

Research of Consumption of Biodiesel in Different Working Operations in the System of Precision Agriculture

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Abstract

The aim of study was to research the consumption of biodiesel in various working operations of the tractor John Deere 8230 with trailer and plow under field conditions. Biodiesel was made from agricultural crop of oilseed rape according to etherification. Experimental measurements were made on land of the Slovak University of Agriculture, in Koliňany, Slovakia. The metering device was used EDMeco recorder and an electronic flow meter of the actual consumption of biodiesel. The measuring system was installed in the fuel system John Deere tractor, the 8230. On the base of the obtained results we can conclude that at the transportation of the tractor with trailer Mega 20 was the average hourly consumption of 15.43 liters of biodiesel. At the plowing with set of tractor and rotating 7-mouldboard plow Ostroj Opava, the average hourly consumption was of 33.93 liters of biodiesel.

Keywords: biodiesel, consumption, working operation, tractor set

1. Introduction

Fuel consumption is an important efficiency indicator of each vehicle and its technical condition indicator as well. Research of fuel consumption is possible by drive tests or by roller dynamometers stations under laboratory conditions. The issue of fuel consumption and other types of energies resonates in all sectors of national economy for same time as well as in agricultural sector. Agriculture does not belong among the biggest energy consumers, however fuel costs create significant cost item, especially in crop production.

According to practice information, during the technological operations in agriculture, fuel consumption is stated in liters per hour, respectively calculated on one hectare of treated area. These operating indicators of fuel consumption depend on effective utilization of engine power under real conditions as well as on technical engine parameters.

Related to fuel conditions, technical parameters of nowadays produced tractor engines are relatively balanced and fuel conditions are significantly affected by operating conditions of tractor utilization. Different interpreted opinions on fuel consumption of various tractors of different companies occur in practice, at the same time information gathered this way cannot be treated as representative.

Operating conditions in agriculture are variable, so what is valid today, could not be valid tomorrow. If we want to get a realistic view of fuel consumption, and achieve a decreasing of this consumption, it is essential to proceed from concrete data.

Generally considered, diesel engine works with 30 to 35% efficiency. This efficiency is achieved by diesel engine only in optimal mode, i.e. when working in maximal power level and its commensurate optimal fuel consumption.

Main benefit of reciprocating (piston) engines is their easy adjustability, i.e. there is an easy possible way to preset into the various modes with different engine rpm, torque and specific fuel consumption. Another benefit of nowadays produced combustion engines is their significant

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torque rise in wide range of engine rpm, when combustion engine achieves almost constant power value.

These characteristics can be utilized while tractor with implements operation, i.e. it is possible to adjust an economic mode at express conditions,

when combustion engine has low specific fuel consumption and high efficiency. So if we know a diesel price, there is an easy calculation [1, 2]. Informative fuel consumption data are presented in Table 1.

Table 1. Informative diesel consumption data according to working operations [3]

Type of work	Diesel fuel in l/ha			
	Production area			
	maize	sugar beet	potatoes	mountain
secondary tillage	22.3	26.3	22.0	18.7
deep plowing	26.3	31.2	26.0	22.0
harrowing and rolling	5.7	6.7	5.6	4.7
combined loosening	5.9	7.0	5.8	5.0
sowing of cereals and oilseeds	3.8	3.9	4.1	4.3
self loading wagons harvest	7.5	7.8	8.0	7.9

2. Materials and methods

The aim of the study was an effect evaluation of different working operations and used mechanization means on biodiesel consumption of JOHN DEERE 8230 (Figure 3) tractor under operating conditions. Experimental measurements were realized on the land of the Slovak University of Agriculture venture Ltd., in Kolíňany.

Characteristic of used measurement appliances and devices (Table 2).

For consumption measurement EDMeco devise was used as a recorder and electronic flow meter of actual biodiesel consumption, installed into the fuel system of John Deere 8230 tractor (Figure 1, 2). Electronic adapter (flow meter) and EDMeco

recorder type is a technically modest way of actual fuel consumption measurement and recording.

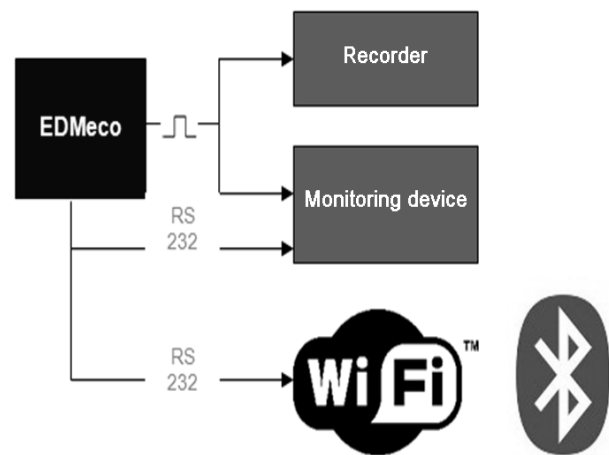


Table 2. Characteristic of used measurement appliances and devices

Technical parameters	Description
Input protocols:	speed, injection valve, EDC signal, CAN
Temperature range:	-30 °C to 70 °C
Supply voltage:	12 V/24 V
Maximal voltage:	32 V
Standby current:	< 40 mA
Maximal current:	< 100 mA
Consumption at 12 V output signal:	max. 0.8 mA

EDMeco is the electronic flow meter – fuel consumption adapter. It is a unique, simple system with significant value in use and high return, which is designed for cartage and bus service and mechanization vehicles sector (construction side

and agricultural vehicles). EDMeco can be used in combination with off-line recorders. EDMeco system is used for actual fuel consumption measurement. Main benefit of the system is its price and possible use within motor vehicles and

mechanization vehicles with data communication and activation functions, which interpret actual fuel consumption.



Figure 1. EDMeco recorder and electric flow meter



Figure 2. USB key for measured data transfer

We used tractor in aggregation with different mechanization means:

- JD 8230 + tractor trailer Mega 20,
- JD 8230 + rotating 7-mouldboard plow - Ostrom Opava.

Full characteristic of devices is described in result and discussion chapter.

Conditions and working flow of experimental measurements

Effect evaluation of different working operations and used mechanization means was focused on:

- Average per hour consumption at working operation,
- Average per hour consumption at working operation + supporting operations.

Methods of experiment evaluation

We used QUATRO PRP 4.0 version and HARVARD GRAFICS program, as well as EXCEL and WORD programmes for mathematical-statistical and graphical evaluation, as well as for measured results processing.

3. Results and discussion

We monitored a biodiesel consumption of selected tractor sets under operating conditions of Slovak University of Agriculture venture Ltd., in Koliňany.

3.1 Characteristic of mechanization means used in individual sets

We evaluated a tractor in the set with tractor trailer Mega 20 (Figure 4) and with rotating 7-mouldboard plow - Ostrom Opava (Figure 5).



Figure 3. Universal tractor John Deere 8230

Technical information of tractor:

- power rating (ECE-R24).....177/240 kW/k,
- maximal power (ECE-R24).....192/260 kW/k,
- engine displacement.....9 liters,
- consumption on engine braking.....197 g/k Wh,
- transmission – speed number.....
AutoPowerShift-16/5,
- maximal hydraulic lifting capacity.....105,8 kN,
- splined driveshaft.....540/1000.



Figure 4. Tractor trailer Mega 20

Technical information of trailer:

- payload.....14570 kg,
- maximal permissible weight of loaded vehicle....
.....20 000 kg,
- maximal permissible weight on axletree.....
.....1- 9 000 kg, 2- 9 000 kg,
- vertical load of lifting eye nut.....2 000 kg,
- body capacity without/ with body..... 22/29 m³,
- vehicle size – total length.....7890 mm,
- total width.....2650 mm.



Figure 5. Rotating 7-mouldboard plow - Ostrój Opava

Technical information of plow:

- number of mouldboards.....7,
- mouldboards drag.....35/40/45/50 cm,
- setup.....adjustable/continuous,
- profile of frame.....180x180 mm,
- clearance frame height.....80 cm,
- mouldboards spacing.....102 cm,
- plow protection.....T-screw,
- guide plates, skimmers, transport wheel.

3.2 Results of fuel consumption operating measurements of monitored agricultural sets.

3.2.1 Comparison of per hour fuel consumption at transportation and plowing (working operation – working operation and supporting operations)

The results of experimental measurements comparison of average per hour fuel consumption at **transportation** and **plowing** are presented in Table 3 and Figure 6.

The results of comparing values of working operations, when fuel consumption of supporting working operations is included are presented in Figure 7.

Table 3. Average per hour fuel consumption

Working operation Tractor set	Average per hour fuel consumption (WORKING OPERATION), l/h	Average per hour fuel consumption (WORKING OPERATION + SUPPORTING OPERATIONS), l/h
TRANSPORTATION, JD 8230 + trailer Mega 20	15.43	13.71
PLOWING, JD 8230 + 7-mouldboard plow - Ostrój Opava	33.93	21.03

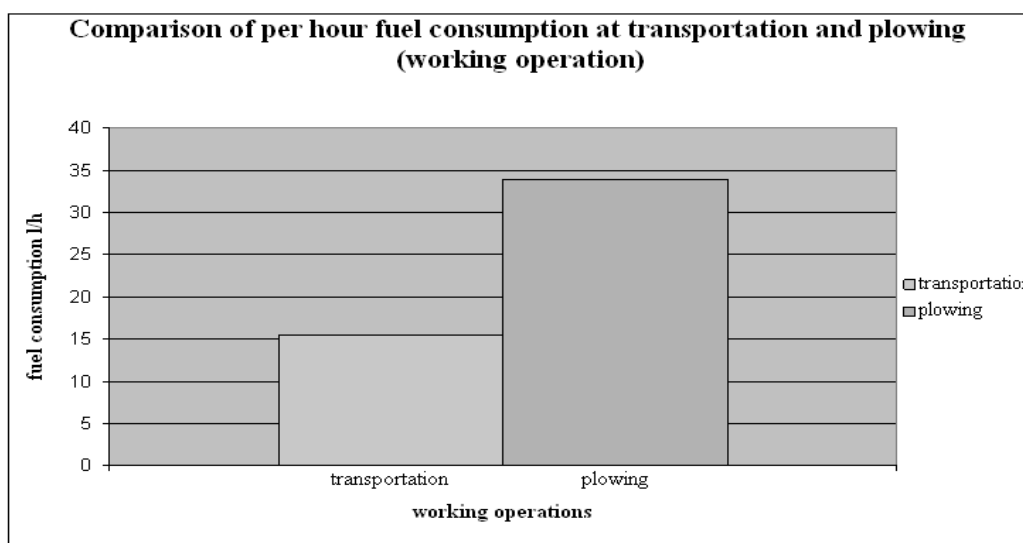


Figure 6. Average per hour consumption values for transportation and plowing

We can allege according to obtained values, that average per hour biodiesel consumption at transportation is 15.43 l/h and 33.93 l/h at

plowing. It is fuel consumption at the main time, i.e. directly during monitored working operation.

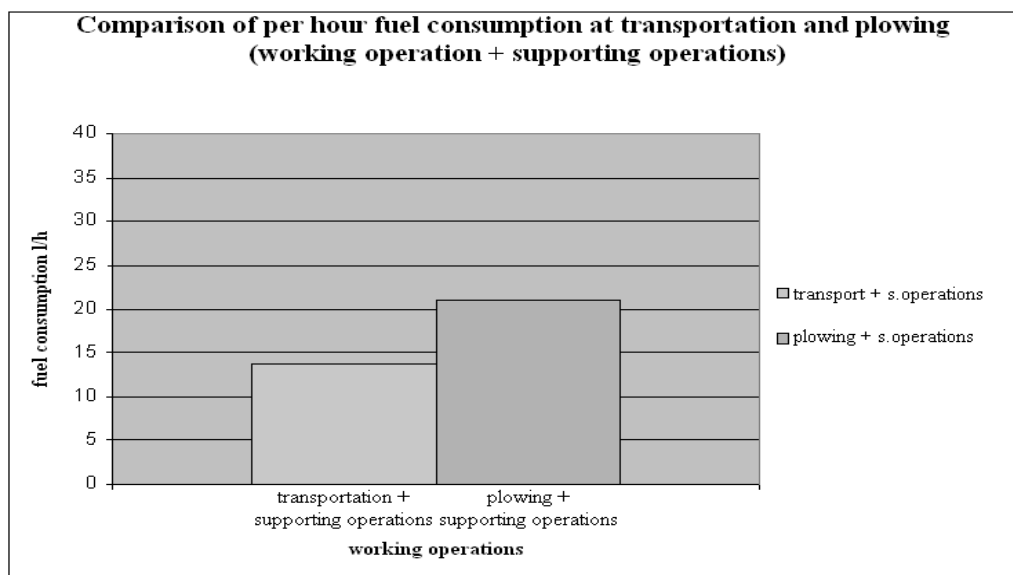


Figure 7. Average per hour consumption values for transportation and plowing and supporting operations

Figure 7 presents an average per hour biodiesel consumption at monitored working operations together with supporting working operations, when value at transport is 13.71 l/h and 21.03 l/h at plowing.

3.2.2 Comparison of per hour fuel consumption within transportation and plowing

The results of experimental measurements comparison of average per hour fuel consumption at **transportation** are presented at Figure 8 and in Figure 9 for **plowing**.

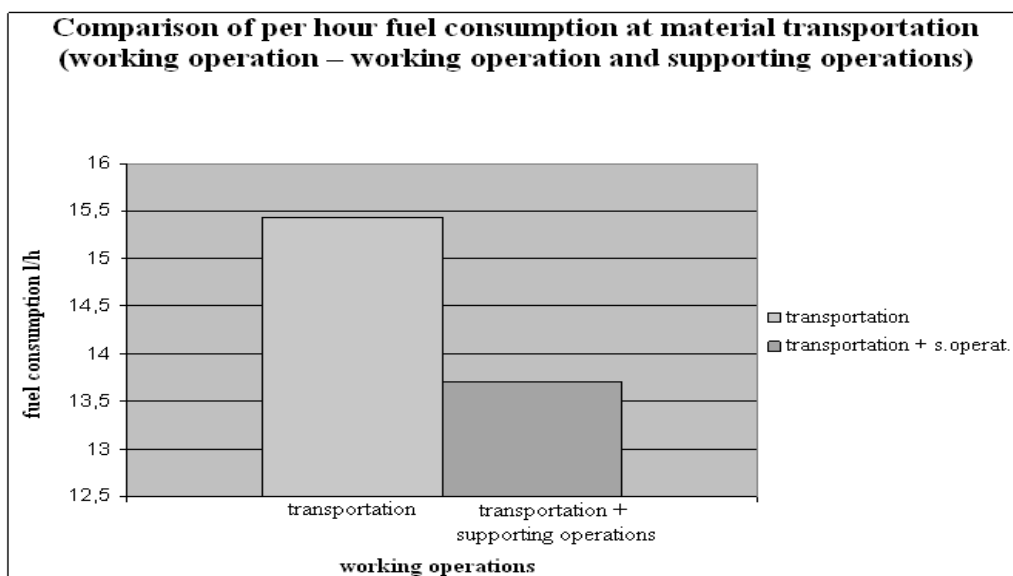


Figure 8. Average per hour consumption for transportation and transportation with supporting operations

The results of experimental measurements comparison of average per hour fuel consumption at material **transportation** show a value of 15.43

l/h and lower value of 13.71 l/h at transportation with supporting operations.

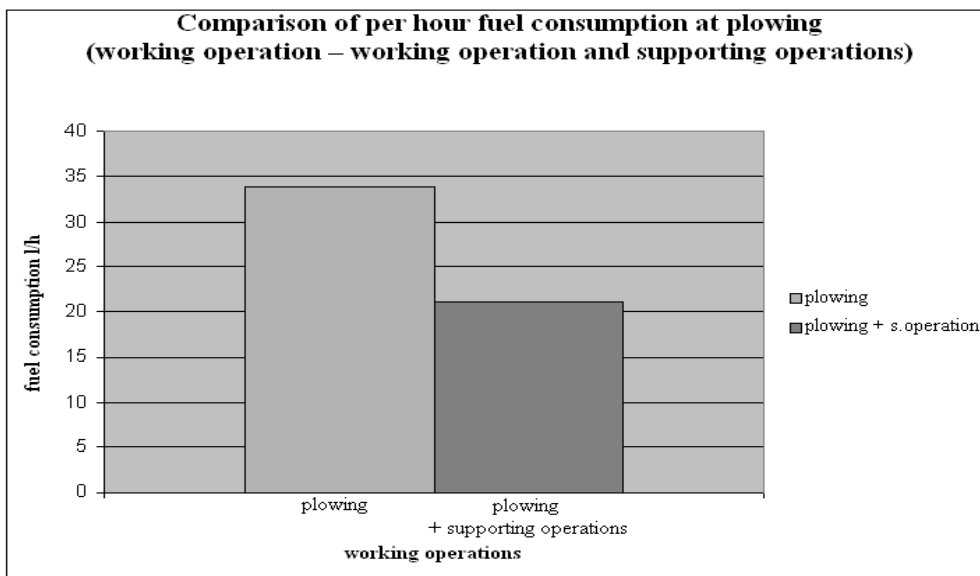


Figure 9. Average per hour consumption for plowing and plowing with supporting operations

Figure 9 shows different values of average per hour fuel consumption, 33.99 l/h at plowing and 21.03 l/h at plowing with supporting operations.

4. Conclusions

Based on obtained results and their evaluation, we can allege, that fuel consumption measurement is a difficult process, because several factors affects the tractor sets work, i.e. fuel consumption under agricultural conditions. Among affecting factors belong soil conditions, soil moisture, soil structure etc.

Operating conditions in agriculture are variable, so what is valid today, could not be valid tomorrow. If we want to get a realistic view of fuel consumption, and achieve a decreasing of this consumption, it is essential to proceed from concrete data. Conditions of our monitored period of soil treating were very difficult, because of the dry and heavy soil in autumn.

We can allege, based on obtained results that fuel consumption at the main time, i.e. during monitored working operation was different. At the tractor set transportation with trailer Mega 20, the average per hour biodiesel consumption was 15.43 liters. At the tractor set plowing with rotating 7-

mouldboard plow - Ostroj Opava, the average per hour biodiesel consumption was 33.93 liters.

It is essential to mention, that average per hour biodiesel consumption during monitored working operations together with supporting operations is lower, when transportation value is 13.71 l/h and 21.03 l/h during plowing.

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References

- Jablonický, J., Žikla, A., Sloboda, A., Tkáč, Z., Müllerová, D., Motorové vozidlá I. first ed., SPU, Nitra, 2010, pp. 97, ISBN 978-80-552-0474-1
- Bauer, F., Sedlák, P., Šmerda, T., Traktory, Nakladatelství Profi Press, s.r.o., Praha, 2006, ISBN 80-86726-15-0
- Žikla, A., Jablonický, J., Reálný pohľad na spotrebu paliva, Roľnícke noviny, 2010, 81, pp. 15, ISSN 1335-440X
- Vlk, F., Vozidlové spalovací motory., first ed. Nakladatelství a vydavatelství VLK, Brno, 2003, ISBN 80-38-8756-4