. The total amount of commercial roundwood which was processed amounted to 389 pieces of a total volume of 60.47 m³, a mean diameter of 19.6 cm, a mean length of 3.6 m, and a mean volume of 0.155 m³.

Table 6. Data on trees which were cut and processed by cutters working alongside Torpedo and Ecotrac tractors on the Kutjevo work site

Tablica 6. Podaci o stablima koja su posjekli i izradili sjekači uz traktore Torpedo i Ecotrac na radilištu Kutjevo

Processed timber components *Sastavnice izradenog drva*	Cutter with Torpedo tractor *Sjekač uz traktor Torpedo* * - x - **	Cutter with Ecotrac tractor *Sjekač uz traktor Ecotac* * - x - **
Number of cut trees, pieces *Broj posječenih stabala, kom*	280	389
Volume of cut trees, m^3 *Obujam posječenih stabala, m^3*	81.79	116.99
Diameter at breast height, cm *Prsni promjer, cm*	(10 - 20.2 - 55)	(9 - 21.1 - 45)
Tree height, m *Visina stabla, m*	(8 - 14.9 - 20)	(7 - 15.4 - 20)
Tree volume, m^3 *Obujam stabla, m^3*	(0.030 - 0.292 - 1.827)	(0.026 - 0.301 - 1.554)
Height to the crown, m *Visina do krošnje, m*	(0.5 - 5.8 - 16)	(1 - 2.9 - 12)
Distance from tree to tree, m *Udaljenost od stabla do stabla, m*	(0.5 - 10.1 - 150)	(0.5 - 10.5 - 100)
	Technical roundwood / *Tehnička oblovina*	
Number of pieces *Broj komada*	111	123
Processed volume, m^3 *Izradeni obujam, m^3*	20.98	25.47
Diameter, cm *Promjer, cm*	(16 - 25.1 - 53)	(16 - 27.2 - 45)
Length, m *Duljina, m*	(2.0 - 3.5 - 6.0)	(2.0 - 3.5 - 6.0)
Piece volume, m^3 *Obujam komada, m^3*	(0.061 - 0.189 - 0.882)	(0.005 - 0.210 - 0.636)
	Long stackwood / *Višemetarsko prostorno drvo*	
Number of pieces *Broj komada*	374	471
Processed volume, m^3 *Izradeni obujam, m^3*	40.70	63.23
Diameter, cm *Promjer, cm*	(8 - 15.9 - 34)	(9 - 17.7 - 38)
Length, m *Duljina, m*	(2.0 - 5.0 - 16.0)	(2.0 - 5.2 - 12.0)
Piece volume, m^3 *Obujam komada, m^3*	(0.013 - 0.109 - 0.554)	(0.002 - 0.130 - 0.680)
Total volume, m^3 *Ukupan obujam, m^3*	61.68	88.70

* Minimal value x Total or mean value ** Maximal value
* *Najmanja vrijednost* *x Ukupna ili srednja vrijednost* ** *Najveća vrijednost*

Table 7. Data on the felling and processing by one cutter at Pleternica
Tablica 7. Podaci o sječi i izradbi jednog sjekača u Pleternici

Processed timber components *Sastavnice izrađenog drva*	Values *Vrijednosti* * - x - **
Number of cut trees, pieces *Broj posječenih stabala, kom*	437
Volume of cut trees, m^3 *Obujam posječenih stabala, m^3*	187.16
Diameter at breast height, cm *Prsni promjer, cm*	10 - 26.2 - 43
Tree height, m *Visina stabla, m*	9 - 23.0 - 31
Tree volume, m^3 *Obujam stabla, m^3*	0.027 - 0.428 - 2.349
Distance from tree to tree, m *Udaljenost od stabla do stabla, m*	1 - 15.4 - 120
Technical roundwood *Tehnička oblovina*	
Number of pieces *Broj komada*	389
Processed volume, m^3 *Izrađeni obujam, m^3*	60.47
Diameter, cm *Promjer, cm*	12 - 19.6 - 58
Length, m *Duljina, m*	2 - 3.6 - 8
Piece volume, m^3 *Obujam komada, m^3*	0.048 - 0.155 - 1.162
Long stackwood *Višemetarsko prostorno drvo*	
Number of pieces *Broj komada*	940
Processed volume, m^3 *Izrađeni obujam, m^3*	95.13
Diameter, cm *Promjer, cm*	10 - 13.4 - 60
Length, m *Duljina, m*	2 - 4.6 - 7
Piece volume, m^3 *Obujam komada, m^3*	0.038 - 0.101 - 1.696
Total processed volume, m^3 *Ukupan izrađeni obujam, m^3*	155.60

* Minimal value x Total or mean value ** Maximal value
* *Najmanja vrijednost* *x Ukupna ili srednja vrijednost* ** *Najveća vrijednost*

Long stackwood amounting to 940 pieces were also processed, of a total volume of 95.13 m³, a mean diameter of 13.4 cm, a mean length of 4.6 m, and a mean volume per piece of 0.101 m³. The total volume of processed wood amounted to 115.60 m³.

SKIDDED WOOD AT THE KUTJEVO WORK SITE
PRIVUČENO DRVO NA RADILIŠTU KUTJEVO

Data on skidded wood are shown in Tables 8 and 9. A Torpedo TD 75A tractor skidded a total of 171.49 m³. The mean volume of the load of 143 cycles amounted to 1.20 m³. The Torpedo tractor mostly skidded processed wood assortments and in 137 cycles skidded an average of 8.3 pieces per cycle. The mean volume of a piece was 0.145 m³.

The Torpedo tractor skidded an average of 8 pieces per cycle. In the total number of skidded pieces, 14 boles of an average volume of 1.10 m³ were skidded in 6 cycles. The mean volume of the assortment was 0.145 m³, and that of a bole 0.470 m³ (Table 8).

Table 8. Overview of skidded wood by a Torpedo TD 75A tractor at Kutjevo
Tablica 8. Prikaz privučenog drva traktorom Torpedo TD 75A u Kutjevu

Components of skidded timber *Sastavnice privučenog drva*	Total Ukupno	Stem Deblo	Timber assortments Drvni sortimenti
	* - x - **	* - x - **	* - x - **
Total skidded timber, m³ *Ukupno privučeno drvo, m³*	171.49	6.57	164.92
Total number of pieces *Ukupan broj komada*	1150	14	1136
Total length of pieces, m *Ukupna duljina komada, m*	6 765.2	279.6	6 485.6
Total cycle number *Ukupan broj turnusa*	143	6	137
Mean load volume, m³ *Srednji obujam tovara, m³*	0.53 - 1.20 - 1.89	0.60 - 1.10 - 1.52	0.53 - 1.20 - 1.89
Average number of pieces in a load *Prosječni broj komada u tovaru*	8.0	1 - 2.3 - 3	5 - 8.3 - 14
Mean piece length, m *Srednja duljina komada, m*	5.9	10.4 - 20.0 - 30	2 - 5.7 - 18
Mean piece volume, m³ *Srednji obujam komada, m³*	0.149	0.265 - 0.470 - 1.050	0.031 - 0.145 0.669
Mean piece diameter, cm *Srednji promjer komada, cm*	18.0	12 - 17.3 - 29	10 - 18.0 - 43

* Minimal value x Total or mean value ** Maximal value
* *Najmanja vrijednost* *x Ukupna ili srednja vrijednost* ** *Najveća vrijednost*

Table 9. An overview of skidded wood by the Ecotrac V 1033F tractor at Kutjevo
Tablica 9. Prikaz privučenog drva traktorom Ecotrac V 1033F u Kutjevu

Components of skidded timber *Sastavnice privučenog drva*	Total *Ukupno*	Stem *Deblo*	Timber assortments *Drvni sortimenti*
	* - x - **	* - x - **	* - x - **
Total skidded timber, m^3 *Ukupno privučeno drvo, m^3*	149.70	3.99	145.71
Total number of pieces *Ukupan broj komada*	991	5	986
Total length of pieces, m *Ukupna duljina komada, m*	5 764.5	112.3	5 652.2
Total cycle number *Ukupan broj turnusa*	134	3	131
Mean load volume, m^3 *Srednji obujam tovara, m^3*	0.54 - 1.12 - 2.41	1.09 - 1.33 - 1.62)	0.54 - 1.11 - 2.41
Average number of pieces in a load *Prosječni broj komada u tovaru*	7.4	1 - 1.7 - 3	3 - 7.5 - 13
Mean piece length, m *Srednja duljina komada, m*	5.8	13.4 - 22.5 - 30.9	2 - 5.7 - 18
Mean piece volume, m^3 *Srednji obujam komada, m^3*	0.151	0.338 - 0.798 - 1.283	0.031- 0.148 - 0.739
Mean piece diameter, cm *Srednji promjer komada, cm*	18.2	14 - 21.0 - 30	10 - 18.1 - 47

* Minimal value x Total or mean value ** Maximal value
* *Najmanja vrijednost* *x Ukupna ili srednja vrijednost* ** *Najveća vrijednost*

The Ecotrac tractor skidded a total of 149 m^3 of wood, of a mean volume per piece of 0.151 m^3 in 134 cycles. The mean volume of a load of wood assortments amounted to 1.12 m^3, and at skidding, 1.33 m^3. A load contained an average of 7.4 pieces (Table 9).

For similar working conditions and for the longwood processing method, Štefančić (1989) gives an average volume of 1.58 m^3 for an IMT 560 tractor load, and for the assortment processing method, an average volume of 1.38 m^3. In lowland conditions, for an IMT 558 tractor, Krpan (1984) gives average loads of 1.08 m^3, 1.09 m^3 and 0.98 m^3 volume, and Bojanin (1975) for the same tractor, mentions a mean volume per load of 1.35 m^3.

SKIDDED WOOD AT THE PLETERNICA WORK SITE
PRIVUČENO DRVO NA RADILIŠTU PLETERNICA

At the Pleternica work site, a Torpedo TD 75A tractor skidded 88.59 m^3 of wood in 56 cycles. The mean volume per load was 1.58 m^3 with an average of 11.1 pieces per load. An Ecotrac V-11-1033F tractor skidded 55.31 m^3 of wood in 47 cycles, of an average volume of 1.18 m^3 per load and an average of 8.6 pieces per load (Table 10).

Table 10. Overview of skidded wood at the Pleternica work site
Tablica 10. Prikaz privučenog drva na radilištu Pleternica

Components of skidded timber *Sastavnice privučenog drva*	Torpedo * - x - **	Ecotrac * - x - **
Total skidded timber volume, m^3 *Ukupno privučeni drv.obujam, m^3*	88.59	55.31
Total number of pieces *Ukupan broj komada*	623	403
Total length of pieces, m *Ukupna duljina komada, m*	3 271	2 084.6
Total cycle number *Ukupan broj turnusa*	56	47
Mean load volume, m^3 *Srednji obujam tovara, m^3*	0.919 - 1.58 - 2.206	0.726 - 1.18 - 1.775
Average number of pieces in a load *Prosječni broj komada u tovaru*	7 - 11.1 - 14	5 - 8.6 - 13
Mean piece length, m *Srednja duljina komada, m*	2 - 5.2 - 7.2	2 - 5.2 - 7
Mean piece volume, m^3 *Srednji obujam komada, m^3*	0.038 - 0.142 - 0.676	0.038 - 0.14 - 0.513
Mean piece diameter, cm *Srednji promjer komada, cm*	10 -18.6 - 47	10 - 18.4 - 35

* Minimal value x Total or mean value ** Maximal value
* *Najmanja vrijednost* x *Ukupna ili srednja vrijednost* ** *Najveća vrijednost*

Figure 3. Overview of the volume of a load according to wood assortments
Slika 3. Prikaz obujma tovara po drvnim sortimentima

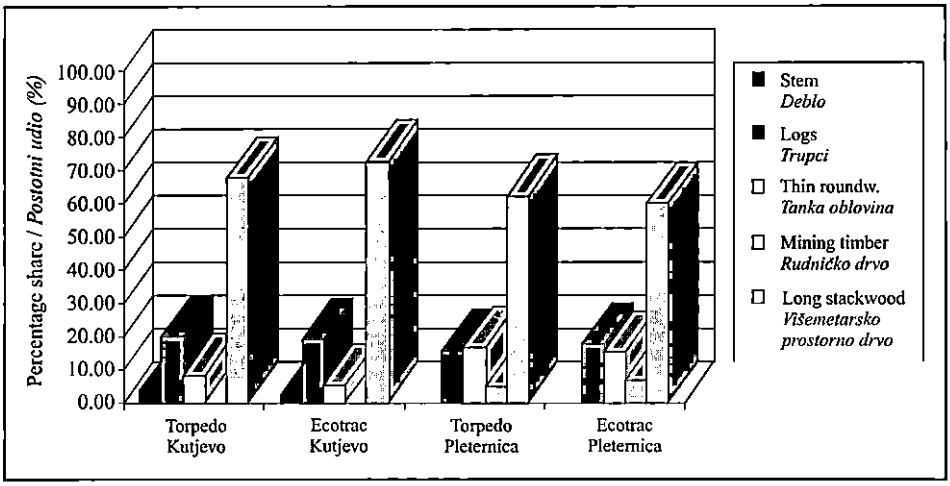


Figure 3 shows the volume of a load according to wood assortments. It is evident from this overview that the largest part consisted of long stackwood, followed by logs and thin roundwood.

TIME ANALYSIS
ANALIZA VREMENA

TOTAL TIME CONSUMPTION OF FELLING
UKUPNO UTROŠENA VREMENA PRETHODNE SJEČE

The cutting of tees in the departments 55a and 56a of the *agricultural* unit management Krndija I, on the Kutjevo work site, was monitored over five working

Table 11. Effective tree-cutting time and average time consumption per tree at Kutjevo
Tablica 11. Efektivno vrijeme sječe stabala i prosječan utrošak vremena po stablu u Kutjevu

Working operation *Radni zahvat*		Total time consumption *Ukupno utrošeno vrijeme*			Time per tree *Vrijeme po stablu*
		min	%		min
Tree time *Stablovno vrijeme*	1. Walking to the tree *1. Hod do stabla*	1 025.53	18.11	39.82	0.34
	2. Determining felling direction *2. Određivanje smjera rušenja*	24.83	0.44	0.96	0.01
	3. Cleaning the surroundings *3. Čišćenje okoliša*	19.37	0.34	0.75	0.01
	4. Processing stem base *4. Obrada žilišta*	0.10	0.00	0.00	0.00
	5. Making the undercut *5. Izrada zasjeka*	102.11	1.80	3.96	0.03
	6. Laying in *6. Potpiljivanje*	118.25	2.09	4.59	0.04
	7. Wedging *7. Zabijanje klinova*	0.54	0.01	0.02	0.00
	8. Tree falling *8. Padanje stabla s oslobađanjem*	1 272.21	22.49	49.40	0.42
	9. Beard cutting *9. Obrada brade*	12.68	0.22	0.49	0.00
Effective time *Efektivno vrijeme*		2 575.62	45.49	100.00	0.85
Delay times *Opća vremena*		3 085.99	54.51		1.01
Total time *Ukupno vrijeme*		5 661.61	100.00		1.86

days. Four cutters worked in a team. Three members permanently carried out the tasks of cutting and processing, while the fourth worked as a cutter or tractor driver, according to the need. In all, 3,047 trees were cut of a total volume of 987.85 m^3. The measuring task took a total of 5,661.61 minutes (Table 11).

In the distribution of total time consumption, the share of effective time was 45.49%, against 54.51% of delay time. The largest part of total time consisted of the working operation of clean felling – 22.49%, and next walking to the tree at an average distance of 9.2 m – 18.11%. In the distribution of effective time, clean felling took up 49.40% of the time, and walking to the tree amounted to 39.82% of the time. The total time per tree amounted to 1.86 minutes, and the effective time amounted to 0.85 minutes. To walk from tree to tree, an average of 0.34 minutes was spent, and 0.42 minutes was taken in felling. Tomanić et al. (1978) suggest the following formula to calculate the time of transfer to the tree:

$t = -0.05 + 0.02968\ Lp + 0.01143\ G$, where

t = time of transfer, Lp = average length of transfer, G = inclination of the terrain on the felling area as a percentage.

For the observed conditions, with a terrain inclination of 12% and an average transfer length of 9.2 m, the time according to the formula of Tomanić et al. (1978) was 0.36 minutes, which, in relation to the measured time of transfer from tree to tree, makes up a difference of 0.02 minutes.

ALLOWANCE CUTTING TIME
DODATNO VRIJEME SJEČE

Allowance cutting time includes time for the lunch break, rest, justified interruptions, interruptions for sporadic jobs, technical interruptions and preparation/completion time.

Allowance time amounted to 1,046.47 minutes, or 40.61% of effective time, that is, 0.34 min/tree, or 1.05 min/m^3. Allowance time was allowance to effective time by using the allowance time coefficient (Kd) which is calculated according to the formula:

$$Kd = 1 + pd / 100,$$

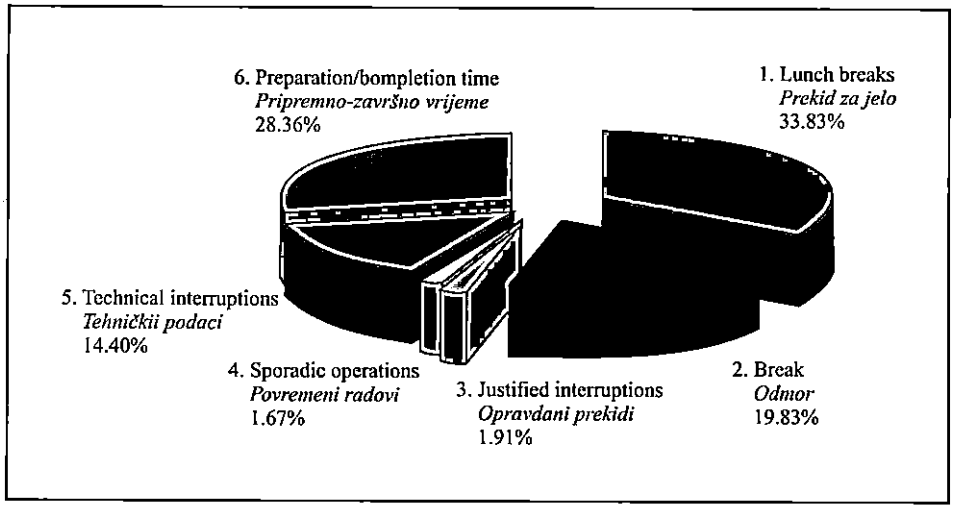
where pd = allowance time percentage.

Another way is to add the absolute amount of allowance time to effective time. In the structure of allowance time, the largest share was taken up by the lunch break at 33.83%, then by preparation/completion time at 28.36%, and the smallest share was taken up by sporadic operations at 1.67% and by justified interruptions at 1.91%. It was calculated that the lunch break should take 30 minutes for 8 hours of work.

Breaks during work enable the worker to maintain the normal intensity of work and to prevent exhaustion to a certain degree. Interruptions for breaks and respite took place eight times a day at the most. The shortest respite was 0.30 minutes. Breaks of up to 5 minutes were allowed. It was assessed that longer breaks were not necessary to restore energy, due to the relatively small share that work

with a power saw had in effective time. Most energy was consumed in walking to the tree and on freeing the tree. Justified interruptions, sporadic work and technical interruptions were recognised in all the consumed times. The preparation/completion time was recognised, according to the evaluation of the time necessary to prepare the tools and equipment, at up to 15 minutes at the beginning of the working day, and at 5 minutes at the end of the day.

Figure 4. Distribution of allowance time in felling tree at Kutjevo
Slika 4. Raspodjela dodatnoga vremena na sječi stabala u Kutjevu



EFFECTIVE AND DELAY TIMES OF PROCESSING, AND OF CUTTING AND PROCESSING TREES AT KUTJEVO
EFEKTIVNO I OPĆA VREMENA IZRADBE TE SJEČE I IZRADBE STABALA U KUTJEVU

The work of cutters working alongside the Torpedo (first cutter) and Ecotrac (second cutter) tractors on the processing of previously felled trees, as well as on the cutting and processing of standing trees, was monitored over 15 working days. Data on the felling and processing of standing trees are shown in Table 6. The work of the first cutter was measured at 5,309.67 minutes, and of the second one at 5,324.70 minutes. During the first 5 days of measuring, the cutters cut and processed the remaining standing trees, and during the next 10 days they processed previously felled, or felled and processed trees. In the total time consumed, the effective time of the first cutter amounted to 35.95%, while the delay time came to 64.05%. The effective time of the second cutter amounted to 42.93%, while the delay time amounted to 57.07%. Vondra (1989) mentions that when processing roundwood of different lengths and long commercial timber, delay time amounts

to 77.9% of net working time. In Table 12 it can be seen that the total time of the first cutter in processing amounted to 531.44 minutes, or 2.35 minutes per tree. The second cutter spent 478.38 minutes, or 2.08 minutes per tree. The effective cutting and processing time of the first cutter amounted to 632.84 minutes, or 2.26 minutes per tree, and of the second cutter, 818.22 minutes, or 2.10 minutes per tree. The effective time of the first cutter in processing trees was 0.09 minutes,

Table 12. Time structure at processing, cutting and processing, percentage of time according to total and effective time and time consumption per tree at Kutjevo

Tablica 12. Struktura vremena na izradbi, sječi i izradbi, postotni udio vremena prema ukupnom i efektivnom vremenu i utrošak vremena po stablu u Kutjevu

Type of operation or procedure *Vrsta operacije ili zahvata*	Time consumption *Utrošak vremena*							
	Cutter with Torpedo (1) *Sjekač uz Torpedo (1)*				Cutter with Ecotrac (2) *Sjekač uz Ecotrac (2)*			
	min	%		min/tree *min/stablu*	min	%		min/tree *min/stablu*
1. Processing time *1. Vrijeme izradbe*	531.44	10.01	27.84	2.35	478.38	8.98	20.93	2.08
1.1. Tree time *1.1 Stablovno vrijeme*	365.26	6.88	19.13	1.62	362.29	6.80	15.85	1.58
1.2. Assortment time *1.2 Sortimentno vrijeme*	166.18	3.13	8.70	0.74	116.09	2.18	5.08	0.50
2. Cutting and processing time *2. Vrijeme sječe i izradbe*	632.84	11.92	33.15	2.26	818.22	15.37	35.80	2.10
2.1. Tree time *2.1 Stablovno vrijeme*	500.23	9.42	26.20	1.79	668.30	12.55	29.24	1.72
2.2. Assortment time *2.2 Sortimentno vrijeme*	132.61	2.50	6.95	0.47	149.92	2.82	6.56	0.39
3. Load preparation *3. Rad na pripremi tovara*	681.89	12.84	35.72	1.35	986.71	18.53	43.17	1.59
4. Auxiliary landing work *4. Rad na pomoćnom stovarištu*	62.90	1.18	3.29	0.12	2.39	0.04	0.10	0.00
5. Effective time *5. Efektivno vrijeme*	1909.07	35.95	100.00	3.77	2285.70	42.93	100.00	3.69
6. Delay time *6. Opća vremena*	3400.60	64.05		6.72	3039.00	57.07		4.91
7. Total time *7. Ukupno vrijeme*	5309.67	100.00		10.49	5324.70	100.00		8.60

or 3.8% per tree longer than in cutting and processing. The second cutter spent 0.02 minutes less of effective time in processing, or 1% less in comparison with the net time in cutting and processing.

To prepare the load, the first cutter spent 681.89 minutes, or 1.35 minutes per tree, that is, 35.72% of effective time, and the second 986.71 minutes, or 1.59 minutes per tree, that is, 43.17% of effective time. Martinić (1990) notes that the time the cutters spend on tractor skidding activities in one day amounts to 88 min/day in one variation, and 95 min/day in the second variation. In these time structures, load fastening takes up 60%, and the manual bunching of the load 39%. At the end of the working day, the cutters sometimes helped with the inspection of the last tractor loads at the auxiliary landing.

The effective time per tree of the first cutter amounted to 3.77 minutes, and of the second one, 3.69 minutes. The time spent by the first cutter on the cutting and processing of 140.76 m^3 of timber amounted to 13.56 min/m^3 of effective time, 24.16 min/m^3 of delay time or to a total of 37.72 min/m^3. In cutting and processing 165.39 m^3 of timber, the second cutter spent 13.82 min/m^3 of effective time, 18.38 min/m^3 of delay time, or a total of 32.21 min/m^3. In similar conditions of teamwork and by using the longwood method, Štefančić (1989) gives a consumption of time of 39.70 min/m^3, of which effective time amounts to 13.33 min/m^3, or only 33.58% of total time. If the assortment method of cutting and processing is used, the same author mentions that the time consumed amounts to 29.36 min/m^3, of which the effective time is 17.96 min/m^3, or 61.17%. The consumption of effective time for teamwork in cutting and processing an average tree of a DBH of 31.3 cm (Tomičić) amounts to 6.69 minutes, and for binding the load, 1.39 minutes. If the assortment method is used and with one worker, the same author gives an effective time consumption of 9.94 minutes per tree with a mean DBH of 21 cm. In a thinned stand of common oak and alder (Bojanin et al., 1989), the effective cutting and processing time of a tree of a DBH of 20 cm amounts to 6.20 minutes for an oak, and 5.23 minutes for an alder.

Delay time in comparison with net cutting and processing time in Sweden amounts to 45%, and in Austria to 56%. In Germany, from 61% of delay time, as much as 80% is taken for the workers' rest, and 20% for all the other interruptions (Martinić, 1990).

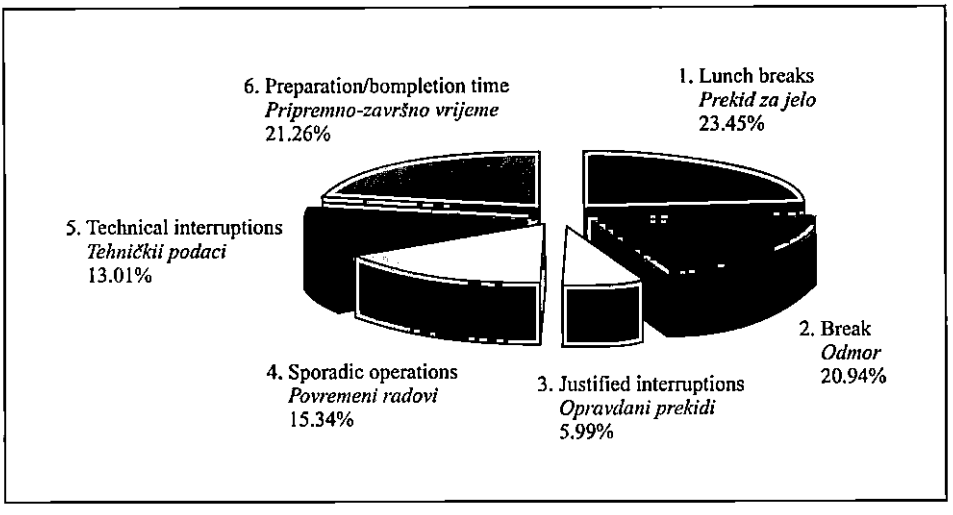
ALLOWANCE PROCESSING TIME, AND CUTTING AND PROCESSING TIME AT KUTJEVO
DODATNO VRIJEME IZRADBE TE SJEČE I IZRADBE U KUTJEVU

Allowance processing time, and the cutting and processing time of the first cutter amounted to 1,407.48 minutes, or 73.7% of effective time. The allowance time of the second cutter amounted to 1,377.50 minutes, or 60.3% of effective time. When calculating allowance time, half an hour lunch break was accepted for 8 hours of work. All the breaks were accepted up to 5 minutes at the most, and justified interruptions in the total amount as they occurred. The sporadic jobs of the first cutter

made up 15.34% of allowance time, and for the second cutter, 6.64%. Technical interruptions amounted to 13.01% and 12.68% respectively, and the largest part of this time was spent in replenishing with fuel. The preparation/completion time made up 21.26% and 27.42 % of allowance time respectively. In 15 days of work, the formed preparation/completion time of the first cutter amounted to 299.30 minutes, and that of the second cutter came to 377.73 minutes, that is, 19.95 min/day and 25.18 min/day respectively. For a hilly terrain, Bojanin et al. (1994) established allowance time as 51% of net working time. This also comprised a 30-minute lunch break. The same authors state that without the lunch break, allowance time amounts to 41.5%. Backhaus (1990) reports that with cutting and processing quotas, allowance time in the whole of Germany amounts to an average of 40%.

The allowance time of the first cutter amounted to 7.56 min/m³ of processed wood assortment of felled trees and of cut and processed standing trees. The allowance time of the second cutter amounted to 5.56 min/m³. The distribution of allowance time is shown in Figures 5 and 6.

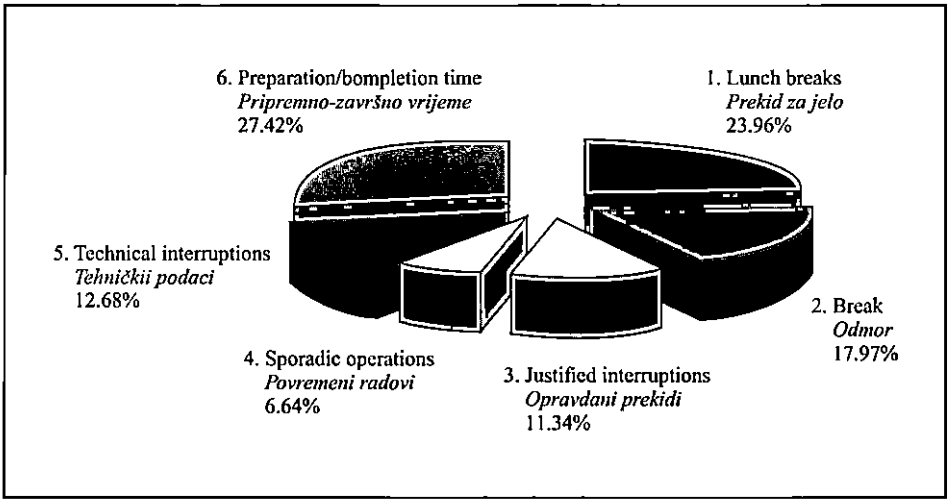
Figure 5. The allowance processing time, and cutting and processing time of cutters working alongside a Torpedo tractor at Kutjevo
Slika 5. Dodatno vrijeme izradbe te sječe i izradbe sjekača uz traktor Torpedo u Kutjevu



EFFECTIVE AND DELAY TIME OF WOOD ASSORTMENT INSPECTION AT KUTJEVO
EFEKTIVNO I OPĆA VREMENA PREUZIMANJA DRVNIH SORTIMENATA U KUTJEVU

A total of 4,521.55 minutes was spent on the inspection of wood assortments (Table 13). According to the data on wood volume shown in Table 15, the effecti-

Figure 6. The allowance processing time, and cutting and processing time of cutters wor king alongside an Ecotrac tractor at Kutjevo
Slika 6. Dodatno vrijeme izradbe te sječe i izradbe sjekača uz traktor Ecotrac u Kutjevu



ve time for 2,038 pieces, or 273.19 m^3 of inspected wood assortments, amounted to an average of 6.21 min/m^3, the delay time to 13.13 min/m^3 and the total time to an average of 19.33 min/m^3. Štefančić (1989) states that the consumption of net time for inspection amounts to 6.27 min/m^3, and of total time to 19.26 min/m^3, of which 8.93 min/m^3 is spent on unnecessary interruptions to organise residue. In the second case, the cutter in a team at the auxiliary landing works an effective 134 minutes, or 27.9% of the total time (Martinić, 1990).

In the total time spent on inspection, effective time amounted to 20.69%, and delay time to 79.31%. In effective time, most time was spent on measuring commercial roundwood (27.35%), then to cover the distance from load to load at the auxiliary landing (25.18%). A total of 22.15% of time was spent on measuring stackwood, and the least net time was spent on bucking wood assortments (3.66%).

Table 13 also shows the time consumption of inspection per piece and per m^3. Effective time per piece of wood assortment (2,038 pieces) amounted to 0.99 minutes, and total inspection time to 2.75 min.

ALLOWANCE TIME AT INSPECTION OF WOOD ASSORTMENTS AT KUTJEVO
DODATNO VRIJEME PRI PREUZIMANJU DRVNIH SORTIMENATA U KUTJEVU

Allowance time amounted to 630.18 minutes, or 67.35% of effective time. Such a high percentage was the consequence of the small consumption of effective time, and since interruptions are necessary during work regardless of how busy the worker is.

Table 13. Time consumption of the inspection of wood assortments at the auxiliary landing

Tablica 13. Utrošak vremena pri preuzimanju drvnih sortimenata na pomoćnom stovarištu

Type of operation or activity *Vrsta operacije ili zahvata*	Total time *Ukupno vrijeme*	Time share *Udio vremena*			
		per total time *prema ukupnom vremenu*	per effective time *prema efektivnom vremenu*	per timber assortment *po drvnom sortimentu*	per m^3 *po* m^3
	min	%		min	
1. Walking to the load *1. Hod do tovara*	235.58	5.21	25.18	0.12	0.86
2. Bucking timber assortments *2. Prikrajanje drvnih. sortimenata*	34.24	0.76	3.66	0.02	0.13
3. Cross-cutting and finalisation *3. Trupljenje i dorada*	93.11	2.06	9.95	0.05	0.34
4. Measuring technical roundwood *4. Mjerenje tehničke oblovine*	255.93	5.66	27.35	0.53	2.86
5. Setting plastic boards *5. Zakucavanje pločica*	51.55	1.14	5.51	0.11	0.58
6. Measuring stackwood *6. Mjerenje prostornog drva*	207.29	4.58	22.15	0.13	1.13
7. Marking with numbering hammer *7. Označavanje kolobrojem*	58.01	1.28	6.20	0.04	0.32
Effective time *Efektivno vrijeme*	935.71	20.69	100.00	0.99	6.21
Delay times *Opća vremena*	3 585.84	79.31		1.76	13.13
Total time *Ukupno vrijeme*	4 521.55	100.00		2.75	19.33

When establishing allowance time, the lunch break was determined according to the working day, so that 30 minutes were allocated for 8 hours of work. Figure 7 shows the share of allowance time. The largest share, 44.84%, was taken by the lunch break, then by preparation/completion time – 26.01%. Justified interruptions amounted to 12.69%, and sporadic operations came to 11.45%.

CUTTING AND PROCESSING TIME AT PLETERNICA
VREMENA SJEČE I IZRADBE U PLETERNICI

One cutter worked on both cutting and processing. Over 9 days, he spent a total of 3,810.15 minutes (Table 14). Effective time amounted to 1,582.44 minutes, or 41.53%, and delay time to 2,227.71 minutes, or 58.47%. The share of cutting and processing time in total time amounted to 40.05% and to 96.42% of effective

Figure 7. Allowance time in the inspection of wood assortments at the auxiliary landing at Kutjevo

Slika 7. Dodatno vrijeme preuzimanja drvnih sortimenata na pomoćnom stovarištu u Kutjevu

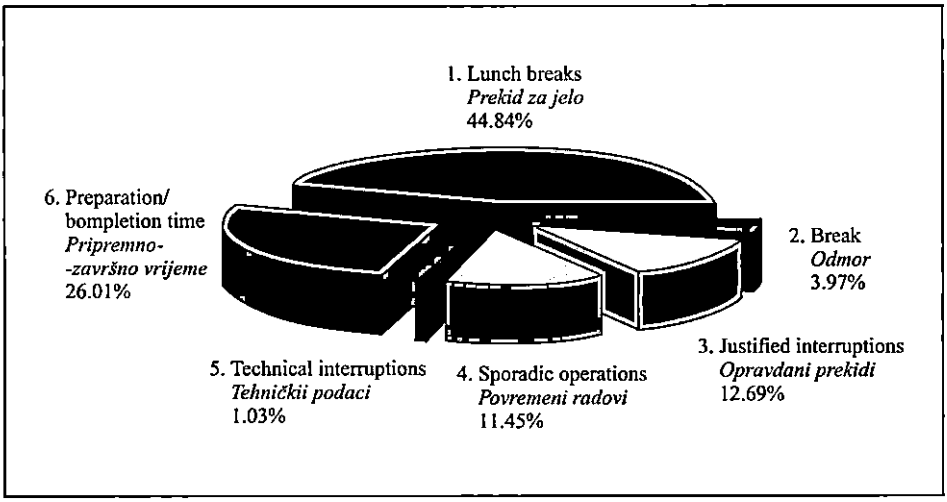


Table 14. Effective and delay tree cutting and processing times and time consumption per tree at Pleternica

Tablica 14. Efektivno i opća vremena sječe i izradbe stabala te utrošak vremena po stablu u Pleternici

Type of operation or procedure *Vrsta operacijeili zahvata*	Time consumption *Utrošak vremena*	Share per *Udio prema*		Shareper tree *Udio po stablu*
		total time *ukupnom vremenu*	effective time *efektivnom vremenu*	
	min	%		min
1. Felling and processing time *1. Vrijeme sječe i izradbe*	1 525.78	40.05	96.42	3.49
1.1 Tree time *1.1 Stablovno vrijeme*	1 203.50	31.59	76.05	2.75
1.2 Assortment time *1.2 Sortimentno vrijeme*	322.28	8.46	20.37	0.74
2. Load preparation *2. Priprema tovara*	56.66	1.49	3.58	0.13
3. Effective time *3. Efektivno vrijeme*	1 582.44	41.53	100.00	3.62
4. Delay times *4. Opća vremena*	2 227.71	58.47		5.10
5. Total time *5. Ukupno vrijeme*	3 810.15	100.00		8.72

time. In total time, tree time amounted to 31.59%, or 7.73 min/m³, and assortment time was 8.46%, or 2.07 min/m³. In effective time, tree time amounted to 76.05% of the time, and assortment time came to 20.37%. In cutting and processing beech in a mountainous area, Bojanin and Krpan (1994) give a consumption of 8.3 min/m³ of assortment time for a mean DBH of 19 cm, and a consumption of 10.5 min/m³ for a DBH of 22 cm.

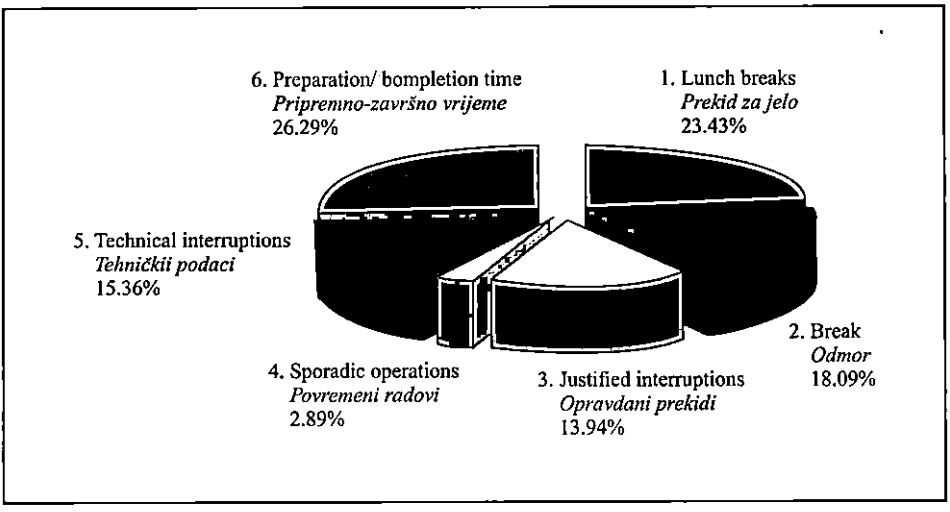
The cutter sometimes bound the load and spent a total of 56.66 minutes in doing so, which amounted to 1.49% of total time, and 3.58% of effective time. The processed volume of wood assortments from 437 cut trees amounted to 155.60 m³. Total time per tree amounted to 8.72 minutes, and for processed wood assortments to 24.49 min/m³. Effective time per tree amounted to 3.62 minutes, or 10.17 min/m³. For similar conditions of teamwork, the total cutting and processing time of wood assortments amounts to 29.36 min/m³, and net time to 17.96 min/m³ (Štefančić, 1989).

ALLOWANCE TIME IN CUTTING AND PROCESSING AT PLETERNICA
DODATNO VRIJEME PRI SJEČI I IZRADBI U PLETERNICI

Allowance cutting and processing time shown in Figure 8 amounted to 1,016.41 minutes, or to 64.23% of effective time.

The largest share was taken by preparation/completion time – 267.18 minutes, or 26.29% of effective time. A considerable amount of time was spent on travelling to the felling site and back, because the cutter had to walk and not ride in the

Figure 8. Distribution of allowance time of cutting and processing at Pleternica
Slika 8. Raspodjela dodatnog vremena sječe i izradbe u Pleternici



tractor. The lunch break took 238.13 minutes, or 23.43%. Breaks were frequent due to the high temperatures and high humidity during the day, and lasted on average 20.46 minutes per day. The workers had to consult on the organisation of the work quite frequently, because all the workers worked on a relatively small area, in a line one behind the other. Sporadic operations had a share of only 2.89%. Technical interruptions occurred when there was a real need to replenish fuel or sharpen the chain, and lasted 156.14 minutes, or 15.36% of this time.

TIMES OF INSPECTION OF WOOD ASSORTMENTS AT THE PLETERNICA FELLING SITE
VREMENA PREUZIMANJA ŠUMSKIH SORTIMENATA NA SJEČINI U PLETERNICI

The consumption of effective and delay time is shown in Table 15. Effective time amounted to 815.45 minutes, or 21.40%, and delay time to 2,995.58 minutes, or 78.61%. A total of 153.08 m³ was inspected, of which 329 pieces of com-

Table 15. Time consumption on the inspection of wood assortments at the Pleternica felling site
*Tablica 15. Utrošci vremena pri preuzimanju drvnih sortimenata u sječini u Pleter*nici

Type of operation or procedure *Vrsta operacija ili zahvata*	Total time *Ukupno vrijeme*	Time share *Utrošak vremena*			
		per total time *prema ukupnom vremenu*	per effective time *prema efektivnom vremenu*	per timber assortment *po drvnom sortimentu*	per m³ *po m³*
	min	%		min	
1. Walking to the stem *1. Hod do debla*	158.45	4.16	19.43	0.14	1.00
2. Measuring *2. Mjerenje*	638.79	16.76	78.34	0.58	4.04
3. Setting plastic boards *3. Zakucavanje pločica*	5.68	0.15	0.70	0.01	0.04
4. Marking with numbering hammer *4. Označavanje kolobrojem*	12.53	0.33	1.54	0.01	0.08
Effective time *Efektivno vrijeme*	815.45	21.40	10.00	0.74	5.16
Delay times *Opća vremena*	2 995.58	78.60		2.73	18.95
Total time *Ukupno vrijeme*	3 811.03	100.00		3.47	24.11

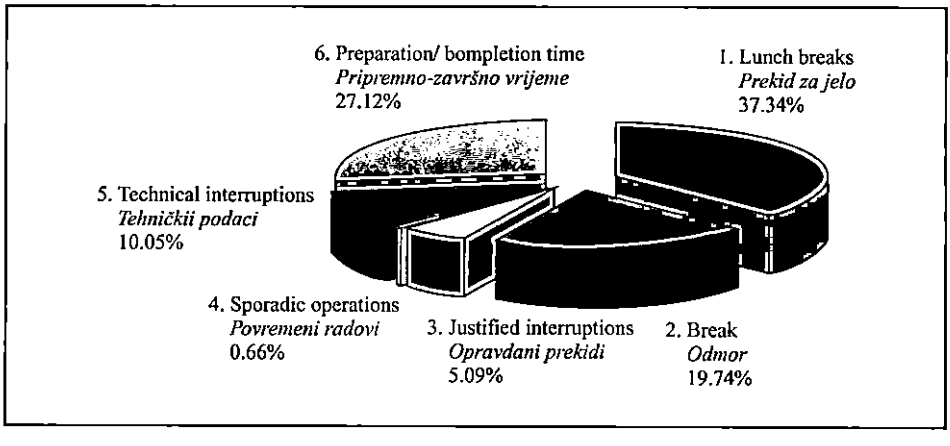
mercial roundwood of a mean volume of 0.181 m³ and 768 pieces of long stackwood of a mean volume of 0.122 m³. The time spent on measuring wood assortments in relation to effective time amounted to 78.34%, or 0.58 minutes per piece, that is, 4.04 min/m³. Effective time amounted to 5.16 min/m³, and delay time 18.95 min/m³, which made up a total of 24.11 min/m³. In similar working conditions, it was noted that a total of 5.58 min/m³ is spent on inspecting wood assortments in the forest, including 3.13 min/m³, or 56.14%, of effective time, and 2.45 min/m³ of delay time (Štefančić, 1989).

ALLOWANCE TIME OF THE INSPECTION OF WOOD ASSORTMENTS AT THE PLETERNICA FELLING SITE
DODATNO VRIJEME PREUZIMANJA DRVNIH SORTIMENATA U SJEČINI U PLETERNICI

Allowance time amounted to 637.97 minutes, or 78.23 % of the effective time, that is, 70.88 min/day. The lunch break was determined according to the total time consumption per day, and amounted to 37.34% of allowance time, that is, to 6.25% of total working time consumption.

Breaks of up to 5 minutes at the most were acknowledged, and were taken 2 to 5 times during the working day. They amounted to a total of 125.96 minutes, or 19.74%, that is, an average of 14 minutes per day. Justified breaks were included in the total amount of 32.49 minutes, or 5.09%. Technical interruptions amounted to a total of 64.14 minutes, or 10.05%. Preparation/completion times lasted 172.99 minutes, or 27.12%. Preparation time and time for collecting the tools up to 15 minutes per day at the most were acknowledged, including 10 minutes on preparation time and 5 minutes on collecting the tools. The time spent on the journey to the felling site and back was included in the total amount (Figure 9).

Figure 9. Allowance time of inspection of wood assortments at the Pleternica felling site
*Slika 9. Dodatno vrijeme preuzimanja drvnih sortimenata u sječini na radilištu Pl*eternica

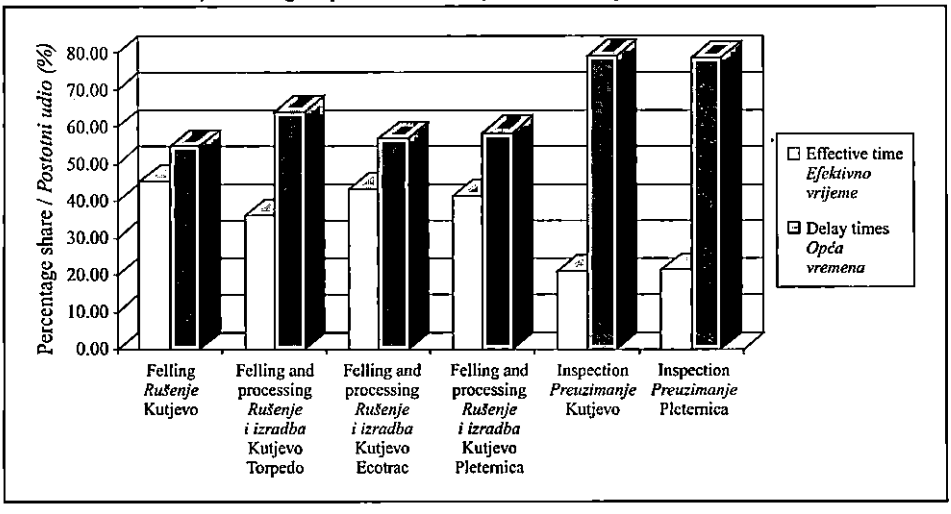


The amount of allowance time of 78.23% is too high. The reason for this lies in the fact that the share of effective time, that is, the organisation of work and the engagement of the cutters, is too small.

RELATIONSHIP BETWEEN THE EFFECTIVE AND DELAY TIME OF CUTTERS
ODNOS EFEKTIVNOG I OPĆIH VREMENA SJEKAČA

Figure 10 shows the relationship between effective and delay time in all the operations of the cutters. The largest effective and smallest delay time was achieved in cutting trees, and the smallest effective and largest delay time was taken in inspecting wood assortments.

Figure 10. The relationship between the effective and delay time of cutters in total time consumption
Slika 10. Odnos efektivnog i općih vremena sjekača u ukupno utrošenom vremenu



TOTAL TIME CONSUMPTION OF TRACTORS
UKUPNO UTROŠENA VREMENA TRAKTORA

TOTAL TIME CONSUMPTION OF A TORPEDO TD 75A TRACTOR
UKUPNO UTROŠENA VREMENA TRAKTORA TORPEDO TD 75A

Table 16 shows the total time consumption of a Torpedo tractor at both work sites and the relative share of individual time in total and effective time.

The work of the tractor was monitored at the Kutjevo work site in the course of 15 days, and at the Pleternica work site in the course of 9 days. At Kutjevo, 143

Table 16. Structure of total time consumption of a Torpedo TD 75A tractor
Tablica 16. Struktura ukupno utrošenih vremena traktora Torpedo TD 75A

Type of operation *Vrsta aktivnosti*	Time consumption *Utrošak vremena*					
	Torpedo - Kutjevo			Torpedo - Pleternica		
	Total time *Ukupno vrijeme*	Percentage per *Postotni udio prema*		Total time *Ukupno vrijeme*	Percentage per *Postotni udio prema*	
		total time *ukupnom vremenu*	effective time *efektivnom vremenu*		total time *ukupnom vremenu*	effective time *efektivnom vremenu*
	min	%		min	%	
1. Unloaded tractor travell *1. Vožnja neopterećenog traktora*	319.85	5.32	9.02	123.21	3.22	6.32
2. Loaded tractor travell *2. Vožnja opterećenog traktora*	384.72	6.40	10.85	175.96	4.60	9.03
3. Felling site work *3. Rad na sječini*	2 162	35.98	60.98	1 055.2	27.56	54.13
3.1. Taking up a position *3.1. Zauzimanje položaja*	152.32	2.53	4.30	71.27	1.86	3.66
3.2. Pulling out of rope *3.2. Izvlačenje užeta*	149.02	2.48	4.20	100.23	2.62	5.14
3.3. Binding load (tractor driver) *3.3. Vezanje tovara (traktorist)*	582.54	9.69	16.43	455.83	11.91	23.38
3.4. Skidding and lifting load *3.4. Privlačenje i podizanje tovara*	1.22	0.02	0.03	-	-	-
3.5. Fixing load *3.5. Ispravljanje tovara*	327.15	5.44	9.23	196.35	5.13	10.07
3.6. Winching *3.6. Privitlavanje*	190.5	3.17	5.37	165.83	4.33	8.51
3.7. Move up and down *3.7. Silaženje i penjanje*	77.36	1.29	2.18	35.76	0.93	1.83
3.8. Preparing and binding load *3.8 Priprema i vezanje tovara sjekača*	681.89	11.35	19.23	29.93	0.78	1.54
4. Auxiliary landing work *4. Rad na pomoćnom stovarištu*	678.74	11.30	19.14	595.01	15.54	30.52
4.1. Loaded tractor travell *4.1. Vožnja opterećenog traktora*	98.62	1.64	2.78	87	2.27	4.46

4.2 Winching *4.2. Privitlavanje*	2.29	0.04	0.06	-	-	-
4.3. Move up and down *4.3. Silaženje i penjanje*	69.16	1.15	1.95	28.49	0.74	1.46
4.4. Unfastening load *4.4. Odvezivanje tovara*	197.95	3.29	5.58	264.19	6.90	13.55
4.5. Unbinding rope *4.5. Izvlačenje užeta*	5.55	0.09	0.16	19.51	0.51	1.00
4.6. Making a wood stack *4.6. Uređenje složaja*	209.79	3.49	5.92	137.86	3.60	7.07
4.7. Unloaded tractor turning *4.7. Okretanje neopterećenog traktora*	20.61	0.34	0.58	1.77	0.05	0.09
4.8. Unloaded tractor travell *4.8. Vožnja neopterećenog traktora*	74.77	1.24	2.11	56.19	1.47	2.88
5. Effective time *5. Efektivno vrijeme*	3 545.31	59.00	100.00	1 949.38	50.91	100.00
6. Delay times *6. Opća vremena*	2 463.44	41.00	-	1 879.42	49.09	-
7. Total time *7. Ukupno vrijeme*	6 008.75	100.00	-	3 828.8	100.00	-
8. Total skidded timber volume, m^3 *8. Ukupno privučeni drvni obujam, m^3*	171.49	-	-	88.59	-	-
9. Effective time per unit, min/m^3 *9. Efektivno vrijeme po jedinici, min/m^3*	20.67	-	-	22.00	-	-
10. Total time per unit, min/m^3 *10. Ukupno vrijeme po jedinici, min/m^3*	35.04	-	-	43.22	-	-
11. Realised daily output, m^3/day *11. Ostvareni dnevni učinak, m^3/dan*	11.43	-	-	9.84	-	-

tractor cycles were measured, and at Pleternica 56 cycles were recorded, which makes a total of 199 tractor cycles. At the Kutjevo work site, 6,008.75 minutes were counted, and at the Pleternica work site, 3,828.80 minutes of work. The structure of total time consumption is shown in Table 36, while the structure of delay time is displayed in Table 37. Effective time was 8.09% longer at Kutjevo than at Pleternica. Delay time amounted to 41.0% and 49.09% respectively. Krpan (1984) holds that the average delay time of 40.0% is too high. Effective

time per unit amounted to 20.67 minutes, or 22.0 minutes, which was 6.4% more than at Pleternica. The total time amounted to 35.04 min/m³, that is, 43.22 min/m³. At Pleternica, it was 23.3% higher than at Kutjevo. With an articulated wheeler tractor, Bojanin (1974) believes that effective time is satisfactory if it amounts to 79.7% of total time.

ALLOWANCE TIME OF THE TORPEDO TD 75A TRACTOR
DODATNO VRIJEME TRAKTORA TORPEDO TD 75A

Table 17 shows the structure of allowance time for a Torpedo TD 75A tractor. Allowance time is made up of parts of delay time which must be acknowledged, since they arise as no fault of the worker.

Allowance time is determined in order to calculate the time and efficiency quotas, and is allowance to effective time in the form of a percentage, an allowance time coefficient or an absolute amount.

Some authors, as shown by Krpan (1984), include justified and personal interruptions in allowance time, as well as breaks and preparation/completion time. If the half-hour lunch break is not included in allowance time (Bojanin 1971, Krivec, 1967), then the daily working time lasts 450 minutes.

According to Table 38, allowance time for a Torpedo TD 75A tractor at Kutjevo amounted to 837.63 minutes, or 23.6%, and at Pleternica to 510.11 minutes,

Table 17. Structure of allowance time of a Torpedo TD 75A tractor
Tablica 17. Struktura dodatnog vremena traktora Torpedo TD 75A

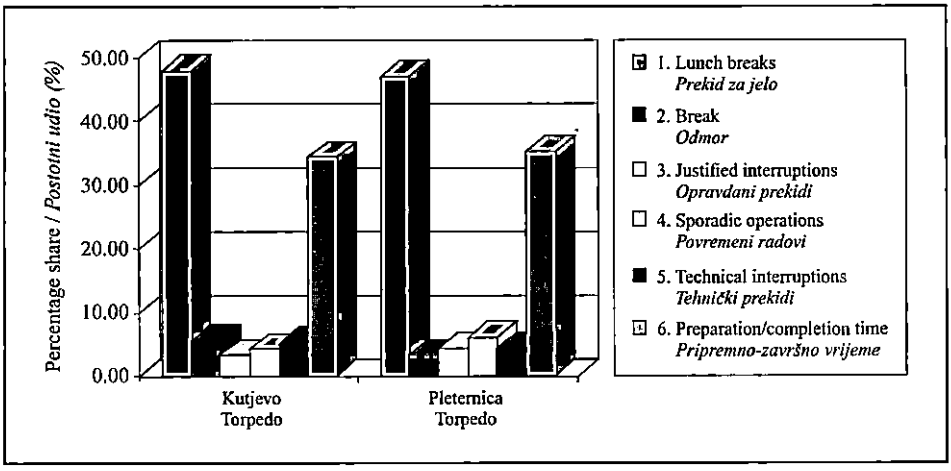
Type of time or work interruption *Vrsta vremena ili prekida rada*	Torpedo TD 75A			
	Kutjevo		Pleternica	
	Time *Vrijeme*	Percentage *Postotni udio*	Time *Vrijeme*	Percentage *Postotni udio*
	min	%	min	%
1. Lunch break *1. Prekid za jelo*	401.00	47.87	240.00	47.05
2. Break and personal needs *2. Odmor i osobne potrebe*	45.45	5.43	16.47	3.23
3. Justified interruptions *3. Opravdani prekidi*	26.97	3.22	22.10	4.33
4. Sporadic operations *4. Povremeni radovi*	34.70	4.14	30.84	6.05
5. Technical interruptions *5. Tehnički prekidi*	42.71	5.10	21.48	4.21
6. Preparation/completion time *6. Pripremno-završno vrijeme*	286.8	34.24	179.22	35.13
7. Allowance time *7. Dodatno vrijeme*	837.63	100.00	510.11	100.00

or 26.2% of effective time. The establishment of allowance time was based on an analysis of each interruption. A lunch break lasting.30 minutes was acknowledged for 8 hours of work. At Kutjevo this amounted to 47.87%, and at Pleternica to 47.05% of allowance time. Time for rest and personal needs at Kutjevo amounted to 5.43%, and at Pleternica it came to 3.23% of allowance time. Sporadic jobs amounted 4.14% and 6.05% of this time at the respective sites. Technical interruptions amounted to 5.1% and 4.21% of allowance time, and were acknowledged based on an evaluation of the time required for repairs. Preparation/completion time at Kutjevo amounted to 34.24%, and at Pleternica to 35.13% of allowance time.

For adapted agricultural tractors, Bojanin (1975) gives allowance time ranging from 11.7% to 38.4%, and Krpan (1984), for all other tractors, gives a range of 13.4% to 25.8%.

Figure 11 shows the share of allowance time at both work sites. It is evident that the lunch break took the largest share, followed by preparation/completion time, whereas other times are evenly represented.

Figure 11. Allowance time in skidding timber with a Torpedo TD 75A tractor
Slika 11. Dodatno vrijeme pri privlačenju drva traktorom Torpedo TD 75A



TOTAL TIME CONSUMPTION OF THE ECOTRAC V-11-1033F TRACTOR
UKUPNO UTROŠENA VREMENA TRAKTORA ECOTRAC V-11-1033F

Table 18 shows the total time consumption of Ecotrac tractors at both work sites, and the share of individual time in the total and effective time. At the Kutjevo work site, the work of the tractor was measured over 15 days, and at the Pleternica work site over 8 days.

A total of 134 tractor cycles were measured at Kutjevo, and 47 at Pleternica, which made a total of 181 tractor cycles. At the Kutjevo work site, 6,295.08 minutes

of work were measured, and at Pleternica, 3,418.74 minutes. Effective time at Kutjevo was 9.11% longer than at Pleternica. Delay time at Kutjevo amounted to 48.54%, and to 57.65% at Pleternica. Effective time per unit amounted to 21.64 min/m³ and 26.18 min/m³ respectively. At Pleternica, 4.54% more net time was spent than at Kutjevo. The total time per unit at Kutjevo amounted to 42.05 min/m³, while at Pleternica it was 19.77 minutes more, amounting to 61.82 min/m³.

Table 18. Structure of total time consumption of an Ecotrac V-11-1033F tractor
Tablica 18. Struktura ukupno utrošenih vremena traktora Ecotrac V-11-1033F

Type of operations *Vrsta aktivnosti*	Time consumption *Utrošak vremena*					
	Ecotrac - Kutjevo			Ecotrac - Pleternica		
	Total time *Ukupno vrijeme*	Percentage per *Postotni udio prema*		Total time *Ukupno vrijeme*	Percentage per *Postotni udio prema*	
		total time *ukupnom vremenu*	effective time *efektivnom vremenu*		total time *ukupnom vremenu*	effective time *efektivnom vremenu*
	min	%		min	%	
1. Unloaded tractor travell *1. Vožnja neopterećenog traktora*	276.31	4.39	8.53	157.07	4.59	10.85
2. Loaded tractor travell *2. Vožnja opterećenog traktora*	291.01	4.62	8.98	171.42	5.01	11.84
3. Felling site work *3. Rad na sječini*	2 130.57	33.85	65.77	621.60	18.18	42.93
3.1. Taking up a position *3.1. Zauzimanje položaja*	78.47	1.25	2.42	36.55	1.07	2.52
3.2. Pulling out of rope *3.2. Izvlačenje užeta*	166.30	2.64	5.13	58.84	1.72	4.06
3.3. Binding load (tractor driver) *3.3. Vezanje tovara (traktorist)*	421.38	6.69	13.01	348.86	10.20	24.09
3.4. Skidding and lifting load *3.4. Privitlavanje i podizanje tovara*	87.64	1.39	2.71	13.74	0.40	0.95
3.5. Fixing load *3.5. Ispravljanje tovara*	145.02	2.30	4.48	49.67	1.45	3.43
3.6. Winching *3.6. Privitlavanje*	177.03	2.81	5.47	59.04	1.73	4.08
3.7. Move up and down *3.7. Silaženje i penjanje*	68.02	1.08	2.10	28.17	0.82	1.95
3.8. Preparing and binding load *3.8 Priprema i vezanje tovara sjekača*	986.71	15.67	30.46	26.73	0.78	1.85

4. Auxiliary landing work *4. Rad na pomoćnom stovarištu*	541.32	8.60	16.71	497.85	14.56	34.38
4.1. Loaded tractor travell *4.1. Vožnja opterećenog traktora*	57.31	0.91	1.77	108.90	3.19	7.52
4.2 Winching *4.2. Privitlavanje*	1.42	0.02	0.04	0.29	0.01	0.02
4.3. Move up and down *4.3. Silaženje i penjanje*	46.91	0.75	1.45	25.64	0.75	1.77
4.4. Unfastening load *4.4. Odvezivanje tovara*	244.52	3.88	7.55	160.34	4.69	11.07
4.5. Unbinding rope *4.5. Izvlačenje užeta*	1.28	0.02	0.04	25.69	0.75	1.77
4.6. Making a wood stack *4.6. Uredenje složaja*	105.69	1.68	3.26	97.09	2.84	6.71
4.7. Unloaded tractor turning *4.7. Okretanje neopterećenog traktora*	30.65	0.49	0.95	9.57	0.28	0.66
4.8. Unloaded tractor travell *4.8. Vožnja neopterećenog traktora*	53.54	0.85	1.65	70.33	2.06	4.86
5. Effective time *5. Efektivno vrijeme*	3 239.21	51.46	100.00	1 447.94	42.35	100.00
6. Delay times *6. Opća vremena*	3 055.87	48.54	-	1 970.80	57.65	-
7. Total time *7. Ukupno vrijeme*	6 295.08	100.00	-	3 418.74	100.00	-
8. Total skidded timber volume, m^3 *8. Ukupno privučeni drvni obujam, m^3*	149.70	-	-	55.31	-	-
9. Effective time per unit, min/m^3 *9. Efektivno vrijeme po jedinici, min/m^3*	21.64	-	-	26.18	-	-
10. Total time per unit, min/m^3 *10. Ukupno vrijeme po jedinici, min/m^3*	42.05	-	-	61.82	-	-
11. Realised daily output, m^3/day *11. Ostvareni dnevni učinak, m^3/dan*	9.98	-	-	6.91	-	-

THE ALLOWANCE TIME OF AN ECOTRAC V-11-1033F TRACTOR
DODATNO VRIJEME TRAKTORA ECOTRAC V -11-1033F

Table 19 shows the structure of allowance time for an Ecotrac tractor. The allowance time of an Ecotrac tractor at Kutjevo amounted to 26.8%. At Pleternica the allowance time of the tractor amounted to 32.8%. If the lunch break of 393.44 minutes and 213.67 minutes is deducted, then the allowance time of the Ecotrac tractor at Kutjevo amounts to 14.6% of effective time, while at Pleternica it comes to 18.1%.

Table 19. Structure of allowance time of an Ecotrac V-11-1033F
Tablica 19. Struktura dodatnog vremena traktora Ecotrac V-11-1033F

Type of time or work interruption *Vrsta vremena ili prekida rada*	Ecotrac V 1033F			
	Kutjevo		Pleternica	
	Time *Vrijeme*	Percentage *Postotni udio*	Time *Vrijeme*	Percentage *Postotni udio*
	min	%	min	%
1. Lunch break *1. Prekid za jelo*	393.44	45.31	213.67	44.94
2. Break and personal needs *2. Odmor i osobne potrebe*	86.42	9.95	29.95	6.30
3. Justified interruptions *3. Opravdani prekidi*	64.03	7.37	18.86	3.97
4. Sporadic operations *4. Povremeni radovi*	0.00	0.00	13.98	2.94
5. Technical interruptions *5. Tehnički prekidi*	27.89	3.21	40.89	8.60
6. Preparation/completion time *6. Pripremno-završno vrijeme*	296.48	34.15	158.07	33.25
7. Allowance time *7. Dodatno vrijeme*	868.26	100.00	475.42	100.00

Rest and personal needs amounted to 9.95% and 6.30%, and justified interruptions to 7.37% and 3.97% at the respective sites. Sporadic jobs took place only at the Pleternica work site and amounted to 2.94% of allowance time. Technical interruptions amounted to 3.21% and 8.60% respectively, and were recognised in the same way as for the Torpedo tractors.

Figure 12 shows a histogram of the structure of allowance time for both tractors. It is evident that the largest share is taken up by the lunch break, followed by preparation/completion time. Other times are represented with marginal differences.

Figure 13 shows the relationship of effective and delay time for Torpedo and Ecotrac tractors at both work sites. It can be seen that the Torpedo tractor at Kutjevo achieved 8%, the Ecotrac at Kutjevo, 2.82%, and the Torpedo at Pleternica just 0.82% more effective time in relation to delay time. The shortest effective time in the total working time was achieved by the Ecotrac tractor at Pleternica, amounting to only 42.35%.

Figure 12. Allowance skidding time of an Ecotrac V-11-1033F tractor
Slika 12. Dodatno vrijeme privlačenja drva traktorom Ecotrac V-11-1033F

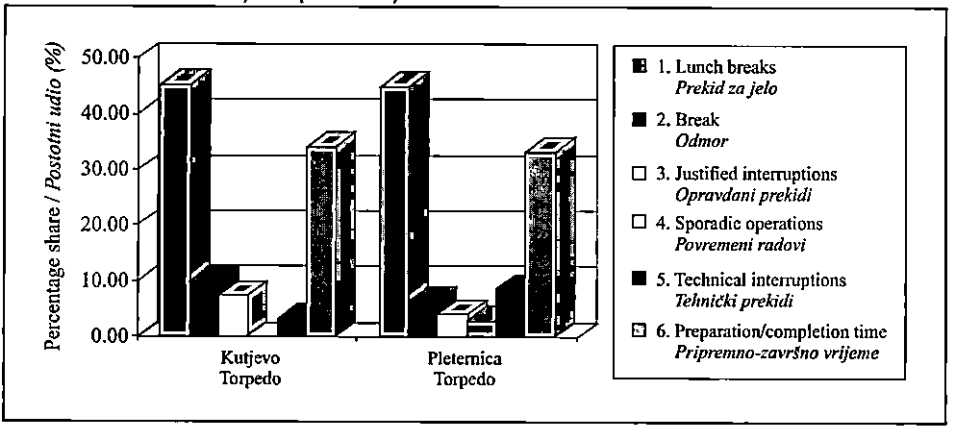
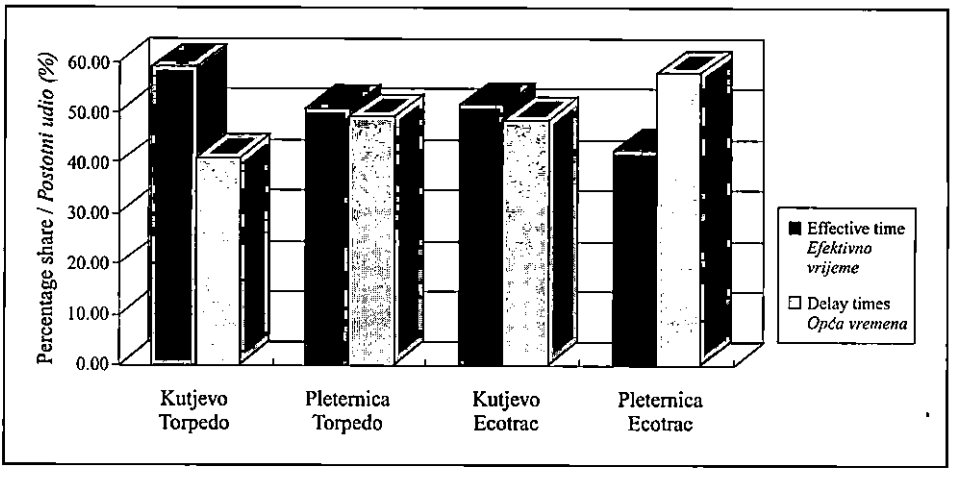


Figure 13. The relationship between effective and delay time in the total time consumption per work sites and tractors
Slika 13. Odnos efektivnog i općih vremena u ukupno utrošenom vremenu po radilištima i traktorima



SOME AVERAGE MEASUREMENTS AT THE WORK SITES
NEKE PROSJEČNE VELIČINE NA RADILIŠTIMA

As can be seen in Table 20, the mean skidding distance ranged between 254 m and 344 m. The average daily output ranged between 6.91 m³/day with the Ecotrac tractor at Pleternica, and 11.43 m³/day with the Torpedo at Kutjevo. The average realised working time per day was between 83.5% to 89% of an 8-hour working day.

Table 20. Some average measurements achieved at the work sites
Tablica 20. Neke prosječno ostvarene veličine na radilištima

Tractor Working site *Traktor Radilište*	Mean skidding distance *Srednja udaljenost privlačenja*	Total cycles time *Ukupno vrijeme turnusa*	Number of cycles per day *Broj turnusa dnevno*	Mean load volume *Srednji obujam tovara*	Output norm *Norma učinka*	Time consumption per product unit *Utrošak vremena po jedinici proizvoda*	Average time consumption per day *Prosječno utrošeno vrijeme po danu*	
	mm	min		m^3	m^3/day *m^3/dan*	min/m^3 *min/m^3*	min	% of 480 min *% od 480 min*
Torpedo Kutjevo	254	41.44	9.7	1.20	11.43	35.04	400.59	83.5
Ecotrac Kutjevo	238	45.13	9.3	1.12	9.98	42.05	419.67	87.4
Torpedo Pleternica	326	68.62	6.2	1.58	9.84	43.22	425.42	88.6
Ecotrac Pleternica	344	72.43	5.9	1.18	6.91	61.82	427.34	89.0

CYCLE TIMES
VREMENA TURNUSA

TIME DISTRIBUTION OF TRACTOR CYCLES
RASPODJELA VREMENA TURNUSA TRAKTORA

Data on the distribution of cycle times are shown in Tables 21 and 22. All the work elements were processed by mathematical statistical methods.

THE TIME STRUCTURE OF TRACTOR CYCLES – KUTJEVO
STRUKTURA VREMENA TURNUSA TRAKTORA - KUTJEVO

The effective time of the cycles of the TK (Torpedo Kutjevo) amounted to 26.84 minutes or to 80.9% of the total cycle times. With the allowance time of 23.6%, the total cycle time was 33.18 minutes. Table 21 also shows the values of the average load volume and the achieved average standard times and daily outputs. Work at the felling site lasted 14.91 minutes, or 55.5% of net time, and the least time, 2.99 minutes, or 11.1%, was spent on driving an unloaded tractor along the skid trail and felling site. When the work was done at the felling site, the tractor driver spent 4.02 minutes or 15.0% in binding the load, while the cutter spent 4.70 minutes or 17.5% of effective time. Binding the load lasted for a total of 8.72 minutes, or 32.5% of effective time. The operation of securing and balancing the load amounted to 8.4% of effective time, while the other working operations at the felling site take up a significantly smaller proportion of time.

Table 21. Time structure of cycles for a skidding distance of 300 m along the skid trail and the felling site, and a distance of 100 m along the auxiliary landing, TK (Torpedo Kutjevo) and EK (Ecotrac Kutjevo)

Tablica 21. Struktura vremena turnusa za udaljenost privlačenja po vlaci i sječini od 300 m i po pomoćnom stovarištu 100 m, TK (Torpedo Kutjevo) i EK (Ecotrac Kutjevo)

Type of time *Vrsta vremena*	Torpedo Kutjevo (TK)			Ecotrac Kutjevo (EK)		
	Cycle consumption time *Utrošak vremena turnusa*			Cycle consumption time *Utrošak vremena turnusa*		
	min	Percentage per *Postotni udio prema*		min	Percentage per *Postotni udio prema*	
		total time *ukupnom vremenu*	effective time *efektivnom vremenu*		total time *ukupnom vremenu*	effective time *efektivnom vremenu*
		%			%	
1. Unloaded tractor travell *1. Vožnja neopterećenog traktora*	2.99	9.0	11.1	2.81	8.7	11.0
2. Loaded tractor travell *2. Vožnja opterećenog traktora*	3.47	10.5	12.9	2.81	8.7	11.0
3. Felling site work *3. Rad na sječini*	14.91	44.9	55.5	15.16	46.8	59.4
3.1 Taking up a position *3.1 Zauzimanje položaja*	1.05	3.2	3.9	0.56	1.7	2.2
3.2 Pulling out of rope *3.2 Izvlačenje užeta*	1.03	3.1	3.8	1.19	3.7	4.7
3.3 Binding load (tractor driver) *3.3 Vezanje tovara (traktorist)*	4.02	12.1	15.0	3.03	9.4	11.9
3.4 Winching and lifting load *3.4 Privitlavanje i podizanje tovara*	0.01	0.0	0.0			
3.5 Fixing load *3.5 Ispravljanje tovara*	2.26	6.8	8.4	1.04	3.2	4.1
3.6 Winching *3.6 Privitlavanje*	1.31	4.0	4.9	1.74	5.3	6.8
3.7 Move up and down *3.7 Silaženje i penjanje*	0.53	1.6	2.0	0.49	1.5	1.9
3.8 Preparation and binding cutter's load *3.8 Priprema i vezanje tovara sjekača*	4.70	14.2	17.5	7.10	21.9	27.8

4. Auxiliary landing wok *4. Rad na pomoćnom stovarištu*	5.48	16.5	20.4	4.76	14.7	18.6
4.1 Loaded tractor travell *4.1 Vožnja opterećenog traktora*	1.16	3.5	4.3	1.03	3.2	4.0
4.2 Winching *4.2 Privitlavanje*	0.02	0.0	0.1	0.01	0.0	0.0
4.3 Move up and down *4.3 Silaženje i penjanje*	0.48	1.4	1.8	0.34	1.0	1.3
4.4 Unbinding load *4.4 Odvezivanje tovara*	1.37	4.1	5.1	1.76	5.4	6.9
4.5 Hauling rope *4.5 Izvlačenje užeta*	0.04	0.1	0.1	0.01	0.0	0.0
4.6 Making a wood stack *4.6 Uređenje složaja*	1.45	4.4	5.4	0.76	2.3	3.0
4.7 Turning of unloaded tractor *4.7 Okretanje neopterećenog traktora*	0.14	0.4	0.5	0.22	0.7	0.9
4.8 Unloaded tractor travell *4.8 Vožnja neopterećenog traktora*	0.83	2.5	3.1	0.63	1.9	2.5
5. Effective time *5. Efektivno vrijeme*	26.84	80.9	100.0	25.54	78.9	100.0
6. Allowance time (23.6 % to effective time) *6. Dodatno vrijeme (23.6 % na efek. vrij.)*	6.34	19.1		6.84	21.1	
7. Total cycle time *7. Ukupno vrijeme turnusa*	33.18	100.0		32.38	100.0	
8. Average load volume, m^3 *8. Prosječan obujam tovara, m^3*	1.20			1.12		
9. Time standard, min/m^3 *9. Norma vremena, min/m^3*	27.65			28.91		
10. Daily output, m^3/day *10. Dnevni učinak, m^3/dan*	17.36			16.60		

In working at the auxiliary landing, most time was consumed on arranging the stack 1.45 minutes, or 5.4% of effective time. This was followed by unloading at 5.1%, and driving the loaded tractor, at 4.3% of effective cycle time (Table 21).

Most time was spent on working at the felling site, 55.5% of effective cycle time for the TK, and 51.9% for the TP (Torpedo Pleternica). At the felling site, most time was spent on binding the load. At the auxiliary landing, the Torpedo at Kutina spent 20.4%, and the Torpedo at Pleternica, 7.6% more effective cycle time. The time for driving the loaded and unloaded tractor differed marginally for both tractors.

Table 21 also shows the time structure of the EK (Ecotrac Kutjevo) tractor cycles. Effective time amounted to 24.54 minutes, or 78.9%, and allowance time to 6.84 minutes, or 21.1% of total cycle time. The table also gives the figures of an average load volume, the standard time and daily output. Work at the felling site lasted 15.16 minutes, or 59.4%, and the least time was spent on driving a loaded and unloaded tractor along the skid trail and felling site – 2.81 minutes, or 11.0%. Work at the auxiliary landing with an EK tractor amounted to 4.76 minutes, or 14.7% of effective, or 18.6% of total time.

When working at the felling site with an Ecotrac tractor at Kutjevo, most time was spent on binding the cutter's load – 7.10 minutes, or 27.8% – and in binding the tractor driver's load – 3.03 minutes, or 11.9% of effective time. The total time for binding the load amounted to 10.13 minutes, or to 39.7% of the effective cycle time. The other working operations were represented in a range from 1.8% to 3.9% of effective cycle time.

The Ecotrac tractor at Kutjevo spent 4.76 minutes, or 18.6% of effective cycle time, at the auxiliary landing. Within working time, most time was spent on unloading – 1.76 minutes, or 6.9% – and on driving the loaded tractor – 1.03 minutes, or 4.0% of effective time.

TIME STRUCTURE OF TRACTOR CYCLES – PLETERNICA
STRUKTURA VREMENA TURNUSA TRAKTORA - PLETERNICA

The time structure of the tractor cycles of the TP (Torpedo Pleternica) and EP (Ecotrac Pleternica) is shown in Table 22. The effective time of a Torpedo tractor cycle at the Pleternica work site amounted to 36.10 minutes, or to 79.2% of total cycle time.

Allowance time amounted to 26.2%, or as an absolute amount to 9.46 minutes. The total time of a cycle was 45.56 minutes. Work at the felling site lasted 18.72 minutes, or 51.9%, and work at the auxiliary landing lasted 10.10 minutes, which is 8.62 minutes, or 46.0%, less than loading time. The least time was consumed in driving an unloaded tractor along the skid trail and the felling site – 3.10 minutes or 8.6%. Apart from effective and delay times, Table 22 also shows the figures for an average load volume, the standard time and daily output.

Driving an unloaded TP tractor along the skid trail and the felling site took 2.5% less time, and driving a loaded tractor took 1.3% less effective cycle time than the TK. The working time of the TP at the felling site was 3.6% shorter than that of the TK. In this time, the time spent on binding the tractor operator's load at Pleternica was 7.4% longer, and the time for binding the cutter's load was 16.0% of effec-

Table 22. Time structure of cycles for a skidding distanceof 300 m along the skid trail and the felling site, and distance of 100 m along theauxiliary landing, Torpedo Pleternica (TP) and Ecotrac Pleternica (EP)

Tablica 22. Struktura vremena turnusa za udaljenost privlačenja po vlaci i sječini od 300 m i po pom. stovarištu 100 m, Torpedo Pleternica (TP) i Ecotrac (Pleternica)

Type of time *Vrsta vremena*	Torpedo Pleternica (TP)			Ecotrac Pleternica (EP)		
	Cycle consumption time *Utrošak vremena turnusa*			Cycle consumption time *Utrošak vremena turnusa*		
	min	Percentage per *Postotni udio prema*		min	Percentage per *Postotni udio prema*	
		total time *ukupnom vremenu*	effective time *efektivnom vremenu*		total time *ukupnom vremenu*	effective time *efektivnom vremenu*
		%			%	
1. Unloaded tractor travell *1. Vožnja neopterećenog traktora*	3.10	6.8	8.6	4.02	9.5	12.6
2. Loaded tractor travell *2. Vožnja opterećenog traktora*	4.18	9.2	11.6	4.64	10.9	14.5
3. Felling site work *3. Rad na sječini*	18.72	41.1	51.9	13.17	31.0	41.1
3.1 Taking up a position *3.1 Zauzimanje položaja*	1.20	2.6	3.3	0.78	1.8	2.4
3.2 Pulling out of rope *3.2 Izvlačenje užeta*	1.79	3.9	5.0	1.25	2.9	3.9
3.3 Binding load (tractor driver) *3.3 Vezanje tovara (traktorist)*	8.10	17.8	22.4	7.42	17.5	23.2
3.4 Fixing load *3.4 Ispravljanje tovara*	3.51	7.7	9.7	1.06	2.5	3.3
3.5 Winching *3.5 Privitlavanje*	2.96	6.5	8.2	1.49	3.5	4.6
3.6 Move up and down *3.6 Silaženje i penjanje*	0.64	1.4	1.8	0.60	1.4	1.9
3.7 Preparation and binding cutter's load *3.7 Priprema i vezanje tovara sjekača*	0.53	1.2	1.5	0.57	1.3	1.8
4. Auxiliary landing work *4. Rad na pomoćnom stovarištu*	10.10	22.2	28.0	10.20	24.0	31.8
4.1 Loaded tractor travell *4.1 Vožnja opterećenog traktora*	1.19	2.6	3.3	1.81	4.3	5.7

4.2 Winching *4.2 Privitlavanje*				0.01	0.0	0.0
4.3 Move up and down *4.3 Silaženje i penjanje*	0.51	1.1	1.4	0.55	1.3	1.7
4.4 Unbinding load *4.4 Odvezivanje tovara*	4.72	10.4	13.1	3.41	8.0	10.7
4.5 Hauling rope *4.5 Izvlačenje užeta*	0.35	0.8	1.0	0.55	1.3	1.7
4.6 Making a wood stack *4.6 Uređenje složaja*	2.46	5.4	6.8	2.07	4.9	6.5
4.7 Turning of unloaded tractor *4.7 Okretanje neopterećenog traktora*	0.03	0.1	0.1	0.20	0.5	0.6
4.8 Unloaded tractor travell *4.8 Vožnja neopterećenog traktora*	0.84	1.8	2.3	1.61	3.8	5.0
5. Effective time *5. Efektivno vrijeme*	36.10	79.2	100.0	32.03	75.3	100.0
6. Allowance time (26.2 % to effective time) *6. Dodatno vrijeme (26.2 % na efek. vrij.)*	9.46	20.8		10.50	24.7	
7. Total cycle time *7. Ukupno vrijeme turnusa*	45.56	100.0		42.53	100.0	
8. Average load volume, m^3 *8. Prosječan obujam tovara, m^3*	1.58			1.18		
9. Time standard, min/ m^3 *9. Norma vremena, min/m^3*	28.84			36.04		
10. Daily output, m^3/day *10. Dnevni učinak, m^3/dan*	16.65			13.32		

tive cycle time shorter than at Kutjevo. The total binding time at Kutjevo amounted to 8.72 minutes, and at Pleternica it was only 0.09 minutes, or 1%, shorter.

The total working time at the Pleternica auxiliary landing was 4.62 minutes or 45.7% longer in relation to the TK. According to the structure and relationship of effective cycle time, the working time at the auxiliary landing at Pleternica was 7.6% longer in relation to the TK.

Table 22 also shows the structure of the EP (Ecotrac Pleternica) tractor cycles. In relation to total time, effective time amounted to 32.03 minutes, or to 75.3%, and allowance time amounted to 10.5 minutes, or to 24.7%. Work at the felling site amounted to 13.17 minutes, or to 41.1%, and at the auxiliary landing to 10.20 minutes or 31.8% of effective cycle time. The difference in time consumption amounted to 2.97 minutes, or to 22.6%. The least time was consumed in driving the unloaded tractor

along the skid trail and the felling site – 4.02 minutes, or 12.6%. The table also shows the figures for an average load volume, and the standard times and daily outputs.

The Ecotrac at Pleternica spent 1.99 minutes or 13.1% less time on work at the felling site than the Ecotrac at Kutjevo. The Ecotrac at Kutjevo spent 10.3 minutes on binding the load, and the Ecotrac at Pleternica spent 2.31 minutes or 22.4% less time.

At the auxiliary landing, the Ecotrac at Pleternica spent 5.44 minutes or 53.3% more time than the Ecotrac at Kutjevo. Unloading took 1.65 minutes or 48.4% longer at Pleternica than it did at Kutjevo. To arrange the stack, the Ecotrac at Pleternica took 2.7 times longer than the Ecotrac in Kutjevo.

THE DRIVING TIME AND SPEED OF UNLOADED TRACTORS AT THE AUXILIARY LANDING
VRIJEME I BRZINE VOŽNJE NEOPTEREĆENIH TRAKTORA PO POMOĆNOM STOVARIŠTU

The driving time of unloaded tractors at the auxiliary landing and the speed for distances ranging between 25 and 350 m were calculated for both tractors and work sites by using regression analysis.

Table 23. Driving time and speeds of unloaded tractors at the auxiliary landing depending on skidding distance and average speed

Tablica 23. Vrijeme vožnje i brzine kretanja neopterećenih traktora po pomoćnom stovarištu u ovisnosti o udaljenosti privlačenja te prosječne brzine kretanja

Skidding distance *Udaljenost privlačenja*	Auxiliary landing travell - unloaded tractors *Vožnja po pomoćnom stovarištu - neopterećeni traktori*							
	Kutjevo				Pleternica			
	Torpedo (TK)		Ecotrac (EK)		Torpedo (TP)		Ecotrac (EP)	
	Time consumption *Utrošak vremena*	Moving speed *Brzina kretanja*	Time consumption *Utrošak vremena*	Moving speed *Brzina kretanja*	Time consumption *Utrošak vremena*	Moving speed *Brzina kretanja*	Time consumption *Utrošak vremena*	Moving speed *Brzina kretanja*
m	min	km/h	min	km/h	min	km/h	min	km/h
50	0.49	6.10	0.39	7.74	0.65	4.58	0.96	3.11
100	0.83	7.23	0.63	9.56	0.84	7.11	1.62	3.71
150	1.17	7.70	0.87	10.37	1.03	8.72	2.27	3.97
200	1.51	7.96	1.11	10.83	1.22	9.83	2.92	4.11
250	1.85	8.13	1.35	11.13	1.41	10.65	3.57	4.20
300	2.18	8.24	1.59	11.34	1.60	11.27	-	-
350	2.52	8.32	-	-	-	-	-	-
Average speed *Prosječna brzina*		7.50		9.86		8.79		3.70

For the regression lines, Krpan (1984) states M. Kump's opinion of 1970 that the indices and coefficients of correlation that go above 0.75 show a strong connection. The author uses *Roemer-Orphal's* distribution to determine the strength of the correlation based on the calculated correlation coefficient:

Correlation coefficient	Correlation strength
0.0 – 0.1	no correlation
0.1 – 0.25	very weak
0.25 – 0.4	weak
0.4 – 0.5	medium
0.5 – 0.75	strong
0.75 – 0.9	very strong
0.9 – 1.0	complete correlation

Driving time of an unloaded Torpedo tractor (Kutjevo)
$y = 0.15341 + 0.00677\ x,\ r = 0.85975;\ fr = 0.25353$
Driving time of an unloaded Ecotrac tractor (Kutjevo)
$y = 0.14788 + 0.00480\ x,\ r = 0.92787;\ fr = 0.13764$
Driving time of an unloaded Torpedo tractor (Pleternica)
$y = 0.46634 + 0.00377\ x,\ r = 0.51085;\ fr = 0.56776$
Driving time of an unloaded Ecotrac tractor (Pleternica)
$y = 0.31336 + 0.01303\ x,\ r = 0.91177;\ fr = 0.39510$

The driving time and speed of unloaded tractors on the auxiliary landing for distances of 25 m to 350 m are shown in Table 23. The table also shows the average speeds of the tractors.

The auxiliary landing at Kutjevo is next to the main forest road along which the tractors are driven, while at Pleternica they move along a soft lorry track.

Speed is a function that combines time and distance. At the Kutjevo work site, a Torpedo tractor moved at an average speed of 7.50 km/h, and at the Pleternica work site, at a speed of 8.79 km/h, which showed the difference in the manner and personality of the tractor drivers. The speed of EK tractors at 25 m amounted to 5.60 km/h, and at 250 m, 11.34 km/h, which makes up an average of 9.86 km/h. At the Pleternica work site, the Ecotrac moved much more slowly, at an average speed of 3.70 km/h, or 2.7 times more slowly than the average speed of the EK, which we could attribute to the driver's personality. The Ecotrac driver at Kutjevo was more energetic, and the one at Pleternica more relaxed. Bojanin (1982) states that the working conditions affect speed by only 30%, while the drivers with their driving style affect it by 70%.

Krpan (1984) states that the speed of an unloaded IMT 558 tractor in lowland conditions on a microelevation on dry days amounts to 4.93 km/h, and on a microdepression on dry days it amounts to 6.77 km/h, and on rainy days it comes to 5.33 km/h and 6.38 km/h on the microelevation and the microdepression respectively. In skidding commercial roundwood with an unloaded adapted agricultural tractor, Bojanin (1982) gives a speed of 6.53 km/h at the auxiliary landing.

TIME AND SPEED OF LOADED TRACTORS AT THE AUXILIARY LANDING
VRIJEME I BRZINE VOŽNJE OPTEREĆENIH TRAKTORA PO POMOĆNOM STOVARIŠTU

The times and speed of loaded tractors at the auxiliary landing for distances ranging from 25 to 150 m at Kutjevo and from 25 to 300 m at Pleternica were equalised through regression analysis in the following manner:

Time of a loaded Torpedo tractor (Kutjevo)
$y = 0.29576 + 0.008663\ x,\ r = 0.70207; fr = 0.22569$
Time of a loaded Ecotrac tractor (Kutjevo)
$y = 0.10063 + 0.00927\ x,\ r = 0.80629; fr = 0.12294$
Time of a loaded Torpedo tractor (Pleternica)
$y = 0.46634 + 0.00377\ x,\ r = 0.51085; fr = 0.56776$
Time of a loaded Ecotrac tractor (Pleternica)
$y = 0.64912 + 0.011656\ x,\ r = 0.84804; fr = 0.51188$

In the driving of loaded tractors at the auxiliary landing at a distance of 50 m, the TP spent 0.79 minutes, that is, 0.06 minutes or 7.6% more than the TK (Table 24). At a distance of 100 m, the TP spent 1.16 minutes, and the TK 1.19 minutes, that is 0.03 minutes or 2.05% longer.

The speeds of the tractors at distances ranging from 25 to 300 m together with the average speed are shown in Table 24. The lowest average speed of 3.54 km/h was that of the EP tractor, and the highest one, of 5.59 km/h, which is 36.6% higher, was achieved by the TP tractor. The TK tractor moved at an average speed of 4.67 km/h, and the EK moved at an average of 5.28 km/h. The TK and TP tractors moved at an almost identical speed. There was a significant difference, though, between the EP and the EK tractors, with the relationship between speeds amounting to 1:1.5.

Loaded wheeler tractors moving on the auxiliary landing, according to Bojanin's study (1982), achieved an average speed of 4.19 km/h.

TIME AND SPEED OF UNLOADED TRACTORS ALONG THE SKID TRAIL AND AT THE FELLING SITE
VRIJEME I BRZINE VOŽNJE NEOPTEREĆENIH TRAKTORA PO VLACI I SJEČINI

The times of unloaded tractors and their speed along the skid trail and at the felling site are shown for both tractors and work sites in Table 25. The skidding distances ranged from 25 to 600 m. Unloaded tractors moved uphill along tractor trails. The mathematical form of regression is shown for each work operation as follows:

Times of an unloaded Torpedo tractor (Kutjevo) along the skid trail and the felling site:

$$y = 0.56770 + 0.00807x,\ r = 0.89103;\ fr = 0.42987$$

Table 24. Driving time and speeds of loaded tractors at the auxiliary landing depending on skidding distance and average speed

Tablica 24. Vrijeme vožnje i brzine kretanja opterećenih traktora po pomoćnom stovarištu u ovisnosti o udaljenosti privlačenja te prosječne brzine kretanja

Skidding distance *Udaljenost privlačenja*	Auxiliary landing travell - unloaded tractors *Vožnja po pomoćnom stovarištu - neopterećeni traktori*							
	Kutjevo				Pleternica			
	Torpedo (TK)		Ecotrac (EK)		Torpedo (TP)		Ecotrac (EP)	
	Time consumption *Utrošak vremena*	Moving speed *Brzina kretanja*	Time consumption *Utrošak vremena*	Moving speed *Brzina kretanja*	Time consumption *Utrošak vremena*	Moving speed *Brzina kretanja*	Time consumption *Utrošak vremena*	Moving speed *Brzina kretanja*
m	min	km/h	min	km/h	min	km/h	min	km/h
50	0.73	4.12	0.55	5.41	0.79	3.79	1.23	2.44
100	1.16	5.16	1.09	5.52	1.19	5.04	1.81	3.31
150	1.60	5.64	-	-	1.59	5.65	2.40	3.75
200	-	-	-	-	1.99	6.02	2.98	4.03
250	-	-	-	-	2.39	6.27	3.56	4.21
300	-	-	-	-	2.79	6.45	4.15	4.34
Average speed *Prosječna brzina*		4.67		5.28		5.59		3.54

Times of an unloaded Ecotrac tractor (Kutjevo) along the skid trail and the felling site:

$$y = 0.52192 + 0.00761\ x,\ r = 0.91004;\ fr = 0.50213$$

Times of an unloaded Torpedo tractor (Pleternica) along the skid trail and the felling site:

$$y = 0.72907 + 0.00787\ x,\ r = 0.76993;\ fr = 0.71707$$

Time of an unloaded Ecotrac tractor (Pleternica) along the skid trail and the felling site:

$$y = 1.04522 + 0.0991\ x,\ r = 0.87636;\ fr = 0.76296$$

Table 25 shows the movement of unloaded tractors, their time consumption and how their speed develops for skidding distances from 50 to 600 m, as well as their average speeds.

In the driving of unloaded tractors along the skid trail and the felling site for distances of 100 m, the EK took the least time – 1.28 minutes, and the EP took the most time – 2.04 minutes, or 36.3% more than the EK. At a distance of 400 m, the EK took the least time – 3.57 minutes – and the EP the most time – 5.01 minute – or 25.5% more than the EK. In covering the same distance, Torpedo tractors took 3.80 minutes at Kutjevo, and at Pleternica 3.88 minutes.

The lowest average speed along the skid trail and the felling site of unloaded tractors was achieved by the Ecotrac tractor (Pleternica) – 4.09 km/h – and the highest – 5.97 km/h – by the Ecotrac tractor (Kutjevo).

Table 25. Driving time and speeds of unloaded tractors along the skid trail and the felling site depending on the skidding distance and the average speed

Tablica 25. Vrijeme vožnje i brzine kretanja neopterećenih traktora po vlaci i sječini u ovisnosti o udaljenosti privlačenja te prosječne brzine kretanja

Skidding distance *Udaljenost privlačenja*	Auxiliary landing travell - unloaded tractors *Vožnja po pomoćnom stovarištu - neopterećeni traktori*							
	Kutjevo				Pleternica			
	Torpedo		Ecotrac		Torpedo		Ecotrac	
	Time consumption *Utrošak vremena*	Moving speed *Brzina kretanja*	Time consumption *Utrošak vremena*	Moving speed *Brzina kretanja*	Time consumption *Utrošak vremena*	Moving speed *Brzina kretanja*	Time consumption *Utrošak vremena*	Moving speed *Brzina kretanja*
m	min	km/h	min	km/h	min	km/h	min	km/h
50	0.97	3.09	0.90	3.32	1.12	2.67	1.54	1.95
100	1.38	4.36	1.28	4.68	1.52	3.96	2.04	2.95
150	1.78	5.06	1.66	5.41	1.91	4.71	2.53	3.55
200	2.18	5.50	2.04	5.87	2.30	5.21	3.03	3.96
250	2.59	5.80	2.42	6.19	2.70	5.56	3.52	4.26
300	2.99	6.02	2.81	6.42	3.09	5.83	4.02	4.48
350	3.39	6.19	3.19	6.59	3.48	6.03	4.51	4.65
400	3.80	6.32	3.57	6.73	3.88	6.19	5.01	4.79
450	4.20	6.43	3.95	6.84	4.27	6.32	5.51	4.90
500	4.60	6.52	4.33	6.93	-	-	6.00	5.00
550	5.01	6.59	4.71	7.01	-	-	6.50	5.08
600	5.41	6.65	5.06	7.11	-	-	-	-
Average speed *Prosječna brzina*		5.60		5.97		5.09		4.09

The lowest average speed along the skid trail and the felling site was 9.5% higher than the lowest average speed achieved at the auxiliary landing. The highest speed of unloaded tractors was achieved at the auxiliary landing, which was 39.5% higher than that along the skid trail and the felling site. Bojanin (1982 and 1980) gives a speed of 4.16 km/h for an unloaded adapted agricultural tractor moving on a mountainous area and 4.12 km/h for a lowland area. On a lowland area (Krpan 1984), unloaded IMT 558 tractors were reported to move on a microelevation at an average speed of 5.02 km/h, and on a microdepression and wet depression at 6.52 km/h and 6.70 km/h respectively.

THE TIME AND SPEED OF LOADED TRACTORS ALONG THE SKID TRAIL AND FELLING SITE
VRIJEME I BRZINE VOŽNJE OPTEREĆENIH TRAKTORA PO VLACI I SJEČINI

The times of loaded tractors along the skid trail and felling site and their speeds for distances ranging from 50 to 550 m are shown in Table 26 for both tractors.

Loaded tractors moved downhill along the skid trail and the felling site. Over a distance of 100 m, the Ecotrac tractor at Kutjevo took the least time – 1.61 minutes – and the most time was taken by the Ecotrac at Pleternica – 2.25 minutes. At 400 m, the Ecotrac at Kutjevo took 3.40 minutes, and the Ecotrac at Pleternica took the most time – 5.84 minutes.

For a distance of 100 m, a loaded Ecotrac tractor at Kutjevo took 0.33 minutes, or 20.5% more time than an unloaded one, and for a distance of 400 m, 0.17 minutes, or 4.8% less time than an unloaded tractor.

For a distance of 100 m, a loaded Ecotrac tractor at Pleternica took 0.21 minutes, or 9.3% more time than an unloaded one, and for 400 m, 0.83 minutes or 14.2% more time than an unloaded tractor. The regression equations are as follows:

Time of a loaded Torpedo tractor (Kutjevo) along the skid trail and the felling site:

$$y = 1.06325 + 0.00803\ x,\ r = 0.76690;fr = 0.65686$$

Time of a loaded Ecotrac tractor (Kutjevo) along the skid trail and the felling site:

$$y = 1.01757 + 0.00596\ x,\ r = 0.76841;fr = 0.71480$$

Time of a loaded Torpedo tractor (Pleternica) along the skid trail and the felling site:

$$y = 1.26979 + 0.00969\ x,\ r = 0.73579;fr = 0.98960$$

Table 26. Driving time and speeds of loaded tractors along the skid trail and the felling site, depending on skidding distance and average speed

Tablica 26. Vrijeme vožnje i brzine kretanja opterećenih traktora po vlaci i sječini u ovisnosti o udaljenosti privlačenja te prosječne brzine kretanja

Skidding distance *Udaljenost privlačenja*	Auxiliary landing travell - unloaded tractors *Vožnja po pomoćnom stovarištu - neopterećeni traktori*							
	Kutjevo				Pleternica			
	Torpedo		Ecotrac		Torpedo		Ecotrac	
	Time consumption *Utrošak vremena*	Moving speed *Brzina kretanja*	Time consumption *Utrošak vremena*	Moving speed *Brzina kretanja*	Time consumption *Utrošak vremena*	Moving speed *Brzina kretanja*	Time consumption *Utrošak vremena*	Moving speed *Brzina kretanja*
m	min	km/h	min	km/h	min	km/h	min	km/h
50	1.46	2.05	1.32	2.28	1.75	1.71	1.66	1.81
100	1.87	3.22	1.61	3.72	2.24	2.68	2.25	2.66
150	2.27	3.97	1.91	4.71	2.72	3.31	2.85	3.16
200	2.67	4.50	2.21	5.43	3.21	3.74	3.45	3.48
250	3.07	4.89	2.51	5.98	3.69	4.06	4.05	3.71
300	3.47	5.18	2.81	6.41	4.18	4.31	4.64	3.88
350	3.87	5.42	3.10	6.77	4.66	4.51	5.24	4.01
400	4.27	5.61	3.40	7.05	5.14	4.67	5.84	4.11
450	4.68	5.77	3.70	7.30	5.63	4.80	6.44	4.19
500	-	-	4.00	7.50	-	-	7.03	4.26
550	-	-	4.30	7.68	-	-	-	-
Average speed *Prosječna brzina*		4.45		5.82		3.70		3.48

Time of a loaded Ecotrac tractor (Pleternica) along the skid trail and the felling site:

$$y = 1.05886 + 0.01195\ x,\ r = 0.79889;fr = 1.13172$$

The speeds of loaded tractors along the skid trail and the felling site are shown in Table 26. The lowest speed at 100 m was achieved by the Ecotrac (Pleternica) – 2.66 km/h, and the highest by the Ecotrac (Kutjevo) – 3.72 km/h.

At distances ranging from 50 to 100 m, the speeds of the tractors differed only marginally. At a distance of 450 m, the differences were significant, because the lowest speed of 4.19 km/h was recorded by the Ecotrac (Pleternica), and the highest speed of 7.30 km/h by the Ecotrac (Kutjevo), which was 42.6% higher.

The lowest average speed of 3.48 km/h was recorded by the Ecotrac (Pleternica), while the highest average speed of 5.92 km/h was achieved by the Ecotrac (Kutjevo), which is 41.2% higher. This difference cannot be justified by the mean volume of the load, which was almost identical – 1.12 m^3 and 1.18 m^3 respectively – but by the personality of one of the drivers.

The average speeds of loaded IMT 558 tractors in lowland conditions for dry weather (Krpan, 1984) ranged from 4.29 to 5.89 km/h. Bojanin (1982) records

Figure 14. Driving a loaded Ecotrac V – 11 – 1033F at the felling site
Slika 14. Vožnja opterećenog traktora Ecotrac V - 11 - 1033F po sječini

that adapted agricultural tractors in mountainous conditions achieved speeds of 5.03 and 2.64 km/h.

DAILY TIMES OF THE TEAM
DNEVNA VREMENA SKUPINE

EFFECTIVE AND ALLOWANCE TIME OF THE TEAM
EFEKTIVNO I DODATNO VRIJEME SKUPINE

Table 27 shows the effective and allowance time for parts of a team and the time of a team in one day. At the Kutjevo work site the team worked in pairs. The first pair consisted of a cutter and a tractor driver with a Torpedo tractor, and the second pair consisted of a cutter and a tractor driver with an Ecotrac.

The first pair spent 318.16 min/day of effective time. The cutter spent this time in cutting trees of a mean DBH of 20.2 cm and the tractor in skidding loads of a mean volume of 1.20 m^3 at an average distance of 254 m.

The second pair spent 302.55 min/day of effective time. The cutter spent this time in cutting trees of a mean DBH of 21.1 cm, and the tractor driver in skidding loads of a mean volume of 1.12 m^3 at an average distance of 238 m.

Allowance time amounted to 149.66 min/day for the first pair and 149.71 min/day for the second pair.

Inspection at the auxiliary landing was carried out by one cutter and it took him only 62.38 min/day of effective time and 42.01 min/day of allowance time, which made up a total of 104.39 min/day, or 10.2% of team time. Total inspection time took up 21.7% of a 480-minute long working day.

Effective team time at Kutjevo amounted to 683.09 min/day or 66.7% of total time. Allowance time amounted to 341.38 min/day or 33.3% of total team time. The time of felling and processing for both cutters amounted to 164.06 min/day or to 16%, and allowance time to 185.65 min/day or to 18.1% of total team time. The consumption of time for both cutters on binding the tractor load amounted to 111.24 min/day or to 10.9% of total team time.

Effective time for the work of the cutter and the tractor amounted to 620.71 min/day, or to 60.6% of total time, that is, to 90.9% of effective team time.

At the Pleternica work site, one cutter and two tractors achieved the effective time of 547.01 min/day, or of 58.8% of total time, that is, 85.8% of effective team time. Allowance time amounted to 222.43 min/day or to 23.9% of total time. The Torpedo tractor skidding at Pleternica achieved 213 min/day, while the Ecotrac tractor achieved 157.91 min/day, that is, 371.18 min/day, or 39.9% of total time, that is, 58.2% of effective team time for both tractors together.

The cutters' allowance time amounted to 112.93 min/day or to 12.1%, and that of tractor drivers amounted to 11.8% of total team time, which makes a total of 23.9%.

The total times of cutters and tractors amounted to 769.44 min/day or to 82.7% of total team time.

Table 27. Times of a team according to the working day and work sites
Tablica 27. Vremena skupine po radnom danu i radilištima

Type of time and working operations *Vrsta vremena i radnih zahvata*		Team in Kutjevo *Skupina u Kutjevu*					Team in Pleternica *Skupina u Pleternici*				
		Cutter and Torpedo *Sjekač i Torpedo*	Cutter and Ecotrac *Sjekač i Ecotrac*	Total time *Ukupno vrijeme*	Percentage per *Postotni udio prema*		Torpedo	Ecotrac	Total time *Ukupno vrijeme*	Percentage per *Postotni udio prema*	
					total time *ukupnom vremenu*	effective time *efektivnom vremenu*				total time *ukupnom vremenu*	effective time *efektivnom vremenu*
		min/day *min/dan*			%		min/day *min/dan*			%	
Effective time *Efektivno vrijeme*	Cutting and processing *Sječa i izradba*	77.62	86.44	164.06	16.0	24.0	169.53		169.53	18.2	26.6
	Binding load *Vezanje tovara*	45.46	65.78	111.24	10.9	16.3	6.3		6.30	0.7	1.0
	Auxiliary landing work *Rad na pomoćnom stovarištu*	4.19	0.16	4.35	0.4	0.6	-		0.00	0.0	0.0
	Skidding *Privlačenje**	190.89	150.20	341.06	33.3	49.9	213.27	157.9	371.18	39.9	58.2
	Total time *Ukupno vrijeme*	318.16	302.60	620.71	60.6	90.9	547.01		547.01	58.8	85.8
Allowance time *Dodatno vrijeme*	Cutter *Sjekač*	93.82	91.83	185.65	18.1		112.93		112.93	12.1	

	Tractor *Traktor*	55.84	57.88	113.72	11.1		56.68	52.82	109.50	11.8	
	Total time *Ukupno vrijeme*	149.66	149.70	299.37	29.2		222.43		222.43	23.9	
Total cutter and tractor, min *Ukupno sjekač i traktor, min*		467.82	452.30	920.08	89.8		769.44		769.44	82.7	
Timber inspection *Preuzimanje*	Effective time *Efektivno vrijeme*			62.38	6.1	9.1			90.61	9.7	14.2
	Allowance time *Dodatno vrijeme*			42.01	4.1				70.89	7.6	
	Total time *Ukupno vrijeme*			104.39	10.2				161.50	17.3	
Team time *Vrijeme skupine*	Effective time *Efektivno vrijeme*			683.09	66.7	100.0			637.62	68.5	100.0
	Allowance time *Dodatno vrijeme*			341.38	33.3				293.32	31.5	
	Total time *Ukupno vrijeme*			1024.47	100.0				930.94	100.0	
Prescribed team time of 480 min/day x no. of members, min *Propisano vrijeme skupine od 480 min/dan x br. članova, min*				2400.0					1920.0		
Percentage of team time in total time, % *Postotni udio vremena skupine u ukupnom vremenu, %*				42.7					48.5		

*Mean skidding distance of tractors according to table 20 - * *Srednja udaljenost privlačenja traktora prema tablici 20*

A cutter at the Pleternica work site took 90.61 min/day or 9.7% of total time, that is, 14.2% of effective team time for inspection at the felling site. The proportion of inspection time amounted to 161.50 min/day, or to 17.3% of total team time. According to the daily time schedule of 480 minutes, this amounted to only 33.6%.

Effective team time at the Pleternica work site amounted to 637.62 min/day or to 68.5%, and allowance time amounted to 293.32 min/day, or to 31.5% of total team time.

The total time of the Kutjevo team amounted to 1,024.47 min/day or to 42.7%, and that of the Pleternica team amounted to 930.94 min/day or 48.5% of scheduled working time.

STANDARD TIME AND EFFICIENCY
NORME VREMENA I UČINKA

STANDARD TIMES AND DAILY OUTPUT OF CUTTERS
NORME VREMENA I DNEVNI UČINAK SJEKAČA

Different variants of the standard time of cutters are shown in Table 28. The cutters worked in three different forms of organisation, that is, in three different

Table 28. Standard times and daily output of cutters at felling, processing and inspection according to variants

Tablica 28. Norme vremena i dnevni učinak sjekača pri sječi, izradbi i preuzimanju po inačicama

Working operations *Radne operacije*			Working site Kutjevo *Radilište Kutjevo*					
			Cutter with Torpedo *Sjekač uz Torpedo*			Cutter with Ecotrac *Sjekač uz Ecotrac*		
			Effective time *Efektivno vrijeme*	Allowance time *Dodatno vrijeme*	Total time *Ukupno vrijeme*	Effective time *Efektivno vrijeme*	Allowance time *Dodatno vrijeme*	Total time *Ukupno vrijeme*
Variant 1 *Inačica 1*	Felling *Sječa*	min/m *min/m³*	4.07	1.05	5.12	4.07	1.05	5.12
	Processing separated from felling *Izradba odvojeno od sječe*		6.72	7.56	14.28	6.25	5.56	11.81
	Inspection at the auxiliary landing *Preuzimanje na pom. stov.*		6.21	4.19	10.40	6.21	4.19	10.40
	Total *Ukupno*		17.00	12.80	29.80	16.53	10.80	27.33
	Daily output, m³/day *Dnevni učinak, m³/dan*		16.11			17.56		

Variant 2 *Inačica 2*	Felling and processing simultaneously *Sječa i izradba istovrem.*	min/m *min/m³*	10.26	7.56	17.82	9.22	5.56	14.78
	Inspection at the auxiliary landing *Preuzimanje na pom. stov.*		6.21	4.19	10.4	6.21	4.19	10.4
	Total *Ukupno*		16.47	11.75	28.22	15.43	9.75	25.18
	Daily output, m³/day *Dnevni učinak, m³/dan*		17.01			19.06		
			Working site Pleternica *Radilište Pleternica*					
Variant 3 *Inačica 3*	Felling and processing simultaneously *Sječa i izradba istovrem.*	min/m *min/m³*	10.17	6.53	16.70			
	Inspection at the felling site *Preuzimanje u sječini*		5.16	4.18	9.34			
	Total *Ukupno*		15.33	10.71	26.04			
	Daily output, m³/day *Dnevni učinak, m³/dan*		18.43					

variants. In variant 1, the cutters cut the trees which they processed only 6 days later, which means that processing and felling were carried out at different times. In variant 2, the remaining standing trees were cut, and the felling and processing took place at the same time. The inspection of wood assortments for variant 1 and 2 was carried out at the auxiliary landing. In variant 3, cutting and processing was carried out at the same time, and the inspection followed immediately at the felling site after which finished wood assortments were skidded.

In variant 1, the total time of cutters with the TK amounted to 19.40 min/m³, and in variant 2 to 17.82 min/m³. The total time of cutters with the Ecotrac in variant 1 amounted to 16.93 min/m³, and in variant 2 to 14.78 min/m³. The inspection time for variants 1 and 2 amounted to an average of 10.4 min/m³. In variant 3, the total time of cutters amounted to 16.70 min/m³, of which 9.34 min/m³ for inspection.

The realised standard time was the lowest with cutters working alongside the Ecotrac in variant 2 – 25.18 min/m³ - and the highest with cutters working alongside the Torpedo in variant 1 – 29.80 min/m³.

According to the data shown in the Table, the daily output for 52 days amounted to 16.11 m³/day with cutters working alongside the Torpedo in variant 1, that is, 19.06 m³/day with cutters working alongside the Ecotrac in variant 2.

Allowance time ranged from 5.56 min/m³ with cutters working alongside the Torpedo in variant 1, to 6.53 min/m³ with cutters in variant 3 at Pleternica,

STANDARD TIME AND EFFICIENCY OF TRACTORS
NORME VREMENA I NORME UČINKA TRAKTORA

The standard time and efficiency of the Torpedo tractor at both work sites is shown in Table 29. At the Kutjevo work site, the standard time was calculated for a distance of 50 to 600 m, as the movement of the tractor was measured along the skid trail and the felling site. Table 30 shows the data of the Ecotrac tractor at both work sites for distances ranging from 50 to 550 m.

The standard time has been calculated as the average time consumed in skidding one unit of product over the mentioned distances, and its components are variable and fixed times, which make up effective time and allowance time. Variable time is made up of a sum of the times it takes to drive loaded and unloaded tractors along the skid trail, the felling site and the auxiliary landing, and fixed times are made up of all the working operations at the felling site and at the auxiliary landing.

From the total time consumed in one cycle and the average load volume, we can calculate the standard time per m³ of skidded timber. This ratio can be expressed with the following formula:

$$N_v = \frac{t}{q} \text{ (min/ m}^3\text{)}$$

where N = standard time, t = total time of one cycle (min)
q = average load volume (m³).

The daily output is calculated on the basis of the standard time or on the daily number of cycles and average load. When we use the standard time, the daily output is obtained by dividing the daily time in minutes by the respective quota. The number of cycles were calculated from the regulated work schedule (480 minutes) and total cycle time. The daily quota was calculated by multiplying the average number of daily cycles by the average load volume, as shown in the following formula:

$$U = N\,q \text{ (m}^3\text{/day)},$$

where U = daily output, N = number of cycles per day, q = average load volume (m³).

When calculating the decline in efficiency, the performance at a distance of 50 m is taken as value 1. With an increase in skidding distance, the daily output deteriorates, and this deterioration is best shown by the factor of the decline in efficiency.

Average efficiency is obtained on the basis of average data determined through mathematical-statistical methods, without evaluating the degree of efficiency

(Krpan, 1984). The degree of efficiency, according to the same author, is the ratio between real and regular efficiency. Regular efficiency is the output of a capable, skilful and thoroughly-well prepared worker, during and in the middle of the shift, who uses previously established breaks.

When calculating the standard time, usually the average output achieved is taken as the regular output. In teamwork, the tractor with all its features, as well as the conditions of the terrain, affect the performance of the cutter's daily output. According to the valid standard times at felling and processing, the daily output is recorded in the cutter's work order, so that he tries to fulfil the set task. When the tractor skidding distances are small, the cutter must engage more effort because he is preparing a larger quantity of wood, and when the distances are longer, he needs less effort to prepare smaller quantities of wood, so that the tractor can carry on with the skidding without waiting around.

The standard time and efficiency of the Torpedo and Ecotrac tractors are shown in Tables 29 and 30. The increasing trend of the standard time as distance grows is shown in Figure 15, and the tendency of the daily output to deteriorate with the increase in distance is presented in Figure 16.

Although the working conditions of all four tractors were similar, when calculating daily output, a great difference was seen between the Ecotrac at Pleternica and the other tractors. The decline in efficiency was the consequence of the lower speeds of loaded and unloaded tractors. According to Table 20, the average load volume of the Ecotrac tractor at Pleternica amounted to 1.18 m^3, while that of the Ecotrac at Kutjevo was 0.06m^3 smaller. The load of the Torpedo at Kutjevo was 0.02 m^3 larger, and that of the Torpedo at Pleternica was 0.04m^3 larger. The larger load volume had a direct impact on the daily output of the Torpedo at Pleternica when compared with the other tractors.

The unloaded Torpedo tractor at Kutjevo moving along the skid trail and felling site took 0.97 minutes at a distance of 50 m, and up to 5.41 minutes at a distance of 600 m. The Torpedo at Pleternica took 1.12 minutes for 50 m, and up to 4.27 minutes at a distance of 450 m.

The time of the unloaded Ecotrac at Kutjevo along the skid trail and the felling site ranged from 0.90 minutes for a distance of 50 m, to 4.71 minutes for a distance of 550 m. The Ecotrac at Pleternica took from 1.54 minutes for 50 m, to 6.50 minutes for a distance of 550 m (Table 30).

The time of the loaded Torpedo tractors at Kutjevo, moving along the skid trail and the felling site, ranged from 1.46 minutes for a distance of 50 m, to 5.88 minutes for a distance of 600 m. The time of the Torpedo at Pleternica ranged from 1.52 minutes for 50 m, to 5.63 minutes for a distance of 450 m.

The time of the loaded Ecotrac tractor on the Kutjevo work site ranged from 1.32 minutes for a distance of 50 m, to 4.30 minutes for a distance of 550 m. The Ecotrac at Pleternica took from 1.66 minutes to 7.63 minutes to cover the same distances.

The time consumption of the unloaded Torpedo tractor at the auxiliary landing at Kutjevo ranged from 0.49 minutes to 4.21 minutes for distances of 50 m to 450 m.

The unloaded Ecotrac tractor on the auxiliary landing at Kutjevo took from 0.39 minutes to 2.79 minutes for distances of 50 m to 550 m, and the Ecotrac at Pleternica from 0.96 minutes to 7.48 minutes to cover the same distances.

The loaded Torpedo tractor at the auxiliary landing at Kutjevo took from 0.73 minutes to 5.49 minutes for distances ranging from 50 to 600 m, and the Torpedo at Pleternica from 0.79 minutes to 3.99 minutes for distances from 50 to 450 m.

The time consumption of the loaded Ecotrac tractor at the auxiliary landing at Kutjevo ranged from 0.56 minutes to 5.20 minutes for distances from 50 to 550 m, and to cover the same distances the Ecotrac at Pleternica took 1.23 to 7.06 minutes.

The total variable times of the Torpedo at Kutjevo ranged from 3.66 minutes to 21.00 minutes for distances ranging from 50 m to 600 m, while those of the Torpedo at Pleternica ranged from 4.09 minutes to 16.06 minutes for distances from 50 to 450 m. The total variable times of the Ecotrac at Kutjevo ranged from 3.17 minutes to 16.99 minutes, and those of the Ecotrac at Pleternica from 5.39 minutes to 28.67 minutes for distances ranging from 50 to 550 m.

The fixed time of the Torpedo tractor at Kutjevo amounted to 19.59 minutes, of which work in the stand took 14.91 minutes and work at the auxiliary landing 4.68 minutes. The total fixed time of the Torpedo at Pleternica amounted to 29.05 minutes, of which work in the stand took 18.42 minutes, and work at the auxiliary landing 10.63 minutes. The total of the fixed time of the Ecotrac at Kutjevo amounted to 19.22 minutes, of which work in the stand took 15.33 minutes and work at the auxiliary landing 3.89 minutes. For the Ecotrac at Pleternica, the total fixed time amounted to 23.82 minutes, including 13.23 minutes of work in the stand and 10.59 minutes of work at the auxiliary landing.

Effective tractor working time is made up of the total of variable and fixed times for determined distances. For the Torpedo tractor at Kutjevo, this ranged from 23.25 minutes to 40.59 minutes for distances ranging from 50 to 600 m, and for the Torpedo at Pleternica, from 33.13 minutes to 45.10 minutes for distances from 50 to 450 m. The effective time of the Ecotrac at Kutjevo ranged from 22.39 minutes to 36.21 minutes, and that of the Ecotrac at Pleternica from 29.21 to 52.48 minutes for distances of 50 to 550 m.

Allowance time is determined as a percentage of effective time for each tractor separately, and is expressed in an absolute value. For the Torpedo at Kutjevo, it amounted to 23.6% of effective time and reached values from 5.49 minutes to 9.58 minutes. For the Torpedo at Pleternica, it amounted to 26.2% of effective time, and ranged from 8.68 minutes to 11.82 minutes. The percentage of allowance time of the Ecotrac at Kutjevo amounted to 26.8% of effective time, and ranged from 6 minutes to 9.71 minutes. For the Ecotrac at Pleternica, allowance time amounted to 32.8%, which, on the measured skidding distances, ranged from 9.58 to 17.21 minutes of absolute value.

The total time per cycle of the Torpedo at Kutjevo ranged from 28.73 minutes to 50.17 minutes, while that of the Torpedo at Pleternica was between the range of 41.81 and 56.92 minutes. The total time of the Ecotrac at Kutjevo ranged from

Table 29. Standard time and efficiency of the Torpedo TD 75A tractors
Tablica 29. Norme vremena i učinci traktora Torpedo TD 75A

Skidding distance *Udaljenost privlačenja*	Skidding line and felling site travell *Vožnja po vlaci i sječini*		Auxiliary landing travell *Vožnja po pomoćnom stovarištu*		Sum of variable times *Zbir varijabilnih vremena*	Feling site work *Rad u sastojini*	Auxiliary landing work *Rad na pomoćnom stovarištu*	Sum of fixed times *Zbir fiksnih vremena*	Effective time *Efektivno vrijeme*	Allo-wance time *Dodatno vrijeme*	Total time per cycle *Ukupno vrijeme po turnusu*	Time standard *Norma vremena*	Number of cycles per day *Broj vožnji dnevno*	Daily output *Dnevni učinak*	Output coeffi-cient decrease *Faktoro padanja učinka*
	Unloaded tractor *Neopte-rećeni traktor*	Loaded tractor *Opterećeni traktor*	Unloaded tractor *Neopterećeni traktor*	Loaded tractor *Opte-rećeni traktor*											
m / *m*	min / *min*											min/m³ *min/m³*		m³/day *m³/dan*	
Ecotrac - Kutjevo															
50	0.97	1.46	0.49	0.73	3.66	14.91	4.68	19.59	23.25	5.49	28.73	23.94	16.7	20.05	1.00
100	1.38	1.87	0.83	1.16	5.23	14.91	4.68	19.59	24.82	5.86	30.68	25.57	15.6	18.77	0.94
150	1.78	2.27	1.17	1.60	6.81	14.91	4.68	19.59	26.40	6.23	32.63	27.19	14.7	17.65	0.88
200	2.18	2.67	1.51	2.03	8.39	14.91	4.68	19.59	27.98	6.60	34.58	28.82	13.9	16.66	0.83
250	2.59	3.07	1.85	2.46	9.96	14.91	4.68	19.59	29.55	6.97	36.53	30.44	13.1	15.77	0.79
300	2.99	3.47	2.18	2.89	11.54	14.91	4.68	19.59	31.13	7.35	38.48	32.06	12.5	14.97	0.75
350	3.39	3.87	2.52	3.33	13.12	14.91	4.68	19.59	32.71	7.72	40.43	33.69	11.9	14.25	0.71
400	3.80	4.27	2.86	3.76	14.69	14.91	4.68	19.59	34.28	8.09	42.37	35.31	11.3	13.59	0.68
450	4.20	4.68	3.20	4.19	16.27	14.91	4.68	19.59	35.86	8.46	44.32	36.94	10.8	13.00	0.65
500	4.60	5.08	3.54	4.63	17.85	14.91	4.68	19.59	37.44	8.84	46.27	38.56	10.4	12.45	0.62
550	5.01	5.48	3.88	5.06	19.42	14.91	4.68	19.59	39.01	9.21	48.22	40.18	10.0	11.95	0.60
600	5.41	5.88	4.21	5.49	21.00	14.91	4.68	19.59	40.59	9.58	50.17	41.81	9.6	11.48	0.57
Ecotrac - Pleternica															
50	1.12	1.52	0.65	0.79	4.09	18.42	10.63	29.05	33.13	8.68	41.81	26.46	11.5	18.14	1.00
100	1.52	2.34	0.84	1.19	5.90	18.42	10.63	29.05	34.94	9.15	44.09	27.91	10.9	17.20	0.95
150	1.91	2.72	1.03	1.59	7.25	18.42	10.63	29.05	36.30	9.51	45.81	28.99	10.5	16.56	0.91
200	2.30	3.21	1.22	1.99	8.72	18.42	10.63	29.05	37.77	9.90	47.66	30.17	10.1	15.91	0.88
250	2.70	3.69	1.41	2.39	10.19	18.42	10.63	29.05	39.24	10.28	49.52	31.34	9.7	15.32	0.84
300	3.09	4.18	1.60	2.79	11.66	18.42	10.63	29.05	40.71	10.66	51.37	32.51	9.3	14.76	0.81
350	3.48	4.66	1.79	3.19	13.12	18.42	10.63	29.05	42.16	11.05	53.21	33.68	9.0	14.25	0.79
400	3.88	5.14	1.97	3.59	14.59	18.42	10.63	29.05	43.63	11.43	55.06	34.85	8.7	13.77	0.76
450	4.27	5.63	2.16	3.99	16.06	18.42	10.63	29.05	45.10	11.82	56.92	36.02	8.4	13.32	0.73

Table 30. Standard time and efficiency of Ecotrac tractors
Tablica 30. Norme vremena i učinci traktora Ecotrac

Skidding distance *Udaljenost privlačenja*	Skidding line and felling site travell *Vožnja po vlaci i sječini*		Auxiliary landing travell *Vožnja po pomoćnom stovarištu*		Sum of variable times *Zbir varijabilnih vremena*	Feling site work *Rad u sastojini*	Auxiliary landing work *Rad na pomoćnom stovarištu*	Sum of fixed times *Zbir fiksnih vremena*	Effective time *Efektivno vrijeme*	Allowance time *Dodatno vrijeme*	Total time per cycle *Ukupno vrijeme po turnusu*	Time standard *Norma vremena*	Number of cycles per day *Broj vožnji dnevno*	Daily output *Dnevni učinak*	Output coefficient decrease *Faktoro padanja učinka*
	Unloaded tractor *Neopterećeni traktor*	Loaded tractor *Opterećeni traktor*	Unloaded tractor *Neopterećeni traktor*	Loaded tractor *Opterećeni traktor*											
m / *m*	min / *min*											min/m³ *min/m³*		m³/day *m³/dan*	
Ecotrac - Kutjevo															
50	0.90	1.32	0.39	0.56	3.17	15.33	3.89	19.22	22.39	6.00	28.39	25.35	16.9	18.93	1.00
100	1.28	1.61	0.63	1.03	4.55	15.33	3.89	19.22	23.77	6.37	30.15	26.92	15.9	17.83	0.94
150	1.66	1.91	0.87	1.49	5.93	15.33	3.89	19.22	25.16	6.74	31.90	28.48	15.0	16.85	0.89
200	2.04	2.21	1.11	1.96	7.32	15.33	3.89	19.22	26.54	7.11	33.65	30.05	14.3	15.98	0.84
250	2.42	2.51	1.35	2.42	8.70	15.33	3.89	19.22	27.92	7.48	35.40	31.61	13.6	15.18	0.80
300	2.81	2.81	1.59	2.88	10.08	15.33	3.89	19.22	29.30	7.85	37.16	33.18	12.9	14.47	0.76
350	3.19	3.10	1.83	3.35	11.46	15.33	3.89	19.22	30.69	8.22	38.91	34.74	12.3	13.82	0.73
400	3.57	3.40	2.07	3.81	12.85	15.33	3.89	19.22	32.07	8.59	40.66	36.31	11.8	13.22	0.70
450	3.95	3.70	2.31	4.27	14.23	15.33	3.89	19.22	33.45	8.96	42.41	37.87	11.3	12.67	0.67
500	4.33	4.00	2.55	4.74	15.61	15.33	3.89	19.22	34.83	9.34	44.17	39.44	10.9	12.17	0.64
550	4.71	4.30	2.79	5.20	16.99	15.33	3.89	19.22	36.21	9.71	45.92	41.00	10.5	11.71	0.62
Ecotrac - Pleternica															
50	1.54	1.66	0.96	1.23	5.39	13.23	10.59	23.82	29.21	9.58	38.79	32.88	12.37	14.60	1.00
100	2.04	2.25	1.62	1.81	7.72	13.23	10.59	23.82	31.54	10.34	41.88	35.49	11.46	13.52	0.93
150	2.53	2.85	2.27	2.40	10.05	13.23	10.59	23.82	33.87	11.11	44.97	38.11	10.67	12.59	0.86
200	3.03	3.45	2.92	2.98	12.38	13.23	10.59	23.82	36.19	11.87	48.07	40.73	9.99	11.78	0.81
250	3.52	4.05	3.57	3.56	14.70	13.23	10.59	23.82	38.52	12.63	51.16	43.35	9.38	11.07	0.76
300	4.02	4.64	4.22	4.15	17.03	13.23	10.59	23.82	40.85	13.40	54.25	45.97	8.85	10.44	0.72
350	4.51	5.24	4.87	4.73	19.36	13.23	10.59	23.82	43.18	14.16	57.34	48.59	8.37	9.88	0.68
400	5.01	5.84	5.52	5.31	21.68	13.23	10.59	23.82	45.50	14.92	60.43	51.21	7.94	9.37	0.64
450	5.51	6.44	6.18	5.89	24.01	13.23	10.59	23.82	47.83	15.69	63.52	53.83	7.56	8.92	0.61
500	6.00	7.03	6.83	6.48	26.34	13.23	10.59	23.82	50.16	16.45	66.61	56.45	7.21	8.50	0.58
550	6,50	7,63	7,48	7,06	28,67	13,23	10,59	23,82	52,48	17,21	69,70	59,07	6,89	8,13	0,56

28.39 minutes to 45.92 minutes, and that of the Ecotrac at Pleternica from 38.79 minutes to 69.70 minutes.

The standard time is expressed by the time consumption per unit of product for the shown distances. The standard time of the Torpedo tractor at Kutjevo ranged from 23.94 min/m³ to 41.81 min/m³, that of the Torpedo at Pleternica from 26.46 min/m³ to 36.02 min/m³, that of the Ecotrac at Kutjevo from 25.35 min/m³ to 41.00 min/m³, and that of the Ecotrac at Pleternica from 32.99 min/m³ to 59.07 min/m³.

The number of cycles for a 480-minute working day ranged from 16.9 for the Ecotrac at Kutjevo, to 6.9 for the Ecotrac at Pleternica.

Figure 15. Standard times of the tractors
Slika 15. Norme vremena traktora

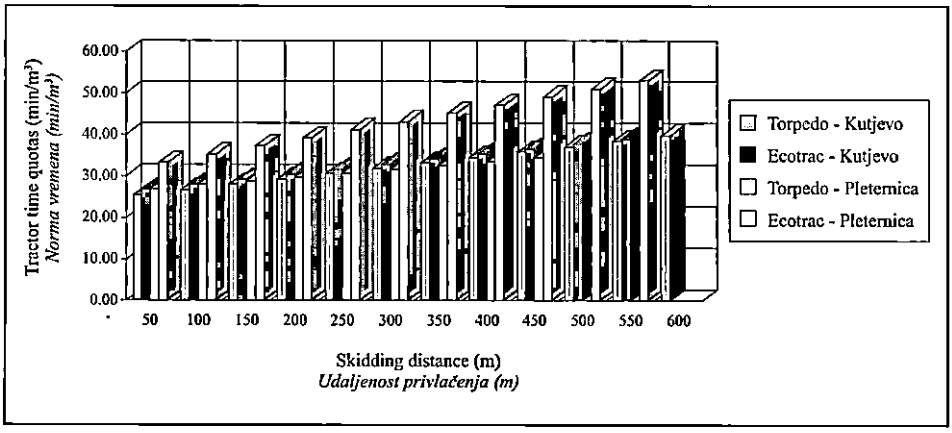
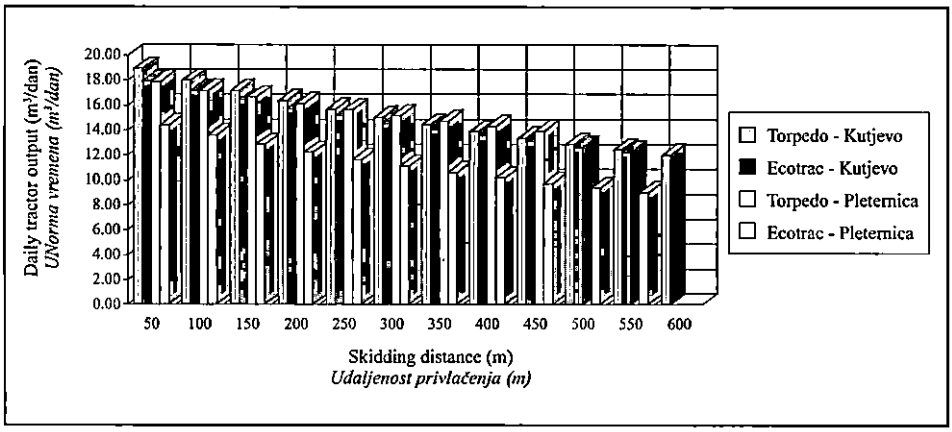


Figure 16. Daily output of the tractors
Slika 16. Dnevni učinci traktora



The daily output of the Torpedo tractor at Kutjevo ranged from 20.05 m³/day to 11.48 m³/day for distances of 50 to 600 m, that of the Torpedo at Pleternica from 11.48 m³/day to 8.43 m³/day for distances from 50 to 450 m, that of the Ecotrac at Kutjevo from 18.93 m³/day to 11.71 m³/day, and that of the Ecotrac at Pleternica from 14.60 m³/day to 8.13 m³/day for distances from 50 to 550 m.

STANDARD TIMES AND RELATIONSHIPS WITHIN THE TEAM
NORME VREMENA I ODNOSI U SKUPINI

Table 31 shows the standard times of the cutters (felling and processing) and those of the tractors, according to the variants for different skidding distances and their mutual relationships.

Since the standard time at inspection does not directly affect the standard time of the tractor, this relationship is not shown.

In the relationship between the standard times for felling and processing and the standard time of the Torpedo tractor (variant 1), it is evident that the tractor took 0.8 of the cutter's standard time for a distance of 50 m. For a distance of 100 to 200 m, it needed 0.7 of the cutter's standard time, while for 250 to 400m it took 0.6, and from 450 to 600 m it needed 0.5 of the cutter's standard time.

In the relationship between the standard time for processing and the standard time of a Torpedo tractor for a distance of 50 m, 0.6 of the cutter's standard time was taken. A distance ranging from 100 to 250 m took 0.5, and a distance from 300 to 600 m needed 0.4 of the cutter's standard time. In other words, at tractor skidding distances ranging from 100 to 600 m, one cutter could process the necessary quantity of wood to serve two tractors.

In variant 2, for a distance of 100 m, the Torpedo tractor needed 0.7 of the cutter's standard time, for distances ranging from 150 to 300 m it needed 0.6, for distances from 350 to 550 m it needed 0.5, and for 600 m it took 0.4 of the cutter's standard time. This means that, in variant 2, one cutter could serve two tractors only for distances starting from 350 m.

According to the data in Table 31 for the Ecotrac (Kutjevo) this relationship of standard times for variant 1 (felling + processing) amounted to 0.6 for distances ranging from 50 to 200 m, and 0.5 for distances from 250 to 450 m, and 0.4 for distances from 500 to 550 m. In variant 2, this relationship was disturbed only at the smallest distance of 50 m, but at larger distances this relationship was favourable and amounted to 0.5 up to distances of 250 m, and 0.4 for distances from 300 to 550 m.

According to the relationship between the processing standard time and the Ecotrac tractors, distances of 50 to 350 m took 0.4 of the cutter's standard time, while those ranging from 350 to 550 m took 0.3 of the cutter's standard time.

Table 32 shows the relationships between the standard time for felling and processing in variant 3 which amounted to 16.70 min/m³ and the standard time of the Torpedo and Ecotrac tractors. The standard time of the Torpedo was significantly lower than that of the Ecotrac, so the relationship according to the time

Table 31. Relationship of the standard time of the cutter for variant 1 and 2 and that of the tractors, according to skidding distances at the Kutjevo work site

Tablica 31. Odnos norme vremena sjekača za inačicu 1 i 2 te traktora prema udaljenostima privlačenja na radilištu Kutjevo

Skidding distance *Udaljenost privlačenja*	Standard time *Norma vremena*			Tractor standard time *Norma vremena traktora*	Standard time ratio *Odnos norme vremena*		
	Variant 1 *Inačica 1*		Variant 2 *Inačica 2*		Variant 1 / Tractorstandard time *Inačica 1 / N.v. traktora*		Variant 2 / Tractor standard time *Inačica 2 / N.v. traktora*
	Felling + processing *Rušenje + izradba*	Processing *Izradba*	Cutting + processing *Sječa i izradba*		Felling + processing *Rušenje + izradba*	Processing *Izradba*	Cutting + processing *Sječa i izradba*
m / *m*	min/m^3 / *min/m^3*						
Torpedo - Kutjevo							
50	19.40	14.28	17.82	25.32	0.8	0.6	0.7
100	19.40	14.28	17.82	26.64	0.7	0.5	0.7
150	19.40	14.28	17.82	27.95	0.7	0.5	0.6
200	19.40	14.28	17.82	29.26	0.7	0.5	0.6
250	19.40	14.28	17.82	30.58	0.6	0.5	0.6
300	19.40	14.28	17.82	31.89	0.6	0.4	0.6
350	19.40	14.28	17.82	33.21	0.6	0.4	0.5
400	19.40	14.28	17.82	34.52	0.6	0.4	0.5
450	19.40	14.28	17.82	35.83	0.5	0.4	0.5
500	19.40	14.28	17.82	37.15	0.5	0.4	0.5
550	19.40	14.28	17.82	38.46	0.5	0.4	0.5
600	19.40	14.28	17.82	39.78	0.5	0.4	0.4
Ecotrac - Kutjevo							
50	16.93	11.81	14.78	26.72	0.6	0.4	0.6
100	16.93	11.81	14.78	27.96	0.6	0.4	0.5
150	16.93	11.81	14.78	29.19	0.6	0.4	0.5
200	16.93	11.81	14.78	30.43	0.6	0.4	0.5
250	16.93	11.81	14.78	31.66	0.5	0.4	0.5
300	16.93	11.81	14.78	32.89	0.5	0.4	0.4
350	16.93	11.81	14.78	34.13	0.5	0.3	0.4
400	16.93	11.81	14.78	35.36	0.5	0.3	0.4
450	16.93	11.81	14.78	36.60	0.5	0.3	0.4
500	16.93	11.81	14.78	37.83	0.4	0.3	0.4
550	16.93	11.81	14.78	39.06	0.4	0.3	0.4

consumed in felling and processing was from 0.1 to 0.2 larger. The Torpedo tractor for distances of up to 200 m needed 0.6 of the cutter's standard time, and for distances from 250 to 450 m took 0.5 of the cutter's standard time.

With the Ecotrac tractor, the relationship of standard times was similar to that on the previous work site. For distances up to 100 m, the relationship between the standard times was 0.5, for distances from 100 to 400 m it amounted to 0.4, and for distances ranging between 450 to 550 m it was 0.3. We can conclude from this that with average effort one cutter could serve two tractors for distances ranging from 50 m to 450 m, and for distances ranging from 450 to 550 m such a cutter could even serve three tractors.

Table 32. Relationship between the cutters' and the tractors' standard times, according to distances at the Pleternica work site

Tablica 32. Odnos norme vremena sjekača za inačicu 3 i traktora prema udaljenostima na radilištu Pleternica

Skidding distance *Udaljenost privlačenja*	Standard time Variant 3 *Norma vremena Inačica 3*	Tractor standard time *Norma vremena traktora*		Standard time ratio *Odnos norme vremena*	
				Variant 3 / Tractor time st. *Inačica 3/ N. v. traktora*	Variant 3 / Tractor time st. *Inačica 3/ N. v. traktora*
		Torpedo	Ecotrac	Torpedo	Ecotrac
m / *m*	min/m³ *min/m³*				
50	16.70	26.81	33.27	0.6	0.5
100	16.70	27.96	35.24	0.6	0.5
150	16.70	28.82	37.22	0.6	0.4
200	16.70	29.75	39.19	0.6	0.4
250	16.70	30.68	41.16	0.5	0.4
300	16.70	31.61	43.14	0.5	0.4
350	16.70	32.53	45.11	0.5	0.4
400	16.70	33.46	47.08	0.5	0.4
450	16.70	34.39	49.05	0.5	0.3
500	16.70	-	51.02	-	0.3
550	16.70	-	53.00	-	0.3

COSTS OF TEAMWORK
TROŠKOVI RADA SKUPINE

CALCULATIONS AND COSTS OF THE CUTTERS
KALKULACIJE I TROŠKOVI SJEKAČA

To calculate the costs for all three models of production, the planned calculations from 1995 of the public enterprise "Croatian Forests", Zagreb, were used. The

calculation for a cutter in the cutting and inspection of wood was established on the basis of 200 working days a year. The calculations include the total reimbursement of costs to the workers, gross wages, and total compensations (contributions were 22.2% of gross wages), and others. In order to calculate the kuna value, the exchange rate of DEM1 = 3.7 kuna was used. The cost of one worker per day to the amount of 359.62 kuna, was reduced according to the new factor to 340.18 kuna.

Of this amount (359.62) the worker's share was 311.05 kuna, the share taken by the power saw amounted to 47.50 kuna, and additional tools accounted for 1.07 kuna.

CALCULATIONS AND COSTS OF TRACTORS
KALKULACIJE I TROŠKOVI TRAKTORA

As for the cutters, the calculations of the public enterprise "Croatian Forests", Zagreb, were also applied to the tractors, at the same exchange rate. The calculations consist of machine costs for the duration of 4 years, workers' costs, gross salaries and wage compensations in the process of production. These three points make up direct costs. General costs are allowance to direct costs at a rate of 45%, so, by including 5% profit to this calculation we can obtain the total cost of production, that is, total costs.

The daily cost of a Torpedo tractor amounted to 1,296.20 kn/day. By reducing this according to the current value of the German mark, we obtained the amount of 1,226.14 kn/day. Direct costs obtained in the same way amounted to 732.37 kn/day.

The daily cost of the Ecotrac tractor was 1,371.01 kn/day, or, in relation to the German mark, 1,296.90 kn, of which direct costs amounted to 764.84 kn.

PRODUCTION COSTS OF A WORKING TEAM
TROŠKOVI PROIZVODNJE RADNE SKUPINE

The costs of teamwork for three different models are shown in Tables 33 and 34. The standard time according to working operations and to variants was used in the calculation, as well as the daily output and the daily costs.

For model 1 in Table 33, the obtained figures are related to the figures for each individual worker. Cutter 1 (working alongside the Torpedo) took an average of 353.98 minutes a day, and cutter 2 (working alongside the Ecotrac) 354.98 minutes. A cutter took 301.44 minutes a day on average for inspection. The Torpedo tractor took an average of 400.59 min/day for an average distance of 254 m, and the Ecotrac 419.67 min/day for 238 m.

For model 2, the average achieved standard times of the current state of model 1 were applied, but for a 480-minute working day.

Model 3 relates to a 480-minute working day, and the formed standard times for all working operations.

Table 33. Daily output and costs of timber production of a team of workers at the Kutjevo work site

Tablica 33. Dnevni učinak i troškovi pridobivanja drva skupine radnika na radilištu Kutjevo

Working components *Radne sastavnice*			Work site Kutjevo *Radilište Kutjevo*					
			Model 1		Model 2		Model 3	
			Cutter 1 *Sjekač 1*	Cutter 2 *Sjekač 2*	Cutter 1 *Sjekač 1*	Cutter 2 *Sjekač 2*	Cutter 1 *Sjekač 1*	Cutter 2 *Sjekač 2*
Time standard, min/m³ *Norma vremena, min/m³*	Cutting and processing *Sječa i izradba*	Variant 1 *Inačica 1*	36.62	30.38	36.62	30.38	19.40	16.93
		Variant 2 *Inačica 2*	34.42	27.61	34.42	27.61	17.82	14.78
	Inspection *Preuzimanje*		19.33		19.33		10.40	
	Skidding *Privlačenje*	Torpedo	35.04		35.04		30.44	
		Ecotrac		42.05		42.05		31.61
Daily output, m³/day *Dnevni učinak, m³/dan*	Cutting and processing *Sječa i izradba*	Variant 1 *Inačica 1*	9.67	11.68	13.11	15.80	24.74	28.35
		Variant 2 *Inačica 2*	10.28	12.86	13.95	17.39	26.94	32.48
	Inspection *Preuzimanje*		15.59		24.83		46.15	
	Skidding *Privlačenje*	Torpedo	11.43		13.70		15.77	
		Ecotrac		9.98		11.41		15.18
Daily cost, kn/day *Dnevni trošak, kn/dan*	Cutting and processing *Sječa i izradba*	Variant 1 *Inačica 1*	340.18					
		Variant 2 *Inačica 2*	340.18					
	Inspection *Preuzimanje*		340.18					
	Skidding *Privlačenje*	Torpedo	1226.14				(723.37)*	
		Ecotrac	1296.9				(764.84)*	
Total cost per unit, kn/m³ *Ukupni trošak pojedinici, kn/m³*	Cutting and processing *Sječa i izradba*	Variant 1 *Inačica 1*	35.19	29.11	25.95	21.53	13.75	12.00
		Variant 2 *Inačica 2*	33.08	26.46	24.39	19.57	12.63	10.47
	Inspection *Preuzimanje*		21.82		13.70		7.37	
	Skidding *Privlačenje*	Torpedo	107.27		89.50		77.75	
		Ecotrac		129.95		113.66		85.43
	Total *Ukupno*	Variant 1 *Inačica 1*	164.29	180.88	129.15	148.89	98.87	104.80
		Variant 2 *Inačica 2*	162.17	178.23	127.59	146.93	97.75	103.28

Direct cost per unit, kn/m³ *Direktni trošak pojedinici, kn/m³*	Cutting and processing *Sječa i izradba*	Variant 1 *Inačica 1*	35.19	29.11	25.95	21.53	13.75	12.00
		Variant 2 *Inačica 2*	33.08	26.46	24.39	19.57	12.63	10.47
	Inspection *Preuzimanje*		21.82		13.70		7.37	
	Skidding *Privlačenje*	Torpedo	63.29		52.80		45.87	
		Ecotrac		77.33		67.03		50.38
	Total *Ukupno*	Variant 1 *Inačica 1*	120.30	128.27	92.45	102.26	66.99	69.75
		Variant 2 *Inačica 2*	118.19	125.61	90.89	100.30	65.87	68.23

* Direct tractor cost * *Direktni trošak traktora*

The standard time represents the average achieved standard time for the average working time of the cutter and the tractor.

The formed standard time represents a standard time that has been analytically processed. Effective time was statistically processed, and allowance time was studied by carrying out an analysis of each work interruption.

The standard times of 36.62 and 30.38 min/m³ respectively for felling and processing in variant 1, models 1 and 2, for cutters 1 and 2, make up the total time consumed in felling trees and the total time consumed in the subsequent processing of the same trees (effective time and delay times).

In felling and processing variant 2, the standard times for models 1 and 2 amount to 34.42 min/m³ and 27.61 min/m³ respectively. Cutter 1 took 2.20 min/m³, while cutter 2 took 2.77 min/m³, that is, 6% and 9.1% less time than in variant 1.

The formed standard time of variant 1 in model 3 is lower than the average standard time by 17.22 min/m³, or 47.0%, for cutter 1, and by 12.83 min/m³, or 46.5%, for cutter 2 in model 1.

The standard time of inspection at the auxiliary landing in models 1 and 2 amounts to 19.33 min/m³, and the formed standard time in model 3 amounts to 10.40 min/m³, that is, 46.2% lower.

The standard times of the tractors were obtained according to the average achieved skidding distances for models 1 and 2 (254 m and 238 m), whereas a skidding distance of 250 m was taken in model 3. In models 1 and 2 the average achieved standard times were applied, and in model 3 the formed standard times were used.

The achieved daily output in variant 2, model 2, was 26.3% higher (cutter 1) and 26.0% higher (cutter 2) than in model 1, and 2.6 and 2.5 times higher in model 3 when compared with model 1.

The achieved daily output at inspection was 1.6 times higher in model 2, and 3.0 times higher in model 3 than in model 1.

The obtained daily output of the Torpedo tractor in model 2 amounted to 13.70 m³/day, and that of the Ecotrac tractor 11.41 m³/day, which was 16.6% and 12.5% higher than in model 1.

The daily output of the Torpedo tractor in model 3 amounted to 15.77 m³/day and that of the Ecotrac tractor 15.18 m³/day, which was 27.2% and 34.2% higher than in model 1, and 12.7% and 24.7% higher than in model 2.

The cost of felling and processing in model 1 was the lowest for cutter 2, variant 2, amounting to 26.46 kn/m³, and was the highest for cutter 1, variant 1, amounting to 35.19 kn/m³.

The cost of felling and processing in model 2 was the lowest for cutter 2, variant 2, amounting to 19.57 kn/m³, and the highest for cutter 1, variant 1, amounting to 25.95 kn/m³.

The cost of felling and processing in model 3 was the lowest for cutter 2, variant 2, amounting to 10.47 kn/m³, and the highest for cutter 1, variant 1, amounting to 13.75 kn/m³.

The cost of cutter 2 and cutter 1 in model 2 was 26.0% and 26.3% lower respectively in relation to model 1. In model 3 in relation to model 1, it was 2.5 and 2.6 times lower, while in model 2, it was 1.9 times lower in relation to model 1 for both cutters.

The cost of inspection in model 1 amounted to 21.82 kn/m³, and in model 2 it amounted to 13.70 kn/m³, or 37.2 % less. In model 3, it amounted to 7.37 kn/m³, being 3 times lower than in model 1, and 1.9 times lower than in model 2.

The Torpedo tractor in model 1, for an average skidding distance of 254 m, had a total cost of 107.27 kn/m³, while the Ecotrac, for an average skidding distance of 238 m, had a cost of 129.95 kn/m³.

In model 2, the cost of the Torpedo tractor amounted to 89.50 kn/m³ which was 16.6% lower in relation to model 1, while the cost of the Ecotrac amounted to 113.66 kn/m³, which was 12.5% lower than in model 1.

In model 3, the cost of the Torpedo for a skidding distance of 250 m amounted to 77.75 kn/m³, which was 27.5% lower in relation to model 1, and 13.1% lower in relation to model 2. In model 3, the cost of the Ecotrac for a skidding distance of 250 m amounted to 85.43 kn/m³, and was 34.3% lower in relation to model 1, and 24.8% lower in relation to model 2.

The total cost of one unit of production (felling and processing, inspection and skidding) in model 1 for the first pair (cutter and Torpedo tractor) amounted to 164.29 kn/m³ in variant 1, and 162.17 kn/m³ in variant 2.

The second pair (cutter and Ecotrac tractor) in model 1 represented a total cost of 180.88 kn/m³ in variant 1, and 178.23 kn/m³ in variant 2, which was 9.2% higher than the first pair in variant 1, and 9.0% higher in variant 2.

In model 2, the total cost of the first pair in variant 1 amounted to 129.15 kn/m³, and that of the second pair 148.89 kn/m³, which was 21.4% and 17.7% lower than in model 1.

In model 2, the total cost of the first pair in variant 2 amounted to 127.59 kn/m³, and that of the second pair 146.93 kn/m³, which was 21.3% and 17.6% lower respectively than in model 1.

In model 3, the total cost of the first pair in variant 1 amounted to 98.87 kn/m³, and that of the second pair 104.80 kn/m³, which was 39.8% and 42.1% lower respectively than in model 1, and 23.4% and 29.7% lower than in model 2.

In model 3, the total cost of the first pair in variant 2 amounted to 97.75 kn/m³, and that of the second pair 103.28 kn/m³, which was 39.7% and 42.1% lower than in model 1, and 23.4% and 29.7% lower than in model 2.

The direct costs in model 1 were the lowest for the first pair in variant 2, amounting to 118.19 kn/m³, and the highest for the second pair in variant 1, amounting to 128.27 kn/m³. In model 2, for the same pair and the same variant, the cost was 90.89 kn/m³ and 102.26 kn/m³ respectively, and in model 3 it amounted to 65.87 and 69.75 kn/m³ respectively.

The direct costs of the first pair in variant 2 model 3 were 44.3% lower, and those of the second pair, variant 1, were 45.6% lower compared with model 1, while compared with model 2 the direct costs were 27.5% lower for the first pair and 31.8% lower for the second pair.

Table 34 shows the standard times, the daily output and the total and direct costs per m³ for models 1, 2 and 3 at the Pleternica work site. All three models were processed identically at both work sites.

A cutter spent a daily average of 423.35 minutes on felling and processing, and a worker (cutter) 423.45 minutes on inspection. The Torpedo tractor spent a daily average of 425.42 minutes at the work site, and the Ecotrac 427.34 minutes.

The standard time for felling and processing in models 1 and 2 for variant 3 amounted to 24.49 min/m³, and the formed standard time in model 3, variant 3, amounted to 16.70 min/m³, which was 31.8% lower than in models 1 and 2.

The standard time of variant 3 at Pleternica was 12.13 min/m³ less than the highest standard time achieved at Kutjevo in model 1 for the first cutter in variant 1. This standard time at Pleternica therefore amounted to 33.1% of the highest standard time at Kutjevo. It was also 3.12 min/m³ or 11.3% lower than the lowest standard time of the second cutter in variant 2.

The standard time for inspection amounted to 24.11 min/m³ in models 1 and 2, and 9.34 min/m³ in model 3, which was 2.6 times lower.

The standard time of the Torpedo tractor for models 1 and 2 amounted to 43.22 min/m³ for an average achieved skidding distance of 326 m, while the standard time of the Ecotrac tractor amounted to 61.82 min/m³ for an average distance of 344 m. In model 3, the average skidding distance of 350 m was taken for both tractors in order to determine the formed standard time.

The daily output of variant 3 in model 1 amounted to 17.29 m³/day, and in model 2 to 19.60 m³/day, which was 11.8% higher. In model 3, the daily output amounted to 28.74 m³/day, or was 39.8% higher than in model 1. The daily output of model 3 was 31.8% higher than that of model 2.

The daily output of inspection in model 1 amounted to 17.56 m³/day, and in model 2 it reached 19.91 m³/day, which was 11.8% higher, while in model 3 it

Table 34. Daily output and costs of timber logging of a team of workers at the Pleternica work site

Tablica 34. Dnevni učinak i troškovi pridobivanja drva skupine radnika na radilištu Pleternica

Working components *Radne sastavnice*			Working site Pleternica *Radilište Pleternica*		
			Model 1	Model 2	Model 3
Time standard, min/m³ *Norma vremena min/m³*	Cutting and processing *Sječa i izradba*	Variant 3 *Inačica 3*	24.49	24.49	16.70
	Inspection *Preuzimanje*		24.11	24.11	9.34
	Skidding *Privlačenje*	Torpedo	43.22	43.22	32.11
		Ecotrac	61.82	61.82	45.11
Daily output. m³/day *Dnevni učinak m³/dan*	Cutting and processing *Sječa i izradba*	Variant 3 *Inačica 3*	17.29	19.60	28.74
	Inspection *Preuzimanje*		17.56	19.91	51.39
	Skidding *Privlačenje*	Torpedo	9.84	11.11	14.95
		Ecotrac	6.91	7.76	10.64
Daily cost, kn/day *Dnevni trošak kn/dan*	Cutting and processing *Sječa i izradba*	Variant 3 *Inačica 3*	340.18		
	Inspection *Preuzimanje*		340.18		
	Skidding *Privlačenje*	Torpedo	1226.14		(723.37)*
		Ecotrac	1296.9		(764.84)*
Total cost per unit, kn/m³ *Ukupni trošak po jedinici kn/m³*	Cutting and processing *Sječa i izradba*	Variant 3 *Inačica 3*	19.37	17.36	11.84
	Inspection *Preuzimanje*		19.37	17.09	6.62
	Skidding *Privlačenje*	Torpedo	124.61	110.40	82.02
		Ecotrac	187.68	167.03	121.88
	Total *Ukupno*	Torpedo	163.35	144.85	100.48
		Ecotrac	226.43	201.47	140.34
Direct cost per unit, kn/m³ *Direktni trošak po jedinici kn/m³*	Cutting and processing *Sječa i izradba*	Variant 3 *Inačica 3*	19.37	17.36	11.84
	Inspection *Preuzimanje*		19.37	17.09	6.52
	Skidding *Privlačenje*	Torpedo	73.51	65.13	48.39
		Ecotrac	110.69	98.51	71.88
	Total *Ukupno*	Torpedo	112.26	99.58	66.75
		Ecotrac	149.43	132.95	90.23

* Direct tractor cost * *Direktni trošak traktora*

amounted to 51.39 m³/day, and was 2.9 times higher in relation to model 1, and 2.6 times higher in relation to model 2.

The daily output of the Torpedo tractor in model 1 amounted to 9.84 m³/day, and in model 2 it reached 11.11 m³/day, which was 11.4% higher. In model 3, it amounted to 14.25 m³/day, and was 30.9% higher in relation to model 1, and 22.0% in relation to model 2.

In model 1, the Ecotrac tractor achieved a daily output of 6.91 m³/day. In model 2, this performance was 7.76 m³/day, or 11.0% higher. In model 3, it amounted to 9.88m³/day, and was 30.1% higher than in model 1, and 21.5% higher than in model 2.

The costs of cutting and processing in variant 3, model 1, amounted to19.37 kn/m³. In model 3, the costs amounted to 17.36 kn/m³, and were 10.4% lower than in model 1, while in model 3 they amounted to 11.84 kn/m³ or 38.9% of model 1.

The cost of inspection in model 1 was equal to the cost of cutting and processing, while in model 2 this cost differed slightly. In model 3, it amounted to 6.62 kn/m³, which was 44.1% lower than the cost of cutting and processing.

The cost of the Torpedo tractor in model 1 amounted to 124.61 kn/m³. In model 2, it amounted to 110.40 kn/m³, or was 11.4% lower. In model 3, the cost amounted to 86.03 kn/m³ and was 31% lower than in model 1, and 22.1% lower than in model 2.

The Ecotrac tractor in model 1 achieved a cost of 187.68 kn/m³. In model 2, the cost was 167.03 kn/m³, or 11.0% lower. In model 3, the cost was 131.28 kn/m³, or 30.1% lower than in model 1, and 21.4% lower than in model 2.

The total cost of one unit of production with the Torpedo tractor in model 1 amounted to 163.35 kn/m³, and with the Ecotrac it reached 226.43 kn/m³, or was 27.9% higher. In model 2, the costs with the Ecotrac tractor were 28.1% higher, and in model 3 they were 30.2% higher than the total costs with the Torpedo tractor.

The cost with the TP in model 2 was 11.3% lower, and in model 3, 38.5% lower than in model 1. The cost with the Ecotract tractor was 11.0% lower in model 2, and 38.0% lower in model 3 than in model 1.

The total direct costs with a Torpedo tractor were 0.88 kn/m³ higher in model 3 than at the other work site with cutter 1, in variant 2, although the average skidding distance was 100 m greater. With the Ecotrac, these costs amounted to 22.0 kn/m³, which were 24.4% higher.

CONCLUSION
ZAKLJUČAK

Research was conducted on teamwork in the felling, processing, skidding and inspection of wood. The productivity was studied of two teams, the first made up of five, and the second of four workers. The work took place in thinning stands on approximately equal terrain and stand conditions.

At Kutjevo, work was carried out in two different ways, or in two variants. In variant 1, the felling was done before the vegetation period and before the engagement of the entire team. In the second case (variant 2), the trees were felled, and immediately processed into assortments which were then skidded and delivered to the auxiliary landing.

At the Pleternica work site, all the jobs were done simultaneously: felling and processing, bucking and timber inspection at the stump, and immediately after that, skidding by tractors to the auxiliary landing

The mean volume of the load of the TP tractor amounted to 1.58 m^3, that of the EP was 1.18 m^3, that of the TK was 1.20 m^3, while the smallest mean volume was that of the EK, which amounted to 1.12 m^3. The difference between the largest and smallest mean load volume was 29.1%. The mean volume of one piece in the load of the EK tractor was 0.151m^3, that of the TK tractor was 0.149 m^3, followed by that of the TP with 0.142 m^3, and that of the EP with 0.140 m^3.

A time analysis was made for felling, processing, timber inspection and skidding of wood at both work sites and for all three variants. The time study was carried out by using the repetitive chronometer method.

The effective time of the cutter working alongside the TK (cutter 1), variant 2, amounted to 35.95% of total time, and the effective time of the cutter alongside the EK (cutter 2) came to 42.93% of total time. Delay time amounted to 64.05% and 57.07% respectively. At the Pleternica work site, the effective time of a cutter amounted to 41.53% of total time, while delay time amounted to 58.47% of total time.

The allowance time of a cutter alongside a TK amounted to 73.7% of effective time, the allowance time of a cutter alongside an EK came to 60.3% of effective time, and at the Pleternica work site allowance time amounted to 64.2% of effective time. Such high allowance time for the cutter was a consequence of the small proportion of effective time in the working day. To obtain the optimal engagement of one cutter, two tractors would be necessary for skidding.

To inspect the wood assortments at the auxiliary landing at Kutjevo, effective time was 20.69% of total time. At the Pleternica work site, it amounted to 21.40% of total time. The average effective time for inspection at the auxiliary landing amounted to 6.21 min/m^3, and at the felling site it came to 5.16 min/m^3.

The allowance time of the cutter for the inspection of wood assortments at the auxiliary landing amounted to 67.35%, and at the felling site to 78.23%, which was 10.88% more. In order to increase the engagement of the timber inspectors, a larger number of tractors would be necessary for skidding timber, because in this way, waiting time would be turned into effective time.

When analysing the time of one cycle, equal distances were taken for all tractors: 300 m along the skid trail and the felling site, and 100 m along the auxiliary landing. The total time of a cycle was the lowest for the EK tractor, amounting to 32.38 minutes, and the highest total time was for the TP, amounting to 45.56 mi-

nutes, which was 13.18 minutes or 28.9% more. The total time of a cycle for the TK amounted to 33.18 minutes, while that of the EP came to 42.53 minutes.

In the structure of the total time of a cycle, effective time ranged from 75.3% for the EP to 80.9% for the TK. The share of work at the felling site for the EP was the smallest and amounted to 41.1%, while the EK had the largest share, which was 59.4% of effective time. When working at the auxiliary landing (unloading), the lowest effective time was that of the EK tractor (18.6%) and the highest was achieved by the EP tractor (1.8%).

The standard time for a skidding distance of 400 m was the lowest for the TP tractor, amounting to 34.85 min/m^3. When compared with the standard time of the TP, the time standard of the TK was 0.46 min/m^3 higher, and for the EK it was 1.46 min/m^3 higher, while the greatest difference of 16.36 min/m^3 was achieved by the EP. The volume of the load and the personality of the tractor driver had a significant impact on the time consumption of a loaded and unloaded tractor.

The work of cutters 1 and 2 in binding the load at Kutjevo amounted to 27.8% and 17.5% of the effective time of the tractor. For the same operation, the tractor driver took 11.9% and 15.0% of effective time. At Pleternica, the time relations were different for binding the load. The cutter and the inspector took 1.5% and 1.8% of effective time, and the tractor drivers took 22.4 and 23.3% of effective tractor time respectively.

The speeds of the unloaded tractors were generally lower along the skid trail and the felling site than at the auxiliary landing. Only the EP achieved a lower speed at the auxiliary landing. Its speed here was 0.39 km/h lower. The other average speeds of the unloaded tractors at the auxiliary landing ranged from 7.50 to 9.86 km/h, and along the skid trail and the felling site the average speeds ranged from 4.09 to 5.97 km/h.

The lowest average speed of a loaded tractor along the skid trail and the felling site was 3.48 km/h, and the highest average speed reached 5.82 km/h. At the auxiliary landing, loaded tractors achieved speeds ranging from 3.54 km/h to 5.59 km/h.

The effective time of a team of five workers at Kutjevo amounted to 683.09 min/day, or 66.7% of total time. Allowance time amounted to 341.38 min/day, or 33.3% of total team time. The effective working time of a cutter and a tractor amounted to 620.71 min/day, or 60.6% of total time, that is, 90.9% of effective team time.

In the 4-worker team at Pleternica, one cutter and two tractors achieved an effective time of 547.01 min/day, or 58.8% of total time, or 85.8 % of effective team time. The total time of the cutters and tractors amounted to 769.44 min/day, or 82.7% of total team time. The effective time of the team at the Pleternica work site amounted to 637.62 min/day, or 68.5% of total time, and allowance time came to 293.32 min/day, or 31.5% of total team time.

The total time of the Kutjevo team amounted to 1,024.47 min/day, or 42.7% of regulated working time, and that of the Pleternica team amounted to 930 min/day, or 48.5% of regulated working time.

The standard time for a skidding distance of 50 m with the TK amounted to 23.94 min/m³. With the EK, it was 1.41 min/m³ higher, with the TP it was 2.52 min/m³ higher, and with the EP it came to 8.94 min/m³ higher. For a skidding distance of 300 m, the differences were significant. Therefore, with the EP tractors, the difference was 13.91 min/m³ compared with the time of the TK tractor for the same distance.

The daily output of the TK ranged from 20.05 m³/day to 11.48 m³/day for distances of 50 to 600 m. The daily output of the TP ranged from 18.14 m³/day to 13.32 m³/day for skidding distances between 50 and 450 m. The daily output of the EK ranged from 18.93 m³/day to 11.71 m³/day for distances of 50 to 550 m, while the daily output of the EP, for the same distances, ranged from 14.60 m³/day to 8.13 m³/day.

The relations of the standard times for felling and processing according to the variants and the tractor standard times show that the burden was not balanced within the team. Within the range of skidding distances of 450 to 600 m, with the TK (variant 1), the relation between the cutter's standard time and that of the tractor was 0.5:1. This shows that for these skidding distances one cutter would be sufficient to serve two tractors. For smaller skidding distances, the ratio was from 0.6:1 to 0.8:1.

With the same tractor and in variant 1, the ratio of the standard time for processing and the standard time of skidding for skidding distances between 50 to 600 m ranged from 0.4:1 to 0.6:1. In variant 2, for distances of 50 to 600 m, the standard time ratio for the TK was from 0.4:1 to 0.7:1.

At the same work site, with the Ecotrac tractor, the relation of the standard time for felling and processing (separately) in variant 1 and the standard time for skidding, for distances ranging from 50 to 550 m, ranged from 0.4:1 to 0.6:1. For the same tractor and variant 1, the ratio of the processing standard time and the skidding standard time, for distances ranging from 50 to 550 m, was from 0.3:1 to 0.4:1. In variant 2, and for the same distances, the ratio was from 0.4:1 to 0.6:1.

At the Pleternica work site, the ratio of felling and processing standard times in variant 3, and the skidding standard time of the Torpedo tractor for skidding distances ranging from 50 to 450 m, was from 0.5:1 to 0.6:1, and that of the Ecotrac tractor, for distances ranging from 50 to 550 m, was from 0.3:1 to 0.5:1.

Costs were considered according to the variants, cost models and cutters. The direct cost of model 1 of the Kutjevo team was the lowest for cutter 1, variant 2, and amounted to 118.19 kn/m³, and the highest for cutter 2, variant 1, and amounted to 128.27 kn/m³. In model 2, the lowest cost, 90.89 kn/m³, was achieved by cutter 1 in variant 2, and the highest cost, 102.26 kn/m³, was that of cutter 2 in variant 1. The direct costs for cutter 1 in model 3, variant 1, amounted to 66.99 kn/m³, and in variant 2 they were 65.87 kn/m³.

The direct costs of the Pleternica team with the TP in model 2 were 11.3% lower, and in model 3, 38.5% lower than in model 1. The costs with the Ecotract were 11.0% lower in model 2 and 38.0% lower in model 3 when compared with

model 1. The direct costs of the Pleternica team with the Torpedo tractor were 0.88 kn/m³ higher in model 3 than at the Kutjevo work site for cutter 1 in variant 2, although the average skidding distance was 100 m greater. With the Ecotrac, these costs were 22.0 kn/m³, or 24.4%, higher.

Teamwork has been accepted in Croatian forestry and has brought about an improvement in production. However, this study on teamwork shows that imperfections exist in team organisation and indicates that there is a need for its optimisation. The factors studied in this work are the basis for improvements to be made in teamwork, in which working time will be better exploited and machines will be more effective, at the same time incurring lower costs. Only with such optimally organised teamwork will the advantages of teamwork over traditional work become fully evident.

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SKUPNI RAD PRI PROREDAMA U SASTOJINAMA POŽEŠKOGA GORJA S POSEBNIM OSVRTOM NA PRIVLAČENJE DRVA TRAKTORIMA

SAŽETAK

Klasični način rada pri eksploataciji šuma traje predugo jer su faze rada vremenski odvojene. Od sječe i izradbe pa do otpreme proizvoda proticalo je više mjeseci. Troškovi eksploatacije šuma uz stanje tržišta, odnosno ponudu i potražnju određene vrste drva i drvnih sortimenata zahtijevali su poboljšane metode rada u eksploataciji šuma. Rješenje za povećenje proizvodnosti treba tražiti u boljoj organizaciji rada i boljem iskorištavanju radnoga vremena. Jedan pokušaj boljega oblikovanja rada pri eksploataciji šuma bio je uvođenje skupnoga rada.

Prema broju izvođača u proizvodnom procesu razlikuje se pojedinačni i skupni rad. Skupni je rad definiran kao rad skupine ljudi u istom vremenu, na istom prostoru i na istom proizvodnom zadatku. Takav se rad odvija u jednostavnoj ili složenoj suradnji i značajan je za sve razvijene oblike proizvodnje.

Radna je skupina usklađena skupina radnika koja se oblikuje zato da bi kao samostalna jedinica s potrebnim radnim sredstvima obavila radni nalog. Bit je skupnoga rada u boljem povezivanju i izvođenju svih postupaka, od pripreme rada do otpreme šumskih sortimenata kupcu.

Cilj je ovoga istraživanja proučavanje primjene skupnoga rada pri sječi, izradbi, privlačenju i preuzimanju drva u prorednim sastojinama požeškoga gorja. Proučavane su dvije skupine radnika i njihovi ostvaraji u odnosu na tri načina organizacije rada.

Provedbom studija rada i vremena utvrdit će se proizvodnost skupine te norme vremena i norme učinka. Također će se istraživati troškovi za tri različita modela na dvama radilištima, i to pojedinačno za svakoga člana i ukupno za skupinu radnika.

Terenska su istraživanja provedena na području Uprave šuma Požega, koja zauzima 49 486,11 ha, s ukupnom drvnom zalihom od 9 001 835 m^3 te prosječnim godišnjim prirastom od 310 072 m^3 i prosječnim etatom od 204 194 m^3.

Efektivno vrijeme skupine u Kutjevu iznosi 683,09 min/dan ili 66,7 % od ukupnoga vremena. Dodatno vrijeme iznosi 341,38 min/dan ili 33,3 % ukupnoga vremena skupine. Vrijeme sječe i izradbe obojice sjekača iznosi 164,06 min/dan ili 16,0 %, a dodatno vrijeme 185,65 min/dan ili 18,1 % ukupnoga vremena skupine.

Utrošak vremena za obojicu sjekača na vezanju tovara traktora iznosi 111,24 min/dan ili 10,9 % ukupnoga vremena skupine.

Na radilištu u Pleternici jedan sjekač i dva traktora ostvarili su efektivno vrijeme u iznosu od 547,01 min/dan ili 58,8 % od ukupnoga, odnosno 85,8 % od efektivnoga vremena skupine. Dodatno vrijeme iznosi 222,43 min/dan ili 23,9 % od ukupnoga vremena.

Norma vremena za traktor Torpedo u Kutjevu se kreće od 23,94 min/m^3 do 41,81 min/m^3, za Torpedo u Pleternici od 26,46 min/m^3 do 36,02 min/m^3, a Ecotraca u Kutjevu od 25,35 min/m^3 do 41,00 min/m^3 te Ecotraca u Pleternici od 32,88 min/m^3 do 59,07 min/m^3.

Dnevni učinak traktora Torpedo u Kutjevu kreće se od 20,05 m^3/dan do 11,48 m^3/dan pri udaljenostima 50 m do 600 m, Torpeda u Pleternici od 11,48 m^3/dan do 8,43 m^3/dan pri udaljenostima 50 m do 450 m, a Ecotraca u Kutjevu od 18,93 m^3/dan do 11,71 m^3/dan te Ecotraca u Pleternici od 14,60 m^3/dan do 8,13 m^3/dan za udaljenost od 50 m do 550 m.

U modelu 3 ukupni trošak prvoga para na radilištu u Kutjevu za inačicu 2 iznosi 97,75 kn/m^3, a drugoga para 103,28 kn/m^3 te je 39,7 %, odnosno 42,1 % manji u odnosu na model 1 i 23,4 %, odnosno 29,7 % u odnosu na model 2.

Ukupan trošak proizvodnje jedinice proizvoda na radilištu u Pleternici uz traktor Torpedo u modelu 1 iznosi 163,35 kn/m^3, a uz Ecotrac 226,43 kn/m^3 ili 27,9 % više. U modelu 2 troškovi uz Ecotrac veći su 28,1 %, a u modelu 3 za 30,2 % od ukupnih troškova uz Torpedo.

Skupni je rad prihvaćen u hrvatskom šumarstvu i donio je napredak u proizvodnosti. Ova su istraživanja skupnoga rada upozorila na nesavršenost organizacije skupine i potrebe njihove optimizacije. Čimbenici proučavani u ovome radu osnova su takve optimizacije pri kojoj će se bolje iskorištavati radno vrijeme, strojevi raditi svrhovitije i uz niže troškove. Tek takvim optimalnim postavljanjem skupnoga rada njegove prednosti pred klasičnim radom doći će do punoga izražaja.

Ključne riječi: skupni rad, sječa, izrada, privlačenje, kontrola, standardno vrijeme, dnevni učinak, troškovi