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DETERMING THE PRICE OF TRACTOR OPERATION DEPENDING ON THE ANNUAL ENGAGEMENT

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ABSTRACT

The paper presents a calculation of fixed and variable costs for a John Deere 6110 B tractor, depending on the annual engagement of 400 and 600 working hours. Depreciation, interest, insurance, garage, repair and registration costs are calculated as fixed (ownership) costs. The costs of tractor maintenance, fuel and lubricants are presented as variable (operating) costs. The gross salary of workers and profit margin are also calculated. The value of fixed costs was calculated, regardless of the hiring of tractors during the year, 4,910 EUR. Depending on the number of working hours of tractors during the year, variable costs ranged from 14,942 EUR to 21,906 EUR. The price of tractor operation per hour was 62.67 EUR for 400 and 56.73 EUR for 600 hours of operation. With the increase in the annual engagement of tractors from 400 to 600 hours, the costs of labor per hour decreases by 5.94 EUR. In the calculation of the price of tractor work, variable costs participated with 59.61% and 64.36%, fixed costs with 19.59% and 14.42%, workers salaries with 4.95% and 5.46% and profit margin with a share of 15.85% and 15.76% for 400 and 600 hours of work, respectively. Taking into account the calculated costs, the prices of services provided by the tractor and machinery can be realistically determined, so based on that, farmers will choose whether it is more profitable for them to buy a new tractor or to rent a tractor as needed.

Key words: agricultural machinery, fixed costs, labor costs, variable costs.

INTRODUCTION

Modern agricultural production is characterized by use a high degree of mechanization, with the aim of replacing human labor with agricultural machinery and simplifying the agrotechnical operations of tillage, sowing, crop care, harvesting and transport. In order to improve their production, farmers acquire the necessary machinery, but do not use it rationally due to the changing circumstances as well as the economic and market problems they face. Due to the lack of financial resources, they are not always able to buy a new machinery and the poor demographic conditions in the countryside have led to a strong demand for the rent of agricultural machines on rural properties. Agrotechnical center Zlatiborski Eko agrar from Čajetina in cooperation with the municipality, recognized these problems and in order to improve the agriculture of this region, acquired new machinery (tractors with attached machines). In order for the purchase of expensive tractors and agricultural machines to be economically profitable, it is necessary to use them as much as possible during the year. By increasing the annual engagement of mechanization, the achieved output increases and labor costs per hour or hectare decrease. The planned goal of

Eko Agrar is to use the purchased machinery on their farm, as well as to rent it, which would increase the annual hiring of tractors. According to research by Altintas & Ozcelik (2014), in Turkey, 51.97% of tractors are used irrationally with an average annual engagement of 406.07 hours, in Poland it is 312 hours per year (Lorencowich & Uziak, 2015) and in Germany tractors are average used 898 hours annually (Lips & Burose, 2012). In Serbia, tractors are used for 421 hours on family farms, while in companies and cooperatives the average annual engagement is significantly higher - 701 hours (Nikolić et al., 2013). The costs of using machinery have a significant share in the total costs. In the production of arable crops in Sweden, mechanization costs account for 25% (Gunnarson, 2008), in Turkey 30 - 40% of total costs (Basaran & Engindeniz, 2015). According to research by Zimmer et al. (2018), fixed costs have a large share in the total costs of mechanization, so the rational use of mechanization and greater annual engagement are necessary in order for the investment in mechanization to be economically justified. Economic methods, mathematical models and web mobile applications can be used to calculate the costs of agricultural machinery. The most reliable data for calculating the costs of agricultural mechanization is one's own complete records of actual costs (Krmpotić & Kiš, 2005; Busato & Berruto, 2014; Najafi & Torabi Dastgerduei, 2015; Edwards, 2015).

The paper provides an analysis of the total costs (fixed and variable) of the John Deere 6110 B tractor, which was purchased from Eko agrar company, depending on the annual engagement for 400 and 600 hours of work. The resulting calculations can be used to achieve economic profitability and to determine optimal and service prices for tractor operations.

MATERIALS AND METHODS

Data for calculating the costs of the John Deere 6110 B tractor were collected at the Agricultural Technical Center of the Zlatiborski Ekoagrar company from Čajetina, for the 2021 production year. The starting parameters for the calculation of the fixed (ownership) costs of the tractor are the purchase price of the tractor of €50,600, that was paid to the supplier, the liquidation value that is assumed after 12 years of use of the tractor, according to data from the second-hand machinery market. Data from banks were used to calculate interest costs, while the fuel costs were calculated based on the data from Table 1, based on fuel prices on the domestic market in that period.

Table 1. Basic parameters for cost calculation for John Deere 6110 B tractor

Parametres	Value
Nominal power of tractor	81 kW
Engine power utilization rate	80%
Specific fuel consumption	238 g/kWh
Ratio between kg and L of fuel	1kg=1.176 L
Fuel consumption in L/h (Pg)	18.14
Price of fuel*	1,6 €
Purchase value (Vo)	50,600 €
Interest rate (Ks)	3% of Vs
Number of years of tractor use (n)	12
Annual engagement of tractor work	400 and 600 hours
Expected liquidation value (Vn)	21,000
Mean value of the tractor (Vs)	35,800
Insurance costs	1% of Vs
Garage costs	1 % of Vo
Repair costs	0.8% of Vo

* Calculation of fuel price is for 2021

For the calculation of annual depreciation costs, the method of time-proportional depreciation was used according to the parameters listed in Table 1: $A_p = \frac{(V_0 - V_n)}{n}$.

The mean value of the tractor (V_s) is calculated according to formula: $V_s = \frac{(V_0 + V_n)}{2}$.

The annual amount of interest (K_i) for funds engaged for the purchase of the tractor is calculated: $K_i = \frac{(V_0 + V_n)}{2}$ x K_s , where K_s is interest rate on borrowed funds.

Fuel consumption (P_g) was calculated using the formula: $P_g = S_w$ x S_i x S_{pg} x k, where P_g is fuel consumption (L), S_w is tractor PTO power (kW), S_i is degree of engine power utilization in% (80%), S_{pg} is specific fuel consumption (g/kWh), k is consumption conversion factor fuel from kg to L (1kg = 1.176 L).

Profit margin was calculated based on the formula, $P_m = \frac{(F_t + V_t)}{100}$ x 20, where P_m is profit margin, F_t are fixed costs; V_t are variable costs.

The total annual costs of the John Deere 6110 B tractor are calculated based on the fixed (ownership) and variable (operating) costs of the tractor. The salary of the tractor operator and the profit margin are especially calculated for the purpose of more precisely forming the price for service use of the tractor. Depending on the annual engagement of 400 and 600 hours for the John Deere 6110 B tractor, a comparison of the total costs in € and per working hour €/h is given.

RESULTS AND DISCUSSION

Based on the annual engagement of the new John Deere 6110 B tractor for 400 and 600 hours of work, the price of the tractor's working hour was calculated. This tractor was used on the Ecoagrar's farm, as well for service work at other farms in the territory of the municipality of Čajetina. The fixed costs of depreciation, insurance, interest, garage, registration and repair of the tractor have been calculated. In total, these costs are unchangeable and amount to €4,910. Depending on the annual engagement of the tractor, the fixed costs may be lower per hour of work. For engagement of 400 hours they amount to €12.28/h and for 600 hours of work they amount to €8.18/h. With a higher annual engagement of the tractor than 200 hours, the fixed costs are reduced by €4.09/h. The largest share in fixed costs is depreciation costs - €2,467 or 50.24%, followed by interest costs - 21.87%, insurance costs - 10.31%, garage costs - 8.25%, repair costs -7.29% and registration costs - 2.04% (Table 2).

Table 2. Calculation of annual fixed (ownership) costs for John Deere 6110 B tractor depending on engagement (in €)

Annual fixed costs	400 hours	600 hours	Share in %
Depreciation costs	2,467	2,467	50.24
Interest costs	1,074	1,074	21.87
Insurance costs	506	506	10.31
Garage costs	405	405	8.25
Repair costs	358	358	7.29
Registration costs	100	100	2.04
Total annual fixed costs	4,910	4,910	100
Fixed costs per hour of work	12.28	8.18	/

The calculated depreciation costs are 4.87% in relation to the purchase price of the tractor John Deere 6110 B. According to the authors Altintas & Ozcelik (2014), the amount of depreciation is 5.8% of the purchase price of the tractor. Repair costs are included in fixed costs and relate to major repairs such as engine overhaul and are calculated on the basis of 0.8% of

the purchase price of the tractor. In relation to the purchase price of the tractor, the share of fixed costs is 9.7%, which is in agreement with the amount of fixed costs stated by Edwards W. (2015) and lower than the costs for new tractors of approximate power (Zimmer et al., 2018; Sopengo et al., 2016). A larger volume of work and the larger use of tractors affects on the amount of variable costs. Within these costs, the costs of fuel, lubrication and maintenance were calculated. The profit margin and salary of the tractor operator were given separately. With the change in the annual engagement of the tractor from 400 to 600 working hours, the variable costs increased from €14,942 to €21,906. (Table 3).

Table 3. Calculation of variable (operating) costs for tractor John Deere 6110 B depending on engagement (in €)

Annual variable costs	400 hours	%	600 hours	%
Fuel costs	11,608	77.69	17,412	79.49
Lubrication costs	2,322	15.54	3,482	15.89
Maintenace costs	1,012	6.77	1,012	4.62
Total annual variable costs	14,942	100	21.906	100
Total variable costs per hour worked	37.36	/	36.51	/

The increase in variable costs was influenced by fuel costs, which amounted to €11,608 - €17,412 and had a share of 77.69 - 79.49% in total variable costs. Also, fuel costs have a large share in the total costs of the tractor, ranging from 46.31% to 51.15%. The obtained results on the level and share of fuel costs in variable costs are in agreement with the results of Altintas & Ozcelik (2014) and Sopengo et al. (2016). Lubrication costs (costs of oil, lubricants, filters) depend on the annual engagement of the tractor, the skill and knowledge of the tractor driver and working conditions. For the John Deere 6110 B tractor, they amount to €2,322 for 400 and €3,482 for 600 hours of tractor operation. Maintenance costs refer to minor breakdowns, replacement of engine and tractor parts, replacement of tires, and the labor of a mechanic to fix them (Table 3). These costs represent 9.3-10.2% of the total costs, which is in agreement with the results of research by Zimmer et al. (2018) and Lazarus (2021), where lubrication costs account for 10-15% of the total costs. Based on the calculated fixed and variable operating costs of the John Deere 6110 B tractor, with the added profit margin and salary for the tractor operator, the total annual costs were obtained. According to data for the year 2021, the labor costs of a tractor operator are €3.10/h. The profit margin, calculated according to the formula stated in the work method, is 20% of the sum of fixed and variable costs, depending on 400 and 600 hours of annual tractor operation, amounting to €9.93/h and €8.94/h (Table 4).

Table 4. Total costs and prices of John Deere 6110 B tractor services depending on annual engagement (in €/h)

Types of costs	400 hours	600 hours
Fixed costs	12.28	8.18
Variable costs	37.36	36.51
Profit margin	9.93	8.94
Salary of worker	3.10	3.10
Price of tractor service (in €/h)	62.67	56.73
Total annual costs (in €)	25,068	34,038

If the calculation showed only the sum of fixed and variable costs for 400 hours of work, they would amount to €49.64/h. For 600 hours of work they would amount to €44.69/h. The

total operating costs of the tractor, on the basis of which the price of service work is calculated, amount to 62.67 €/h for 400 hours of work, or 56.73 €/h for 600 hours of work (Table 4). Compared to research by Stiles & Stark (2021), the operating costs of a 90-119 kW tractor, with an annual engagement of 600 hours, are €54.32/h, which is close to results in this research. At the authors Sopengo et al. (2016), labor cost is 41 €/h for 75 kW tractors, while the lower cost is 38.70 €/h for annual tractor engagement of 400 hours (Edwards, 2015). The calculated results of the tractor costs in this research cannot be completely in agreement with the results of other researchers, due to differences in the purchase price of the tractor, as well as the value of variable costs due to the large difference in the price of fuel in certain countries, which was also confirmed in the research of Goyal & Singh (2020).

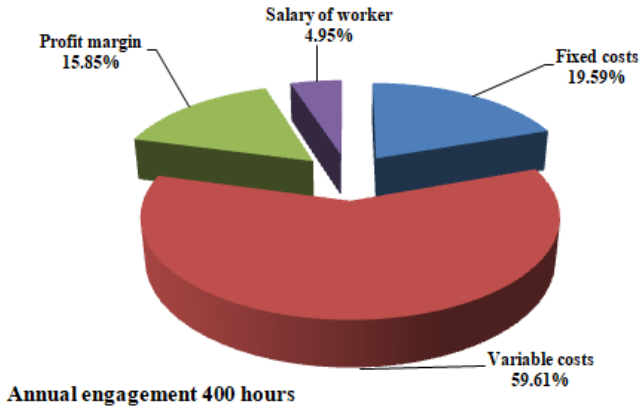

Figure 1. Percentage share of costs in the price of service for John Deere 6110 B tractor for 400 hours of work

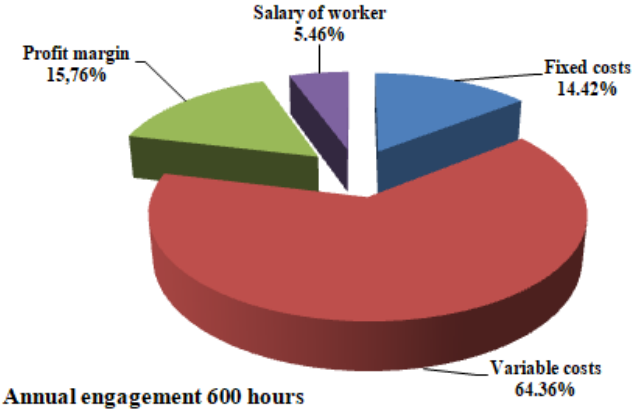

Figure 2. Percentage share of costs in the price of service for John Deere 6110 B tractor for 600 hours of work

In the total operating costs of the tractor, variable costs have the largest share of 59.61% and 64.36% and depend on the number of working hours per year (Figure 1 and Figure 2). Fixed costs are represented by 19.59% and 14.42%, so their influence on the final price of the tractor is smaller. The shown share of fixed costs is in agreement with the researches of Altintas and Ozcelik (2014) and Sopengo et al. (2016). In the case of tractors with less power, the purchase price of the tractor is lower and depreciation costs are lower and their participation in fixed costs is over 50% (Koprivica et al. 2022). In order for the price of tractor services to be

lower and tractors affordable for small farmers, Molenhuis (2020) suggests that the calculated profit margin should be 15% of the total cost of the tractor. Taking into consideration the obtained calculations of tractor operating costs, Ecoagrar does not calculate the profit margin, as well does not calculate the fuel costs of arrival and return from the plot in the area of the municipality of Čajetina. With the acquisition of new tractors and agricultural machinery in this Agrocenter and through the joint use of machinery, the advantages would be recognized and the farmers would possibly join a machinery ring in the future.

CONCLUSIONS

It can be concluded that in fixed (ownership) costs, the largest share is depreciation costs - 50.24%, followed by interest costs - 21.87%, insurance costs - 10.31%, garage costs - 8.25%, repair costs - 7.29% and registration costs - 2.04%. In the calculation of variable (operating) costs, the largest share is fuel costs 77.69 - 79.49%, then lubrication costs 15.54 - 15.89% and regular maintenance 6.77 - 4.62% for 400 and 600 hours of annual engagement of the John Deere 6110 B tractor (power of 81 kW). In the total operating costs of the tractor, variable costs with fuel costs had the largest share. The obtained results will help the company to rationally use agricultural machinery and form the average service cost of tractor operations, as well as other farmers to calculate costs more easily if they rent their machinery.

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